Various Functions Via Supra Soft-gpr-Closed Sets in Soft Supra Topological Spaces

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***Abstract*: The aim of this paper is to define and study the concepts of supra soft gpr-continuous,supra soft gpr-irresolute, supra soft contra gpr-continuous and supra soft almost contra gpr-continuous functions in soft supra topological spaces. Also we obtain some of their characterization.**

***Keywords*: Supra soft gpr-continuous, supra soft gpr-irresolute, supra soft conta gpr-continuous, supra soft almost contra-gpr-continuous.**

1. Introduction

The soft set theory is a rapidly processing field of mathematices. Soft set theory was initiated by **Molodtsov[14]** as a new method for vagueness. **Levine [13]** introduced g-closed sets in general topology. **Kannan [11]** developed soft g-closed sets in soft topological spaces. **Hussain et al [9]** continued to study the properties of soft topological space. In 2013, **Cigdem Gunduz Aras et al., [5]** studied and discussed the properties of soft continuous mappings which are defined in an initial universe set with a fixed set of parameters. In 1996, **Dontchev [6]** introduced the notion of contra continuous functions. **Singal et al., [15]** discussed the concept of almost continuity in topological spaces. **Erdal Ekici [7]** introduced the notion of almost contra-pre-continuous functions in topological spaces in 2004. In 2015, **Arockiarani, Selvi [1,2]** introduced the concept of contra πg-continuous functions and almost πg- continuous functions in soft topological spaces. **Janaki and Sreeja [10]** discussed the notion of conta πgb- continuous finctions in soft topological spaces.

El-Sheikh and **Abd El-Latif [8]** presented the concept of supra soft topological spaces, which is wider and more general than the class of soft topological spaces. They introduced a unification of some types of different kinds of subsets of supra soft topological spaces using the notion of γ-operation and studied the decompositions of some forms of supra soft continuity. After that, **Kandil et al [12]** studied the concept of soft supra g-closed sets in supra soft topological spaces, which is generalized in **[3]**.

The purpose of this paper is to introduce the concepts of supra soft- gpr-continuous, supra soft-conta-gpr continuous, supra soft almost-gpr continuous, supra soft almost-gpr-continuous and obtain some characterization of these mappings .

2. Preliminaries

Let X be an initial universe set and E be the set of all possible parameters with respect to X, where parameters are the characteristics or properties of objects in X. Let P (X) denote the power set of X, and let $A \subseteq E$.

Definiton[2.1][3]:

A pair (F, A) is called a soft set in X where $A \subseteq E$ and $F : A \rightarrow P(X)$ is a set valued mapping. In other words, a soft set in X is a parameterized family of subsets of the universe X. For $\forall e \in A$, F(e) may be considered as the set of e -approximate elements of the soft set (F,A). It is worth noting that F(e) may be arbitrary. Some of them may be empty, and some may have nonempty intersection.

Definiton [2.2][16]:

A soft set (F, A) in U is said to be a null soft set denoted by φ if for all $e \in A$, F(e) =φ . A soft set (F, A) in U is said to be an absolute soft set denoted by A if for all $e \in A$, F(e) =U .

Definition [2.3][4]:

Let Y be a nonempty subset of X, then $\tilde{Y}$ denotes the soft set (Y, E) in X for which Y (e) = Y , for all $e \in E$. In particular, (X, E) will be denoted by $\tilde{X}$.

Definition[2.4][16]:

For two soft sets (F, A) and (G, B) in a common universe X.
The union of two soft sets (F, A) and (G, B) is the soft set (H, C), where $C = A \cup B$ and for all $e \in C$,

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

We write $(F, A) \cup (G, B)=(H, C)$.

Definition [2.5][4]

Let $\tilde{\tau}$ be the collection of soft sets in a universe X with a fixed set of parameters E, then $\tilde{\tau}$ is said to be a soft topology on X.

(1) $\varphi, \tilde{X} \in \tilde{\tau}$

(2) the union of any number of soft sets in $\tilde{\tau}$ belongs to $\tilde{\tau}$.

(3) the intersection of any two soft sets in $\tilde{\tau}$ belongs to $\tilde{\tau}$.

The triplet (X, $\tilde{\tau}$,E) is called a soft topological space. Every member of $\tilde{\tau}$ is called a soft open set. A soft set (F, E) is called soft closed in X if $(F,E)^c \in \tilde{\tau}$.

Definition [2.6][3]:

Let μ be the collection of supra soft sets in a universe X with a fixed set of parameters E, then μ is said to be a supra soft topology on X if

(1) $\varphi, X \in \mu$

(2) the union of any number of soft sets in μ belongs to μ .

The triplet (X, μ ,E) is called a supra soft topological space.

Every member of μ is called a supra soft open set. A soft set (F,E) is called supra soft closed set in X if (F, E)$^c \in \mu$.

Definition [2.7][17]:

Let (X, μ ,E) be a supra soft topological space and (F,E) be a supra soft set in X.

(i) a supra soft semi open if (A, E) $\subseteq$((A, E)^{os}) $^{-s}$

(ii) a supra soft regular open if (A, E)= ((A, E)$^{-s}$)^{os}.

(iii) a supra soft α-open if (A, E) $\subseteq$ (((A, E)^{os})$^{-s}$)^{os}

(iv) a supra soft b-open if (A, E) $\subseteq$((A, E)^{os})$^{-s}$ ((A, E)$^{-s}$)^{os}

(v) a supra soft pre-open set if (A, E) $\subseteq$((A, E)$^{-s}$)^{os}.

