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On dual soft local function

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Abstract

Set theory is one of the tools that plays an effective role in both applied and practical fields. It was circulated and used to facilitate and treat many important scientific problems. It should be noted that we mention the fuzzy sets, which is a subset of $X \times [0, 1]$, the soft sets, which are a subset of $E \times p(x)$, center sets, which are subsets of $p(x) \times p(x)$ and the dual soft sets are subsets of $E \times p(x) \times p(y)$, where E is the parameters of elements of X and Y. Here in this paper, the concepts of ideal and local function have been generalized to dual soft sets and the study of their impact within this field.

Keywords: Dual Soft Local Function, dual soft ideal topological space, StT_E-open
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1 Introduction

The concept of idealism first appeared in a Genr 1933 by the scientist Kuratowski [11] due to its great importance through its immersion in topological spaces, where it was studied on the fuzzy set theory that the scientist knew Zadeh in the year 1965 [14]. In 2020 [4] the researcher Af-Mohammed studied the concept of idealism on these sets, as well as studying several types of local functions on them which was originally know in 1945 by Vaidyanathaswany [13]. In 1999 soft sets were defined by Molodtsov [12] in 2018 [5, 6] the researcher Awad studied the concept of ideal on these sets, It also developed a new definitions of soft cluster points, and these points influenced notions of separation axioms producing impressive results in this respect. In 2019 [1, 2, 3], the researcher Abdulsada developed a new type of sets called center sets, based on the proximity relations that researcher Efremovic in 1952 [10]. He also developed a new definition of ideal called center ideal, where he studied its most important properties with in this field. In 2006 [15]. A new type of topological spaces was created by researcher Irina, who called it i-topological spaces. In the years 2019-2021 [4, 8, 9] researcher Mahdi invited these spaces based on ideal and liked them with proximity relation to produce new concepts of density as well as defining the local function based on these new spaces.

2 Preliminaries

Definition 2.1. [7] The sub collection $II_{(U_1,U_2)}$ of $DS_{(U_1,U_2)}$ is called the dual soft ideal if satisfy the following.

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1. If $(A, F_1, G_1) \in II_{(U_1,U_2)_E}$ and $(B, F_2, G_2)_E \subseteq (A, F_1, G_1)$ then $(B, F_2, G_2)_E \in II_{(U_1,U_2)_E}$.
2. If $(A, F_1, G_1).(B, F_2, G_2) \in I_{(U_1,U_2)_E}$ then $(A, F_1, G_1) \cup (B, F_2, G_2) \in II_{(U_1,U_2)_E}$.

Definition 2.2. [7] The sub collection StT_E of $DS_{(U_1,U_2)_E}$ is called dual soft topology StT_E on X_{Ds} if satisfy.

1. $\emptyset_{Ds}, X_{Ds} \in StT_E$.
2. If $FG_A, f_1G_{1_B} \in StT_E$ then $FG_A \cap f_1G_{1_B} \in StT_E$.
3. For any index Λ if $f_iG_{i_{A_I}} \in StT_E$. Then $\cup_{i\in\Lambda} f_iG_{i_{A_I}} \in StT_E$.

So $StT_E = \{\emptyset_{Ds}, X_{Ds}, FG_A\}$ is dual soft topology and (X_{Ds}, StT_E) is dual soft topological space.

3 Dual Soft Local Function

Definition 3.1. Let $(X_{Ds}, StT_E, II_{(U_1,U_2)})$ be dual soft ideal topological space and FG_A be a subset of X_{Ds}. Then the forma.

$FG_A^* = \{e_{xy} \in X_{Ds}$ for each $HK_A \in StT_E(e_{xy}) : HK_A \cap FG_A \notin II_{(U_1,U_2)}\}$ is called second type of soft local function of FG_A, when HK_A is StT_E-open and $e_{xy} \in StT_E$.

Example 3.2. Let $X = \{x_1, x_2\}, Y = \{y_1, y_2\}, E = \{e_1, e_2, e_3\}, A = \{e_1, e_2\}$

$FG_A = \{(e_1, \{x_1\}, \{y_1\}), (e_2, \{x_2\}, \emptyset), (e_3, \emptyset, \emptyset)\}$

$HK_A = \{(e_1, \{x_2\}, \{y_1\}), (e_2, X, \{y_2\}), (e_3, \emptyset, \emptyset)\}$

$H_1K_{1\ A1} = \{(e_1, \{x_1\}, \emptyset), (e_2, \{x_1\}, \{y_1\}), (e_3, \emptyset, \emptyset)\}$

$H_2K_{2\ A2} = \{(e_1, X, \{y_1\}), (e_2, X, Y), (e_3, \emptyset, \emptyset)\}$

$H_3K_{3\ A3} = \{(e_1, \emptyset, \emptyset), (e_2, \{x_1\}, \emptyset), (e_3, \emptyset, \emptyset)\}$

$StT_E = \{\emptyset_{DS}, X_{DS}, HK_A, H_1K_{1\ A1}, H_2K_{2\ A2}, H_3K_{3\ A3}\}$ then we have that.

