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Supra soft generalized pre-regular closed and open sets in soft supra topological spaces

S Vinnarasi and K Mohana

Abstract
In this paper, we define supra soft generalized preregular closed and open sets in soft supra topological spaces, and we investigate some basic properties of these concepts. Further, we present the notion of supra soft gpr-connectedness and study their characteristics in soft supra topological space.

Keywords: Supra soft topological spaces, supra soft gpr closed, supra soft gpr open, supra soft- gpr-separate and connected.

1. Introduction
The soft set theory is a rapidly processing field of mathematices. Soft set theory was initiated by Molodtsov [11] as a new method for vagueness. Shabir and Naz [12] introduced the soft topological spaces which are defined over an initial universe with a fixed set of parameters and studied some basic notions of soft topological spaces such as soft open and closed sets, soft subspace, soft closure, soft neighbourhood of a point, soft separation axioms. Maji *et al* [10] carried out Molodtsov's idea by introducing serveral operations in soft set theory. Chen [3] introduced the concept of soft semi-open sets in soft topological spaces. The concept of generalized closed sets was introduced by N. Levine [9]. K. Kannan [7] studied soft generalized closed sets in soft topological spaces along with its properties. After then *Yü* ksel *et al* [13] defined soft regular generalized closed and open sets in soft topological spaces. Many mathematicians [2, 4, 5] extended the results of generalized closed sets in soft topological spaces.

El-Sheikh and Abd El-Latif [6] introduced 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* [8] introduced the concept of soft supra g-closed sets in supra soft topological spaces, which is generalized in [1].

In this paper, we introduce the concept of supra soft generalized pre-regular closed soft sets with respect to a supra soft topological spaces. We investigate many properties of these concepts. We establish several interesting results and present their properties with the help of some examples.

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

Definiton [2.1] [1]
A pair (F, A) is called a soft set over U where $A \subseteq E$ and $F : A \rightarrow P(U)$ is a set valued mapping. In other words, a soft set over X is a parameterized family of subsets of the universe U. 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] [12]
A soft set (F, A) over 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) over U is said to be an absolute soft set denoted by A if for all e $\in$ A, F(e) =U.

Definition [2.3] [2]

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

Definition [2.4] [2]:
For two soft sets (F, A) and (G, B) over U, we say that (F, A) is a soft subset of (G, B) if A $\subseteq$ B and for all e $\in$ A, F(e) and G(e) are identical approximations. We write (F, A) $\tilde{\subseteq}$ (G, B). (F, A) is said to be a soft super set of (G, B), if (G, B) is a soft subset of (F, A). We denote it by (G, B) $\tilde{\subseteq}$ (F, A). Then (F, A) and (G, B) are said to be soft equal if (F, A) is a soft subset of (G, B) and (G, B) is a soft subset of (F, A).

Definition [2.5] [12]
For two soft sets (F, A) and (G, B) over a common universe U.
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 [2.6] [2]
The intersection (H, C) of two soft sets (F, A) and (G, B) over a common universe U denoted (F, A) $\cap$ (G, B) is defined as C = A $\cap$ B and H(e) = F(e) $\cap$ G(e), for all e $\in$ C.

Definition [2.7] [5]

For a soft set (F, A) over the universe U, the relative complement of (F, A) is denoted by $(F, A)^c$ and is defined by $(F, A)^c$ = (F^c , A), where F^c : A → P(U) is a mapping defined by F^c (e) = U - F(e), for all e $\in$ A.

Definition [2.8] [2]
Let $\tilde{\tau}$ be the collection of soft sets over a universe U with a fixed set of parameters E, then $\tilde{\tau}$ is said to be a soft topology on U.

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

(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 (U, $\tilde{\tau}$,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 U if $(F, E)^c \in \tilde{\tau}$.

Definition [2.9] [1]
Let μ be the collection of supra soft sets over a universe U with a fixed set of parameters E, then μ is said to be a supra soft topology on U if

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

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

The triplet (U, 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 in U if (F, E)$^c \in \mu$.

Remark [2.10] [13]
Every soft topological space is supra soft topological space, but the converse is not true in general as shown in the following example.

3. Supra Soft Generalized Pre-regular Closed Sets

Definition [3.1]
Let (U, μ ,E) be a supra soft topological space and (F,E) be a soft set over U.