(vi) a supra soft clopen is (A, E) is both supra soft open and supra soft closed.

Definition [2.8][17]:

(1) A supra soft regular generalized closed set(supra soft rg-closed) if (F, E) $^{-s}$ $\subseteq$(G, E) and (G, E) is supra soft regular open in U.

(2) A supra soft α -generalized closed set (supra soft α g-closed) if (F, E) $^{-\alpha s}$ $\subseteq$(G, E) and (G, E) is supra soft open in U.

(3) A supra soft generalized semi closed set (supra soft gs-closed) if (F, E) $^{-ss}$ $\subseteq$(G, E) and (G, E) is supra soft open in U.

(4) A supra soft generalized regular set(supra soft gr-closed) if (F, E) $^{-sr}$ $\subseteq$(G, E) and (G, E) is supra soft open in U.

(5) A supra soft generalized closed (supra soft g-closed) in U if (F, E)$^{-s}$ $\subseteq$ (U, E) whenever (A, E) $\subseteq$ (U, E) and (U, E) is supra soft open in U.

Definition [2.9][17]:

Let (U, μ ,E) be a supra soft topological space in U. A soft set (F, E) is called a supra soft generalized pre-regular closed set (supra soft gpr-closed) in U if (F, E) $^{-sp}$ $\subseteq$ (G, E) whenever (F, E) $\subseteq$ (G, E) and (G, E) is supra soft regular open in U.

3. Supra soft-gpr-continuous and irresolute functions

Definition [3.1]:

Let (X, μ ,E) and (Y, μ^*, E) be two supra soft topological spaces and $f:(X,\mu,E)\rightarrow(Y,\mu^*,E)$ be a function. Then the function f is said to be supra soft-gpr –continuous function if $f^{-1}(F,E)$ is supra soft-gpr-closed set in (X, μ ,E), for every supra soft closed set (F,E) of (Y, μ^*, E).

Definition [3.2] :

A supra soft topological space X is called supra soft gpr- space if every supra soft gpr- closed set is supra soft closed.

Definition [3.3]

Let (U, μ ,E) be a supra soft topological space over U and (F, E) be a supra soft set over U.

(1) The supra soft gpr-closure of (F, E) is the supra soft set gpr-(F, E)$^{-s}$ = $\cap$ {(G, E) : (G, E) is supra soft gpr-closed and (F, E) $\subseteq$ (G, E)}.

(2) The supra soft gpr-interior of (F, E) is the supra soft gpr-set (F, E)^{os} = $\cup$ {(H, E): (H, E) is supra soft gpr-open and (H, E) $\subseteq$ (F, E).

Clearly, gpr-(F, E)$^{-s}$ is the smallest supra soft gpr-closed set over U which contains (F, E) and gpr-(F, E)^{os} is the largest supra soft gpr-open set over U which is contained in (F, E).

Definition [3.4]:

Let (X, μ ,E) and (Y, μ^*, E) be two supra soft topological spaces and $f:(X,\mu,E)\to(Y,\mu^*,E)$ be a function. Then the function f is

(i) supra soft - gpr-open, if f (F, E) is supra soft-gpr-open set in (Y, μ^*, E), for every supra soft-open set (F,E) of (X, μ ,E).

(ii) supra soft-gpr-closed, if f (F, E) is supra soft-gpr-closed set in (Y, μ^*, E), for every supra soft-closed set (F,E) of (X, μ ,E).

Definition [3.5]:

Let (X, μ ,E) and (Y, μ^*, E) be two supra soft topological spaces and $f:(X,\mu,E)\to(Y,\mu^*,E)$ is said to be

(1) supra soft -semi-continuous, if $f^{-1}(F,E)$ is supra soft - semi open in (X, μ ,E) , for every supra soft-open set (F,E) of (Y, μ^*, E).

(2) supra soft-rg-continuous, if $f^{-1}(F,E)$ is supra soft -rg-open in (X, μ ,E) , for every supra soft-open set (F,E) of (Y, μ^*, E).

(3) supra soft-gr-continuous, if $f^{-1}(F,E)$ is supra soft -gr-open in (X, μ ,E) , for every supra soft-open set (F,E) of (Y, μ^*, E).

(4) supra soft - πgs -continuous, if $f^{-1}(F,E)$ is supra soft - πgs -open in (X, μ ,E) , for every supra soft-open set (F,E) of (Y, μ^*, E).

(5) supra soft - αg -continuous, if $f^{-1}(F,E)$ is supra soft - αg -open in (X, μ ,E) , for every supra soft-open set (F,E) of (Y, μ^*, E).

Theorem [3.6]:

1. Every supra soft - continuous function is supra soft- gpr - continuous function.
2. Every supra soft - rg- continuous function is supra soft- gpr - continuous function.
3. Every supra soft - αg - continuous function is supra soft- gpr - continuous function.
4. Every supra soft - gs- continuous function is supra soft -gpr - continuous function.
5. Every supra soft - gr- continuous function is supra soft- gpr - continuous function.
6. Every supra soft - πgs -continuous function is supra soft- gpr - continuous function.

Proof:

The proof follows from the definition.

Remark [3.7] :

The converse of the above theorem need not be true as shown in the following example.

Example [3.8]:

Let X={a,b,c}=Y, E={e_1 ,e_2} and F_1, F_2,F_3, F_4, F_5, F_6 are functions from E to P(X) and are defined as follows
$F_1(e_1)$ = {X}, $F_1(e_2)$ ={a}, $F_2(e_1)$ = {b}, $F_2(e_2)$ ={a}, $F_3(e_1)$ = {X}, $F_3(e_2)$ ={a,b},
$F_4(e_1)$ = { ϕ }, $F_4(e_2)$ ={c}, $F_5(e_1)$ = {X}, $F_5(e_2)$ ={a,c}, $F_6(e_1)$ = {b}, $F_6(e_2)$ ={a,c}.

Then $\mu_1=\{X,\phi,(F_1,E),\ldots(F_6,E)\}$ is a supra soft topology and elements in μ_1 are supra soft-open sets.
Let H_1, H_2, H_3 , H_4, H_5 are functions from E to P(Y) and are defined as follows
$H_1(e_1)$ ={a}, $H_1(e_2)$ = {b}, $H_2(e_1)$ ={a,b}, $H_2(e_2)$ = { ϕ }, $H_3(e_1)$ ={a}, $H_3(e_2)$ = { ϕ },
$H_4(e_1)$ ={b,c}, $H_4(e_2)$ = {c}, $H_5(e_1)$ ={a,c}, $H_5(e_2)$ = {X}.

Then $\mu_2=\{X,\phi,(H_1,E),\ldots(H_5,E)\}$ is a supra soft topology on Y. Let $f:(X,\mu_1,E)\to(Y,\mu_2,E)$ be an identity function.

(1) Here the inverse image of the supra soft- open set $(H_1,E)=\{\{a\},\{b\}\}$ in Y is supra soft -gpr-open set in X, but not supra soft-open set in X. Hence supra soft-gpr-continuous need not be supra soft continuous.
(2) The inverse image of the supra soft- open set $(H_2,E)=\{\{a,b\},\{\phi\}\}$in Y is supra soft -gpr-open set in X, but not supra soft-rg-open set in X. Hence supra soft- gpr-continuous need not be supra soft-rg-continuous.
(3) The inverse image of the supra soft- open set $(H_4,E)=\{\{a,c\},\{X\}\}$ in Y is supra soft -gpr-open set in X, but not supra soft -αg -open set in X. Hence supra soft- gpr-continuous need not be supra soft-αg - continuous .

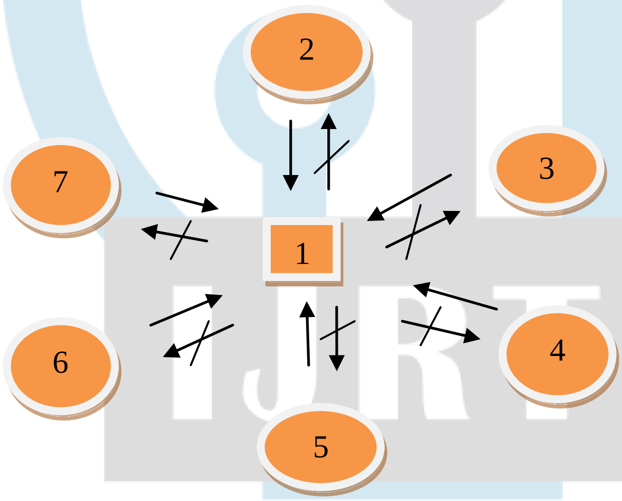
Example [3.9]:

Let X={a,b,c}=Y, E={e_1 ,e_2} and F_1, F_2,F_3, F_4 , F_5, F_6 are functions from E to P(X) and are defined as follows;
$F_1(e_1) = \{X\}$, $F_1(e_2) =\{a\}$, $F_2(e_1) = \{b\}$, $F_2(e_2) =\{a\}$, $F_3(e_1) = \{X\}$, $F_3(e_2) =\{a,b\}$,
$F_4(e_1) = \{\phi\}$, $F_4(e_2) =\{c\}$, $F_5(e_1) = \{X\}$, $F_5(e_2) =\{a,c\}$, $F_6(e_1) = \{b\}$, $F_6(e_2) =\{a,c\}$.

Then $\mu_1 = \{X,\phi,(F_1,E),...(F_6,E)\}$ is a supra soft topology and elements in μ are supra soft-open sets.

Let G_1, G_2, G_3 , G_4, G_5, G_6, G_7, G_8 ,G_9 ,G_{10}, G_{11} are functions from E to P(Y) and are defined as follows;
$G_1(e_1) =\{b,c\}$,$G_1(e_2) = \{b,c\}$,$G_2(e_1) =\{a,c\}$,$G_2(e_2) = \{a,b\}$, $G_3(e_1) =\{a,c\}$, $G_3(e_2) = \{a,c\}$, $G_4(e_1) =\{b\}$, $G_4(e_2) = \{b,c\}$, $G_5(e_1) =\{c\}$, $G_5(e_2) = \{b\}$, $G_6(e_1) = \{c\}$, $G_6(e_2) = \{c\}$, $G_7(e_1) = \{a,c\}$, $G_7(e_2) = \{a\}$, $G_8(e_1) = \{\phi\}$, $G_8(e_2) = \{b\}$, $G_9(e_1) = \{c\}$, $G_9(e_2) = \{\phi\}$, $G_{10}(e_1) = \{\phi\}$, $G_{10}(e_2) = \{c\}$, $G_{11}(e_1) = \{\phi\}$, $G_{11}(e_2) = \{b\}$.