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

(2) The supra soft interior of (F,E) is the supra soft set $(F, E)^{os} = \cup$ {(H, E) : (H, E) is supra soft open and (H, E) $\subseteq$ (F, E)}.
Clearly, $(F, E)^{-s}$ is the smallest supra soft closed set over U which contains (F, E) and
$(F, E)^{os}$ is the largest supra soft open set over U which is contained in (F,E).

Definition [3.2]
Let (U, μ ,E) be a supra soft topological space and (F, E) be a supra soft set over U.

(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 [3.3]
Let (U, μ ,E) be a supra soft topological space. A soft set (F, E) is called supra soft preopen set in U if (F, E) $\subseteq ((F, E)^{-s})^{os}$.
The relative complement of a supra soft preopen set is called a supra soft pre-closed set.
It is obvious that every supra soft closed set is supra soft pre-closed.

Definition [3.4]
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 preclosure of (F, E) is the supra soft set $(F, E)^{-sp} = \cap$ {(G, E) : (G, E) is supra soft preclosed and (F, E) $\subseteq$ (G, E)}.
(2) The supra soft preinterior of (F, E) is the supra soft set $(F, E)^{osp} = \cup$ {(H, E):(H, E) is supra soft preopen and (H, E) $\subseteq$ (F, E).
Clearly, $(F, E)^{-sp}$ is the smallest supra soft preclosed set over U which contains (F, E) and $(F, E)^{osp}$ is the largest supra soft preopen set over U which is contained in (F, E).

Definition [3.5]
Let (U, μ ,E) be a supra soft topological space over 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.

Definition [3.6]
(1) A supra soft regular generalized closed set(brisfly 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(brisfly 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(brisfly 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(brisfly 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.

Theorem [3.7]
1. Every supra soft closed set is supra soft gpr-closed set.
2. Every supra soft rg closed set is supra soft gpr-closed set.
3. Every supra soft α g closed set is supra soft gpr-closed set.
4. Every supra soft gs closed set is supra soft gpr-closed set.
5. Every supra soft gr closed set is supra soft gpr-closed set.
6. Every supra soft π gr closed set is supra soft gpr-closed set.

Proof
1) Suppose (F,E) $\subseteq$ (G,E),where (G,E) is a supra soft regular open in U,
then $(F,E)^{-s}$ =(F,E) $\subseteq$ (G,E).Thus $(F,E)^{-sp} \subseteq (F,E)^{-s} \subseteq$ (G,E). Hence (F,E) is supra soft gpr-closed.

2)Let (F,E) $\subseteq$ (G,E) and (G,E) be supra soft regular open. Then $(F,E)^{-s} \subseteq (G,E)$. since ever supra soft closed set is supra soft pre closed, $(F,E)^{-sp} \subseteq (F,E)^{-s} \subseteq (G,E)$. Hence (F,E) is supra soft gpr closed.

3)Let (F,E) be supra soft α g closed set in U and (F,E) $\subseteq$ (G,E) and (G,E) be supra soft regular open. Since every supra soft α closed set is supra soft pre closed set, we have

$(F,E)^{-s\alpha} \subseteq (G,E)$. Hence $(F,E)^{-sp} \subseteq (F,E)^{-s\alpha} \subseteq (G,E)$. Then (F,E) is supra soft gpr closed.

4) Let (F,E) $\subseteq$ (G,E) and (G,E) be supra soft regular open. By assumption $(F,E)^{-ss} \subseteq (G,E)$.

Since every supra soft semi closed set is supra soft pre closed set then

$(F,E)^{-sp} \subseteq (F,E)^{-ss} \subseteq (G,E)$. Hence (F,E) is supra soft gpr closed.

5) Let (F,E) be supra soft gr closed set in U and (F,E) $\subseteq$ (G,E), where (G,E) be supra soft regular open. since ever supra soft closed set is supra soft pre closed.

Hence $(F,E)^{-sp} \subseteq (F,E)^{-sr} \subseteq (G,E)$. Hence (F,E) is supra soft gpr closed.

6) Let (F,E) be supra soft π gs-closed set in U and (F,E) $\subseteq$ (G,E), where (G,E) be supra soft regular open. By assumption $(F,E)^{-ss} \subseteq (G,E)$. Also

$(F,E)^{-sp} \subseteq (F,E)^{-ss} \subseteq (G,E)$. Hence (F,E) is supra soft gpr closed.