Then $\mu_2 = \{X,\phi,(G_1,E),...(G_{11},E)\}$ is a supra soft topology on Y. Let $f:(X,\mu_1,E)\to(Y,\mu_2,E)$ be an identity function.
(4) Here the inverse image of the supra soft- open set $(G_4,E)=\{\{b\},\{b,c\}\}$ in Y is supra soft -gpr-open set in X, but not supra soft-gs-open set in X. Hence supra soft -gpr-continuous need not be supra soft-gs-continuous.
(5) Here the inverse image of the supra soft- open set $(G_2,E)=\{\{a,c\},\{a,b\}\}$ in Y is supra soft -gpr-open set in X, but not supra soft-gr-open set in X. Hence supra soft- gpr-continuous need not supra soft -gr-continuous
(f) The inverse image of the supra soft- open set $(G_6,E)=\{\{c\},\{c\}\}$in Y is supra soft -gpr-open set in X but not supra soft- πgs -open set in X. Hence supra soft- gpr-continuous need not supra soft - πgs -continuous



1. supra soft-gpr-continuous 2.supra soft-rg-continuous 3.supra soft- αg -continuous 4. supra soft-gs-continuous 5. supra soft- gr -continuous 6.supra soft - πgs -continuous

Theorem[3.10]:

Let f : (X, μ ,E) → (Y, μ', E) be supra soft topological function, and the following are equivalent:

[1] f is supra soft-gpr-continuous.

[2] The inverse image of every supra soft-open set in (Y, μ', E) is also supra soft-gpr-open set in (X, μ ,E).

Proof :

[1]→[2] Let (F,E) be supra soft-open set in (Y, μ', E) then Y-(F,E) be an supra soft-closed set in (Y, μ', E). Since f is supra soft-gpr-continuous, so f^{-1} (Y-(F,E)) is an supra soft gpr-closed set in X. Hence [X- f^{-1} (F,E)] belongs to supra soft-gpr-closed set in X. Then f^{-1} (F,E) is supra soft-gpr-open set in X.

[2]→[1] Follows from the definition.

Theorem[3.11]:

Let (X, μ ,E) and (Y, μ', E) be supra soft topological space and let f : (X, μ ,E) → (Y, μ', E) be a map. Then f is supra soft-gpr-continous if and only if the inverse image of every supra soft closed in (Y, μ', E) is supra soft gpr-closed in (X, μ ,E).

Proof:

Let (F,E) be supra soft closed set in (Y, μ' ,E). Then Y-(F,E) is supra soft open in (Y, μ' ,E). Since f is supra soft-gpr continous, f^{-1}(Y-(F,E)) is supra soft-gpr open. But f^{-1}(Y-(F,E)) =X- f^{-1}(F,E) , thus f^{-1}(F,E) is supra soft-gpr-closed in (X, μ ,E).

Conversely, let (G,E) be an supra soft-open subset in (Y, μ', E). Then Y-(G,E) is supra soft- closed in (Y, μ', E). Since the inverse image of each supra soft- closed subset in (Y, μ', E) is supra soft gpr-closed in (X, μ, E). We have f^{-1}(Y-(G,E)) is to be supra soft-gpr-closed in (X, μ, E). But f^{-1}(Y-(G,E)) =X- f^{-1}(G,E). Thus f^{-1}(G,E) is supra soft gpr-open. Therefore f is supra soft gpr-continous.

Theorem [3.12] :

If a funcwtion f : (X, μ ,E) → (Y, μ', E) is supra soft gpr-continuous if and only if $f(gpr\ -(F,E)^{-s}) \subset (F,E)^{-s}$ for every supra soft open set (F,E) of X.

Proof:

Let f : (X, μ ,E) → (Y, μ', E) be supra soft-gpr-continuous and $(F,E) \subset X$. Then $(f(F,E))^{-s}$ is supra soft closed in Y. Since f is supra soft-gpr continuous, $f^{-1}((f(F,E)^{-s}))$ is supra soft gpr-closed in X and $(F,E) \subset f^{-1}(f(F,E)) \subset f^{-1}((f(F,E))^{-s})$. As gpr- $(F,E)^{-s}$ is the smallest supra soft-gpr-closed set containing (F,E), $gpr\ -(F,E)^{-s} \subset f^{-1}((f(F,E))^{-s})$. Hence $f(gpr\ -(F,E)^{-s}) \subset (f(F,E))^{-s}$.

Conversely, Let (G,E) be any supra soft closed set of Y. Then $f^{-1}(G,E) \in X$ and so $f(gpr\ -(F,E)^{-s}) \subset (f(f^{-1}(F,E)))^{-s}$.Therefor $f(gpr\ -(f^{-1}(G,E))^{-s}) \subset (G,E)^{-s}$ which implies that $gpr\ -(f^{-1}(G,E))^{-s} \subset f^{-1}(G,E)$. In general $f^{-1}(G,E) \subset gpr\ -(f^{-1}(G,E))^{-s}$. Thus $f^{-1}(G,E) = gpr\ -(f^{-1}(G,E)^{-s})$. Hence $f^{-1}(G,E)$ is supra soft-gpr-closed. Therefore f is supra soft-gpr-continuous.

Theorem [3.13] :

If a function f : (X, μ ,E) → (Y, μ', E) is supra soft gpr-continuous if and only if $f^{-1}(G,E)^{os} \subset (gpr-(f^{-1}(G,E))^{os})$ for every supra soft open set (G,E) of X.

Proof :

Let f : (X, μ ,E) → (Y, μ', E) be supra soft gpr-continuous. Now $(f(G,E))^{os}$ is supra soft open set in Y. Then by the supra soft gpr-continuity of f, $f^{-1}((f(G,E))^{os})$ is supra soft gpr-open and $f^{-1}((f(G,E))^{os}) \subset (G,E)$. As gpr-$(G,E)^{os}$ is the largest supra soft gpr-open set contained in (G,E), $f^{-1}((f(G,E))^{os}) \subset gpr-(G,E)^{os}$. Conversely, assume that, $f^{-1}((G,E)^{os}) \subset gpr-(f^{-1}(G,E))^{os}$ for every supra soft open set (G,E) of X. Then $f^{-1}(G,E) \subset gpr-(f^{-1}(G,E))^{os}$. In general $gpr-(f^{-1}(G,E))^{os} \subset f^{-1}(G,E)$.Therefore $f^{-1}(G,E) = gpr-(f^{-1}(G,E))^{os}$. Hence f^{-1}(G,E) is supra soft-gpr-open. This proves that f is supra soft-gpr-continuous.

Theorem [3.14]:

Let f : (X, μ ,E) → (Y, μ', E) be supra soft closed function and g:(Y,μ′,E)→(Z, μ^* ,E) be supra soft -gpr-closed function, then gof: (X, μ, E) → (Z, μ*, E) is supra soft -gpr-closed set.

Proof:

Let (F,E) be supra soft-closed set in (X, μ, E). Then f(F, E) is supra soft-closed set in (Y, μ ′, E). Since g is supra soft-gpr-closed function, g(f(F,E)) is supra soft-gpr -closed in (Z, μ^* ,E). Then gof is supra soft-gpr- closed set.

Definition [3.15] :

Let (X, μ, E) and (Y, μ ′, E) be two supra soft topological spaces and let f : (X, μ ,E) → (Y, μ ′,E) is said to be supra-soft gpr-irresolute if f^{-1}(G, E) is supra-soft gpr-closed set in (X, μ, E), for every supra-soft gpr- closed set (G, E) of (Y, μ′, E).

Theorem [3.16] :

Let (X,μ,E) be a supra soft-gpr-space. If f: (X, μ ,E) → (Y, μ ′,E) is surjective, supra soft closed and supra soft-gpr-irresolute ,then (Y, μ ′,E) is a supra soft-gpr-space.

Proof :

Let (F,E) be a supra soft-gpr-closed subset of (Y, μ ′,E). Since f is supra soft-gpr-irresolute, $f^{-1}(F,E)$ is supra soft-gpr-closed subset of (X,μ,E). Since (X,μ,E) is supra soft-gpr-space, $f^{-1}(F,E)$ is a supra soft-closed subset of (X,μ,E) . Since f is supra soft-closed function, f^{1}(f(F,E)) is supra soft closed set in (Y, μ ′,E). Then (F,E) is supra soft closed set in (Y, μ ′,E) .Hence (Y, μ ′,E) is a supra soft-gpr-space.

Theorem [3.17] :

Every supra soft-gpr-irresolute function is supra soft-gpr-continuous.

Proof :

Assume that f is supra soft gpr-irresolute. Let (G,E) be a supra soft- closed set in (Y, μ^{*}, E). Every supra soft closed set is supra soft-gpr-closed. This implies (G,E) be a supra soft gpr-closed set in (Y, μ^{*}, E). Since f is supra soft gpr-irresolute , $f^{-1}(G,E)$ is supra soft- gpr- closed set in (X, μ ,E) . Hence f is supra soft-gpr-continuous.

Remark [3.18] :

Converse of the above theorem need not be true.

Example [3.19] :

Let X={a,b,c}=Y , E={e_1,e_2} and F_1,F_2, F_3,F_4 are functions from E→P(X) and are defined as follows;

$F_1(e_1)$ = {a,b}, $F_1(e_2)$ = {b}, $F_2(e_1)$={φ}, $F_2(e_2)$ = {a,c},
$F_3(e_1)$={a,c}, $F_3(e_2)$ = {X}, $F_4(e_1)$={a}, $F_4(e_2)$ = {b}.

Then μ={X,φ, (F_1,E), (F_2,E) ,(F_3,E), (F_4,E)} is a supra soft topology and elements in μ are supra soft-open sets.

Let G_1,G_2, G_3,G_4......G_7 are functions from E→P(Y) and are definend as follows;

$G_1(e_1)$ = {a}, $G_1(e_2)$ = {b}, $G_2(e_1)$={b}, $G_2(e_2)$ = {c}, $G_3(e_1)$={a,b}, $G_3(e_2)$ = {b,c}, $G_4(e_1)$={c}, $G_4(e_2)$ = {b} ,$G_5(e_1)$ = {ac}, $G_5(e_2)$ = {b}, $G_6(e_1)$ = {X},$G_6(e_2)$ = {b,c}, $G_7(e_1)$ = {b,c}, $G_7(e_2)$ = {b,c} is a supra soft topology on Y.

Let $f:(X,\mu,E)\to(Y,\mu^{*},E)$ be an identity function.

Here the inverse image of {{b},{ φ }} in Y is supra soft-gpr- closed set in X. Hence f is supra soft-gpr-continuous not supra soft-gpr-irresolute function.