Remark [3.8]

Converse of the above theorem need not be true as seen in the following example.

Example [3.9]

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

$F_1(e_1)$ ={X},$F_1(e_2)$={a}, $F_2(e_1)$ ={b},$F_2(e_2)$={a},

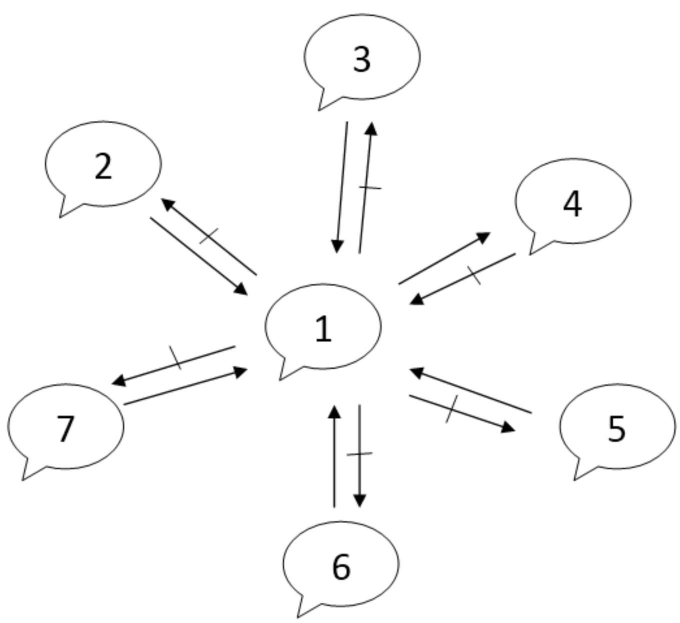
$F_3(e_1)$ ={X},$F_3(e_2)$={a,b}, $F_4(e_1)$ ={ φ },$F_4(e_2)$={c},

$F_5(e_1)$ ={X},$F_5(e_2)$={a,c}, $F_6(e_1)$ ={b},$F_6(e_2)$={a,c}.

Then μ ={ φ ,X, (F_1,E)....(F_6,E) } is supra soft topology and elements of μ is supra soft open -sets.

(1) The supra soft set (A,E)={{a},{a,b}} is gpr-closed, but not supra soft -closed.
(2) The supra soft set (A,E)={{c},{X}} is gpr-closed, but not supra soft rg -closed.
(3) The supra soft set (A,E)={{X},{c}} is gpr-closed, but not supra soft α g-closed.
(4) The supra soft set (A,E)={{b},{a,c}} is gpr-closed, but not supra soft gs -closed.
(5) The supra soft set (A,E)={{X},{a,b}} is gpr-closed, but not supra soft gr-closed.
(6) The supra soft set (A,E)={{a,b},{a}} is gpr-closed, but not supra soft π gs-closed.

Remark [3.10]



1. supra soft gpr- closed set
2. supra soft regular generalized closed set
3. supra soft α generalized closed set
4. supra soft generalized semi soft closed set
5. supra soft gr closed set
6. supra soft πgs closed set

Remark [3.11]
The union of two supra soft gpr-closed sets is generally not a supra soft gpr-closed set.

Example [3.12]: Let X={a,b,c}, E={e_1,e_2}, 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}.

Proof
Let (A,E) and (B,E) be two soft sets over U such that A(e_1) ={ φ }, A(e_2)= {a} and B(e_1) = { φ }, B(e_2) = {c}. Clearly, (A,E) and (B,E) are supra soft gpr –closed sets in
(X, μ ,E), but (A,E) $\cup$ (B,E) is not a supra soft gpr –closed set.

Remark [3.13]
The intersection of two supra soft gpr-closed sets is generally not a supra soft gpr-closed set.

Example [3.14] : Let X={a,b,c}, E={e_1,e_2}, 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}.

Proof
Let (A,E) and (B,E) be two soft sets over U such that A(e_1) = {X}, A(e_2) ={b} and B(e_1) = {a}, B(e_2) ={X}. Clearly, (A,E) and (B,E) are supra soft gpr –closed sets in (X, μ ,E) but (A,E) $\cap$ (B,E) is not a supra soft gpr –closed set.