4. Supra soft-contra and almost-contra- gpr- continuous functions

Definition [4.1]:

Let (X, μ ,E) and (Y, μ^{*}, E) be two supra soft topological spaces and $f:(X,\mu,E)\to(Y,\mu^{*},E)$ be a function. Then the function f is said to be supra soft-contra-gpr- continuous function if $f^{-1}(F,E)$ is supra soft-gpr-closed set in (X, μ ,E), for every supra soft-open set (F,E) of (Y, μ^{*}, E).

Definition [4.2]:

Let (X, μ ,E) and (Y, μ^{*}, E) be two supra soft topological spaces. A supra soft function $f:(X,\mu,E)\to(Y,\mu^{*},E)$ is said to be

(1) supra soft contra-continuous if $f^{-1}(F,E)$ is supra soft closed set in X, for every supra soft open set (F, E) of Y.

(2) supra soft-contra-pre- continuous , if $f^{-1}(F,E)$ is supra soft-pre-closed set in X , for every supra soft-open set (F,E) of Y.

(3) supra soft-contra-rg-continuous , if $f^{-1}(F,E)$ is supra soft-rg-closed set in X , for every supra soft-open set (F,E) of Y.

(4) supra soft -contra-πgs -continuous, if $f^{-1}(F,E)$ is supra soft - πgs -closed set in X, for every supra soft-open set (F,E) of Y.

(5) supra soft - contra-αg -continuous, if $f^{-1}(F,E)$ is supra soft - αg closed set in X, for every supra soft-open set (F,E) of Y.

Theorem [4.3]:

1.Every supra soft -contra continuous function is supra soft-contra-gpr- continuous function.

2.Every supra soft-contra-rg- continuous function is supra soft-contra-gpr-continuous function.
3.Every supra soft-contra-αg -continuous function is supra soft-contra-gpr- continuous function.
4.Every supra soft-contra-gs- continuous function is supra soft-contra-gpr- continuous function.
5.Every supra soft-contra-gr-continuous function is supra soft contra-gpr - continuous function.
6.Every supra soft-contra- πgs - continuous function is supra soft-contra- gpr - continuous function.

Remark [4.4]:
Converse of the above theorem is not true as shown in the following example.

Example [4.5]:
Let X={a,b,c} ,Y={a,b,c} and E={e_1,e_2} and F_1, F_2,F_3, F_4 , F_5, F_6 ,F_7 are functions from E to P(X) and are defined as follows;
$F_1(e_1)$ = {a}, $F_1(e_2)$ ={b}, $F_2(e_1)$ = {b}, $F_2(e_2)$ ={c}, $F_3(e_1)$ = {a,b}, $F_3(e_2)$ ={b,c},
$F_4(e_1)$ = {c}, $F_4(e_2)$ ={b}, $F_5(e_1)$ = {a,c}, $F_5(e_2)$ ={b}, $F_6(e_1)$ = {X}, $F_6(e_2)$ ={b,c},
$F_7(e_1)$={b,c}, $F_7(e_2)$={ b,c}
Then $\mu_1 = \{X,\phi,(G_1,E),...(G_7,E)\}$ is a supra soft topology and elements in μ are supra soft-open sets.
Let G_1, G_2, G_3, G_4, G_5, G_6, G_7.....G_{11} are functions from E to P(Y) and are defined as follows;
$G_1(e_1)$ ={b,c},$G_1(e_2)$ = {a,c}, $G_2(e_1)$ ={a,c}, $G_2(e_2)$ ={a,b},$G_3(e_1)$ ={c}, $G_3(e_2)$ = {a},$G_4(e_1)$ ={a,b}, $G_4(e_2)$ = {a,c},$G_5(e_1)$ ={b},$G_5(e_2)$ = {a,c}, $G_6(e_1)$ = {ϕ}, G_6 (e_2) = {a},$G_7(e_1)$ = {a}, $G_7(e_2)$={a},$G_8(e_1)$={a,b},$G_8(e_2)$={c}, $G_9(e_1)$={a,b}, $G_9(e_2)$={b,c},$G_{10}(e_1)$={a,c}, $G_{10}(e_2)$={ ϕ }, $G_{11}(e_1)$={a,c}, $G_{11}(e_2)$={b}.
Then $\mu_2 = \{X,\phi,(G_1,E),...(G_7,E)\}$ be a supra soft topology on Y, and $f:(X,\mu,E) \to (Y,\mu^*,E)$ be an identity map.

(1) Here the inverse image of supra soft open set, (A,E)={{ac},{b}} in Y is not supra soft closed set in X. Hence f is not supra soft-contra continuous, but it is supra soft contra-gpr-continuous.

(2) The inverse image of supra soft open set (A,E)={{ac}, {φ}} in Y is not supra soft rg- closed set in X. Hence f is not supra soft-contra-rg- continuous.

(3) Here inverse image of supra soft open set (A,E)={{a},{φ}} in Y is not supra soft gr-closed set in X. Hence f is not supra soft-contra-gr- continuous.

(4) The inverse image of supra soft open set (A,E)={ {ab},{bc}} in Y is not supra soft gs-closed set in X. Hence f is not supra soft-contra-gs continuous.

(5) The inverse image of supra soft open set (A,E)={{b},{bc}} in Y is not supra soft-αg closed set in X. Hence f is not supra soft-contra-αg continuous.

(6) Here inverse image of supra soft open set (A,E)={{ac},{b}} in Y is not supra soft- πgs closed set in X. Hence f is not supra soft-contra-πgs - continuous.