Theorem [3.15]
Let (X, μ ,E) be a supra soft topological space and (F,E) be a supra soft set over U. If a supra soft set (F,E) is supra soft gpr-closed, then $(F, E)^{-sp} - (F, E)$ contains only null supra soft regular closed set.

Proof
Suppose that (F,E) is supra soft gpr-closed. Let (H,E) be a supra soft regular closed subset of $(F,E)^{-sp}$ - (F,E). Then (H,E) $\subseteq$ $(F,E)^{-sp}$ $\cap$ $(F,E)^c$ and so (F,E) $\subseteq$ $(H,E)^c$. Since (F,E) is a supra soft gpr-closed set and $(H,E)^c$ is supra soft regular open, we obtain $(F,E)^{-sp}$ $\subseteq$ $(H,E)^c$. Consequently (H,E) $\subseteq$ $((F,E)^{-sp})^c$. We have already (H,E) $\subseteq$ $(F,E)^{-sp}$. Hence we obtain (H,E) $\subseteq$ $(F,E)^{-sp} \cap ((F,E)^{-sp})^c = \varphi$. This shows (H,E) = φ . Therefore $(F,E)^{-sp}$ - (F,E) contains only null supra soft regular closed set.

Theorem [3.16]
Let (X, μ ,E) be a supra soft topological space over U and (F,E) be a supra soft gpr-closed set in U. (F,E) is supra soft gpr closed if and only if $(F,E)^{-sp}$ - (F,E) is supra soft regular closed.

Proof:
Let (F,E) be a supra soft gpr-closed set. If (F,E) is supra soft gpr closed, then
$(F,E)^{-sp}$ = (F,E). So $(F,E)^{-sp}$ - (F,E) = φ . Which is supra soft regular closed.
Conversely, suppose that $(F,E)^{-sp}$ - (F,E) is supra soft regular closed. Since (F,E) is supra soft gpr-closed, then $(F,E)^{--sp}$- (F,E) = φ . That is $(F,E)^{-sp}$ = (F,E). Hence (F,E) is supra soft preclosed.

Theorem [3.17]
Let (U, μ ,E) be a supra soft topological space, (F,E) and (G,E) are supra soft sets over U. If (F,E) is supra soft gpr-closed and (F,E) $\subseteq$ (G,E) $\subseteq$ $(F,E)^{-sp}$, then (G,E) is supra soft gpr-closed.

Proof
Let (G,E) $\subseteq$ (H,E) where (H,E) is supra soft regular open. Then (F,E) $\subseteq$ (G,E) implies (F,E) $\subseteq$ (H,E). Since (F,E) is supra soft gpr-closed, $(F,E)^{-sp}$ $\subseteq$ (H,E).
(G,E) $\subseteq$ $(F,E)^{-sp}$ implies $(G,E)^{-sp}$ $\subseteq$ $(F,E)^{-sp}$. Thus $(G,E)^{-sp}$ $\subseteq$ (H,E) and this shows that (G,E) is supra soft gpr-closed.

Definition [3.18]
Let (U, μ ,E) be a supra soft topological space. A supra soft set (F,E) is called supra generalized preregular open soft (supra soft gpr-open) in U if $(F,E)^c$ is supra soft rg-closed.

Theorem [3.19]
A soft set (F,E) is supra soft gpr-open in a soft topological space (U, μ,E) if and only if (H,E) $\subseteq$ $(F,E)^{os}$ whenever (H,E) is supra soft regular closed in U and (H,E) $\subseteq$ (F,E).

Proof
Suppose that (H,E) is supra soft regular closed and (H,E) $\subseteq$ (F,E) implies
(H,E) $\subseteq$ (F,E). Let $(F,E)^c$ $\subseteq$ (G,E) where (G,E) is supra soft regular open. Then $(G,E)^c$ $\subseteq$ (F,E) where $(G,E)^c$ is supra soft regular closed. By hypothesis $(G,E)^c$ $\subseteq$ $(F,E)^{osp}$. That is $((F,E)^{osp})^c$ $\subseteq$ (G,E). Equivalently $((F,E)^c)^{-sp}$ $\subseteq$ (G,E). Thus $(F,E)^c$ is supra soft gpr-closed. Hence we obtain (F,E) is supra soft gpr-open.
Conversely, suppose that (F,E) is supra soft gpr-open, (H,E) $\subseteq$ (F,E) and (H,E) is supra soft regular closed. Then $(H,E)^c$ is supra soft regular open. Then $(F,E)^c$ $\subseteq$ $(H,E)^c$. Since $(F,E)^c$ is supra soft gpr-closed, $((F,E)^c)^{-sp}$ $\subseteq$ $(H,E)^c$. Therefore(H,E) $\subseteq$ $(((F,E)^c)^{-sp})^c = (F,E)^{-sp}$.

Theorem [3.20]
Let (U, μ,E) be a supra soft topological space, (F,E) and (G,E) supra soft sets over U. If (F,E) is supra soft gpr-open in U and $(F,E)^{sop}$ $\subseteq$ (G,E) $\subseteq$ (F,E), then (G,E) is supra soft gpr-open.

Proof
$(F,E)^{sop}$ $\subseteq$ (G,E) $\subseteq$ (F,E) implies $(F,E)^c$ $\subseteq$ $(G,E)^c$ $\subseteq$ $((F,E)^{-sp})^c$.
That is, $(F,E)^c$ $\subseteq$ $(G,E)^c$ $\subseteq$ $((F,E)^c)^{-sp}$. Since $(F,E)^c$ is supra soft gpr-closed, $(G,E)^c$ is supra soft gpr-closed and (G,E) is supra soft gpr-open.

4. Supra Soft gpr Separated
Definition [4.1]
Two non-null supra soft sets (G,E) and (H,E) of a supra soft topological space
(U, μ,E) are said to be supra soft gpr-separated sets if (G,E) $\cap$ gpr^{-s}(H,E) = φ and
gpr^{-s}(G,E) $\cap$ (H,E) = φ.

Definition [4.2]
A soft set (F,E) of a supra soft topological space (U, μ,E) is said to be supra gpr-soft clopen set if it is both supra soft gpr-open set and supra soft gpr-closed set.

Remark [4.3]
(1): Each two supra soft gpr-separated sets are always disjoint.
(2): Each two disjoint supra soft sets, in which both of them either supra soft gpr-open sets or supra soft gpr-closed sets, are supra soft gpr-separated.

Theorem [4.4]
Let (G,E) and (H,E) be non-null supra soft sets of a supra soft topological space
(U, μ,E). Then, the following statements hold:
(1) If (G,E) and (H,E) are supra soft gpr-separated, (G_1,E) $\subseteq$ (G,E) and (H_1,E) $\subseteq$ (H,E) then (G_1,E) and (H_1,E) are supra soft gpr-separated sets.
(2): If (G,E) and (H,E) are supra soft gpr-open soft sets, (A,E) = (G,E) $\cap$ ((U,E) - (H,E)) and (B,E) = (H,E) $\cap$ ((U,E) - (G,E)), then (A,E) and (B,E) are supra soft gpr-separated sets.

Proof
(1) Since (G_1,E) $\subseteq$ (G,E). Then, gpr^{-s} (G_1,E) $\subseteq$ gpr^{-s} (G,E).
Hence, (H_1,E) $\cap$ $gpr^{-s}(G_1,E)$ $\subseteq$ (H,E) $\cap$ gpr^{-s} (G,E) = φ. Similarly,
(G_1,E) $\cap$ gpr^{-s} (H_1,E) = φ. Thus, (G_1,E) and (H_1,E) are supra soft gpr-separated sets.
(2) Let (G,E) and (H,E) be supra soft gpr-open sets. Then, ((U,E) – (G,E)) and ((U,E) – (H,E)) are supra soft gpr-closed sets. Assume that, (A,E) = (G,E) $\cap$ ((U,E)-(H,E)) and (B,E) =(H,E) $\cap$ ((U,E)-(G,E)). Then, (A,E) $\subseteq$ ((U,E) – (H,E)) and (B,E) $\subseteq$ ((U,E) –(G,E)). Hence, gpr^{-s}(A,E) $\subseteq$ ((U,E)–(H,E)) $\subseteq$ ((U,E)-(B,E)) and gpr^{-s} (B,E) $\subseteq$ (U,E)-(G,E) $\subseteq$ (U,E)-(A,E). Consequently, gpr^{-s} (A,E) $\cap$ (B,E) = φ and gpr^{-s} (B,E) $\cap$ (A,E) = φ. Therefore, (A,E) and (B,E) are supra soft gpr-separated sets.