Definition [4.6]:

Let (X, μ ,E) and (Y, μ ′,E) be two supra soft topological spaces. A function f : (X, μ ,E) → (Y, μ ′,E) is said to be supra soft contra gpr-irresolute if $f^{-1}(G,E)$ is supra soft gpr- closed (open) in (X, μ,E) , for every supra soft gpr-open (closed) set (*G*,*E*) of (Y, μ ′,E).

Definition [4.7] :
Let (X, μ ,E) and (Y, μ ′,E) be two supra soft topological spaces. A function f : (X, μ ,E) → (Y, μ ′,E) is said to be supra soft almost contra gpr-continuous if $f^{-1}(F,E)$ is supra soft gpr- closed (open) in (X, μ ,E) , for every supra soft regular- open (closed) set (*F*,*E*) of (Y, μ′,E).

Definition [4.8] :
Let (X, μ ,E) and (Y, μ', E) be two supra soft topological spaces. A supra soft function $f:(X,\mu,E) \to (Y,\mu',E)$ is said to be

(1) supra soft almost contra-continuous if $f^{-1}(F,E)$ is supra soft closed in X, for every supra soft regular open set (F, E) of Y.

(2) supra soft almost contra-rg-continuous if $f^{-1}(F,E)$ is supra soft-rg-closed in X, for every supra soft regular open set (F, E) of Y.

(3) supra soft almost contra-gs-continuous if $f^{-1}(F,E)$ is supra soft-gs-closed in X, for every supra soft regular open set (F, E) of Y.

(4) supra soft almost contra-gr-continuous if $f^{-1}(F,E)$ is supra soft-gr-closed in X, for every supra soft regular open set (F, E) of Y.

Theorem [4.9] :

1. Every supra soft almost contra-rg-continuous function is supra soft almost contra gpr- continuous function.
2. Every supra soft almost contra-αg -continuous function is supra soft almost contra gpr- continuous function.
3. Every supra soft almost contra-πgs -continuous function is supra soft almost contra gpr- continuous function.
4. Every supra soft almost contra-gs-continuous function is supra soft almost contra gpr- continuous function.
5. Every supra soft almost contra-gr-continuous function is supra soft almost contra gpr- continuous function.

Remark [4.10] :

Converse of the above theorem is not true as shown in the following example.

Example [4.11] :

Let X={a,b,c }=Y, E={e_1,e_2}, and F_1, F_2,F_3, F_4, F_5, F_6 ,F_7 are functions from E to P(X) defined as follows;
$F_1(e_1)$ ={a}, $F_1(e_2)$ ={b}, $F_2(e_1)$ ={b}, $F_2(e_2)$ ={c}, $F_3(e_1)$ ={a,b}, $F_3(e_2)$ ={bc},
$F_4(e_1)$ ={c}, $F_4(e_2)$ ={b}, $F_5(e_1)$ ={a,c}, $F_5(e_2)$ ={b}, $F_6(e_1)$ ={X}, $F_6(e_2)$ ={b,c},
$F_7(e_1)$ ={b,c}, $F_7(e_2)$ ={b,c},
Then μ_1={X,φ, F_1, F_2,F_3, F_4 ... F_7,} is supra soft topology and elements of μ, is supra soft open sets.
Let G_1,G_2 are functions from E to P(Y) defined as follows;
$G_1(e_1)$ ={b} , $G_1(e_2)$ ={c} , $G_2(e_1)$ ={a,c}, $G_2(e_1)$ ={b}
Then μ_2 ={X,φ, G_1,G_2} is supra soft regular open on Y. Let f:(X,μ_1,E)→(Y, μ_2 ,E) be an identity function. Here f is supra soft almost-contra-gpr-continuous.

(1) Here $f^{-1}(\{b\},\{c\})$ is not supra soft almost contra-gs-closed set in X. Therefore f is not supra soft almost contra-gs-continuous

(2) Here $f^{-1}(\{b\},\{c\})$ is not supra soft almost-contra αg -closed set in X.Hence f is not supra soft almost contra-αg -continuous in Y.

(3) Here $f^{-1}(\{b\},\{c\})$ is not supra soft almost-contra πgs -closed set in X, thus f is not supra soft almost contra-πgs -continuous in Y.

Example [4.12]:

Let X={a,b,c} , Y={a,b,c}, E={e_1,e_2}, F_1, F_2,F_3, F_4 are functions from E to P(X) defined as follows;
$F_1(e_1)$ ={c} $F_1(e_2)$ ={a,c}, $F_2(e_1)$ ={X} $F_2(e_2)$ ={b},
$F_3(e_1)$ ={b} $F_3(e_2)$ ={ φ }, $F_4(e_1)$ ={b,c} $F_4(e_2)$ ={a,c}.
Then μ_1={X,φ, F_1, F_2,F_3, F_4} is supra soft topology and elements of μ, is supra soft open sets.
Let G_1,G_2 are functions from E to P(Y) defined as follows;
$G_1(e_1)$ ={b} , $G_1(e_2)$ ={φ} , $G_2(e_1)$ ={c}, $G_2(e_1)$ ={a,c}
Then μ_2 ={X,φ, G_1,G_2} is supra soft regular open on Y. Let f:(X,μ_1,E)→(Y, μ_2,E) be an identity function .

(4) Here $f^{-1}(\{b\},\{\varphi\})$ is not supra soft almost contra gr-closed set in X, thus f is not supra soft almost contra- rg-continuous in Y.