5. Supra Soft gpr-connected
Definition [5.1]
Let (U, μ,E) be a supra soft topological space. A supra soft gpr-separation of U is a pair of non-null proper supra soft gpr-open sets in μ such that (F,E) $\cap$ (G,E) = φ and U= (F,E) $\cup$ (G,E).

Definition [5.2]
A supra soft topological space (U, μ ,E) is said to be supra soft gpr-connected if and only if there is no supra soft gpr-separations of U. If (U, μ ,E) has such supra soft gpr-separations, then (U, μ ,E) is said to be supra soft gpr-disconnected.

Remark [5.3]
(1)**:** φ is always supra soft gpr-connected.
(2)**:** If (G,E), (H,E) are non-null supra soft gpr-separated sets. Then, the pair (G,E), (H,E) is called the supra soft gpr-disconnection of U.

Theorem [5.4]
Let (U, μ ,E) be a supra soft topological space, then the following statements are equivalent:
(1): U is supra soft gpr-connected.
(2): U can not be expressed as a soft union of two non-null disjoint supra soft gpr-open sets.
(3): U can not be expressed as a soft union of two non-null disjoint supra soft gpr-closed sets.
(4): There is no proper supra soft gpr-clopen set in (U, μ ,E).
(5): U can not be expressed as a supra soft union of two non-null supra soft gpr-separated sets.

Proof
(1) $\Leftrightarrow$ (2)**:** It is obvious from the above Definition.
(2) $\Rightarrow$ (3)**:** Suppose that U = (F,E) $\cup$ (G,E) for some supra soft gpr-closed sets (F,E) and (G,E) such that (F,E) $\cap$ (G,E) = φ . Then, (F,E) = $(G,E)^c$ which is gpr-open supra soft set, U = (G,E) $\cup$ $(G,E)^c$ and (G,E) $\cap$ $(G,E)^c$ = φ , which is a contradiction with (2).
(3) $\Rightarrow$ (4)**:** Suppose that there is a proper supra soft gpr-clopen subset (F,E) of U. Then, $(F,E)^c$ is supra soft gpr-clopen set, where U = (F,E) $\cup$ $(F,E)^c$ and (F,E) $\cup$ $(F,E)^c$ = φ , which is a contradiction with (3).
(4) $\Rightarrow$ (3)**:** Suppose that U = (F,E) $\cup$ (G,E) for some supra soft gpr-closed sets (F,E) and (G,E) such that (F,E) $\cap$ (G,E) = φ . Then, (F,E) = $(G,E)^c$ and (G,E) =$(F,E)^c$. Thus, (F,E) and (G,E) are proper supra soft gpr-clopen sets, which is a contradiction with (4).
(3) $\Rightarrow$ (5)**:** Suppose that U = (H,E) $\cup$ (G,E) for some supra soft gpr-separated sets (H,E) and (G,E). Then, (G,E) $\cap$ gpr^{-s} (H,E) = φ and gpr^{-s} (G,E) $\cap$ (H,E) = φ . It follows that,
(H,E) $\cap$ (G,E) = φ . Hence, (H,E) = $(G,E)^c$ and (G,E) = $(H,E)^c$. Therefore,
gpr^{-s} (H,E) $\subseteq$ $(G,E)^c$=(H,E) and gpr^{-s} (G,E) $\subseteq$ $(H,E)^c$ = (G,E). But, (H,E) $\subseteq$ gpr^{-s} (H,E) and (GE) $\subseteq$ gpr^{-s} (G,E). Thus, (H,E) and (G,E) are supra soft gpr-closed sets, which is a contradiction with (3).
(5) $\Rightarrow$ (1)**:** Suppose that U= (F,E) $\cup$ (G,E) for some supra soft gpr-open sets (F,E) and (G,E) such that (F,E) $\cap$ (G,E) = φ . Then (F,E) = $(G,E)^c$ and (G,E) =$(F,E)^c$. Thus, (F,E) and (G,E) are supra soft gpr-clopen sets. Hence, (F,E) and (G,E) are supra soft gpr-separated sets, which is a contradiction with (5).

6. References

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