(5) Here $f^{-1}(\{b\},\{\varphi\})$ is not supra soft almost contra-gr- closed set in X, thus f is not supra soft almost contra-gr-continuous in Y.

Theorem [4.13] :

If f : (X, τ ,E) → (Y, τ ′,E) is supra soft-contra-gpr-continuous, then it is supra soft-almost-contr- gpr-continuous.

Proof;

Let (G,E) be supra soft regular open set in (Y, τ ′,E). Then (G,E) is supra soft open in (Y, τ ′,E). Because every supra soft regular open set is supra soft open set. By assumption $f^{-1}(G,E)$ is supra soft gpr-closed set in (X, τ, E). Thus f is supra soft almost-contra-gpr-continuous.

5. Supra soft almost-gpr-continuous functions

Definition [5.1] :

Let (X, μ ,E) and (Y, μ ′,E) be two supra soft topological spaces. A function f : (X, μ ,E) → (Y, μ ′,E) is said to be supra soft almost-gpr-continuous if $f^{-1}(G,E)$ is supra soft gpr- closed (open) in (X, μ ,E), for every supra soft regular- closed (open) set (*G*,*E*) of (Y, μ ′,E).

Theorem [5.2] :

Every supra soft-gpr-continuous is supra soft almost-gpr-continuous.

Proof :

Let f : (X, μ ,E) → (Y, μ ′,E) be a supra soft-gpr-continuous function and (G,E) be any supra soft regular closed set in (Y, μ ′,E). Since every supra soft regular closed set is supra soft closed, (G,E) is supra soft closed in (Y, μ ′,E). So by assumption $f^{-1}(G,E)$ is supra soft gpr-closed in (X, μ ,E). Therefore f is supra soft almost gpr-continuous.

Theorem [5.3] :

Every supra soft-gpr-irresolute function is supra soft almost-gpr-continuous.

Proof :

Let f : (X, μ ,E) → (Y, μ ′,E) be a supra soft-gpr-irresolute function and (G,E) be any supra soft regular closed set in (Y, μ ′,E). Since every supra soft regular closed set is supra soft closed, and it is (G,E) is supra soft-gpr- closed set. So (G,E) is supra soft-gpr-closed set in (Y, μ ′,E). Hence by assumption $f^{-1}(G,E)$ is supra soft gpr-closed in (X, μ ,E). Therefore f is supra soft almost gpr-continuous.

Theorem [5.4] :

Let (X,μ,E) and (Y,μ', E) be two supra soft topological spaces and f : (X, μ ,E) → (Y, μ ′,E) be a supra soft almost continuous function, then f is supra soft almost-gpr-continuous function.

Proof:

Let (F,E) be supra soft-regular-closed set in Y. By assumption f^{-1}(F,E) is supra soft- closed set in X. Since every supra soft- closed set is supra soft-gpr-closed, f^{-1}(F,E) is supra soft gpr-closed set in X. Therefore f is supra soft almost-gpr-continuous.

Theorem [5.5] :

Let (X,μ,E) and (Y,μ',E) be two supra soft topological spaces and f : (X, μ ,E) → (Y, μ ′,E) be a supra soft function, then the following conditions are equivalent

[1] f is supra soft almost gpr-continuous.

[2] The inverse image of each soft regular-open set in Y is supra soft gpr-open in X.

Proof :

[1]→[2]

Let f be supra soft almost gpr-continuous and (F, E) be a supra soft regular-open set in Y. Then Y-(F, E) is supra soft regular-closed in Y. Therefore f^{-1}(Y-(F,E)) is supra soft gpr-closed set in X. That is X- f^{1} (F,E) is supra soft gpr-closed is X. Hence f^{-1} (F,E) is supra soft gpr-open in X.

[2]→[1]

Let (F,E) be any supra soft regular closed set in Y. Therefore (Y- (F,E)) supra soft-regular-open in Y. By hypothesis, f^{-1}(Y-(F,E)) = X- f^{1} (F,E) is supra soft-gpr open in X. Therefore, f^{-1}(F,E) is supra soft gpr-closed in X and consequently f is supra soft alomost gpr-continuous.

Theorem [5.6] :

Let f: (X,μ.E)→(Y,μ',E) and g:(Y,μ',E)→(Z,μ'',E) be two maps in supra soft topological space such that $g \circ f : (X, \mu, E) \to (Z, \mu'', E)$

f	g	$g \circ f$
supra soft-gpr-continuous	supra sof- continuous	supra soft-gpr-continuous
supra soft-gpr-irresolute	supra soft-gpr-irresolute	supra soft-gpr-irresolute
supra soft-gpr-irresolute	supra soft-gpr-continuous	supra soft-gpr-continuous
supra soft-gpr-continuous	supra soft-contra-continuous	supra soft-contra-gpr-continuous
supra soft-gpr-irresolute	supra soft-contra-gpr-irresolute	supra soft-contra-gpr- irresolute
supra soft-gpr-irresolute	supra soft-contra-gpr-continuous	supra soft-contra-gpr-continuous
supra soft-contra-gpr-continuous	supra soft-continuous	supra soft-contra-gpr-continuous
supra soft-contra-gpr-irresolute	supra soft-gpr-irresolute	supra soft-contra-gpr-irresolute
supra soft-gpr-irresolute	supra soft-gpr-continuous	supra soft-contra-gpr-continuous

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