$FG_A^* = \{(e_1, X, \{y_1\}), (e_1, \{x_2\}, \{y_1\}), (e_1, \{x_1\}, \emptyset), (e_2, X, \{y_2\}), (e_2, X, Y)\}$.

Remark 3.3. The minimal dual soft ideal is $\{\emptyset_{DS}\}$ in any dual soft ideal topological space $(X_{Ds}, StT_E, II_{(U_1,U_2)})$ and the maximal dual soft ideal is $\{P(X_{Ds})\}$.

Theorem 3.4. Let $(X_{Ds}, StT_E, II_{(U_1,U_2)})$ be a dual soft ideal topological space the following properties are hold:

1. $HK_A \subseteq FG_A$ then $HK_A^* \subseteq FG_A^*$
2. If $JJ_{(U_1,U_2)} \supset II_{(U_1,U_2)}$ on X_{Ds} then $FG_A^*(JJ_{(U_1,U_2)}, StT_E) \subset FG_A^*(II_{(U_1,U_2)}, StT_E)$
3. $FG_A^*(II_{1(U_1,U_2)} \cap II_{2(U_1,U_2)}) = FG_A^*(II_{1(U_1,U_2)}) \cup FG_A^*(II_{2(U_1,U_2)})$
4. $(HK_A \cup FG_A)^* = HK_A^* \cup FG_A^*$

Proof .

1. Let $e_{xy} \notin FG_A^*$ then there exist HK_A containing e_{xy} such that $HK_A \cap FG_B \in II_{(U_1,U_2)}$ for each StT_E since $HK_A \subseteq FG_A$ then $HK_A \cap FG_B \subseteq HK_A \cap FG_B \in II_{(U_1,U_2)}$ then $e_{xy} \notin FG_A^*$ this implies $HK_A^* \subseteq FG_A^*$.
2. Let $e_{xy} \in FG_A^*(JJ_{(U_1,U_2)}, StT_E)$ then for each $HK_A \in StT_{e_{xy}}$ such that $HK_A \cap FG_A \notin JJ_{(U_1,U_2)}$ since $JJ_{(U_1,U_2)} \supset II_{(U_1,U_2)}$ so $HK_A \cap FG_A \notin II_{(U_1,U_2)}$ then $e_{xy} \in FG_A^*(JJ_{(U_1,U_2)}, StT_E)$ hence $FG_A^*(JJ_{(U_1,U_2)}, StT_E) \subset FG_A^*(II_{(U_1,U_2)}, StT_E)$.
3. Since $II_{1(U_1,U_2)} \cap II_{2(U_1,U_2)} \subset II_{1(U_1,U_2)}$ and $II_{1(U_1,U_2)} \cap II_{2(U_1,U_2)} \subset II_{2(U_1,U_2)}$ and by (2) we have $FG_A^*(II_{1(U_1,U_2)}) \subset FG_A^*(II_{1(U_1,U_2)} \cap II_{2(U_1,U_2)})$ and $FG_A^*(II_{2(U_1,U_2)}) \subset FG_A^*(II_{1(U_1,U_2)} \cap II_{2(U_1,U_2)})$, let $e_{xy} \in FG_A^*(II_{1(U_1,U_2)} \cap II_{2(U_1,U_2)})$ for each $HV_A \in StT_E(e_{xy})$ such that $HK_A \cap FG_A \notin II_{1(U_1,U_2)} \cap II_{2(U_1,U_2)}$ hence $HK_A \cap FG_A \notin II_{1(U_1,U_2)}$ or $HK_A \cap FG_A \notin II_{2(U_1,U_2)}$ then $e_{xy} \in FG_A^*(II_{1(U_1,U_2)}, StT_E)$ or $e_{xy} \in FG_A^*(II_{2(U_1,U_2)}, StT_E)$ this implies $e_{xy} \in FG_A^*(II_{1(U_1,U_2)}) \cup FG_A^*(II_{2(U_1,U_2)})$.
4. Let $e_{xy} \in (HK_A \cup FG_A)^*$ then for each $HK_A \in StT_E$ such that $HK_A \cap (HK_A \cup FG_A) \notin II_{(U_1,U_2)}$, $e_{xy} \in HK_A^* \cup FG_A^*$ this implies $e_{xy} \in HK_A^* \cup FG_A^*$, $(HK_A \cup FG_A)^* \subset HK_A^* \cup FG_A^*$, $FG_B, FG_A \subseteq HK_A \cup FG_A$ thus $HK_A^* \subseteq (HK_A \cup FG_A)^*$, $FG_A^* \subseteq (HK_A \cup FG_A)^*$ thus $HK_A^* \cup FG_A^* \subseteq (HK_A \cup FG_A)^*$.

□

Theorem 3.5. Let $(X_{Ds}, StT_E, II_{(U_1,U_2)})$ be a dual soft ideal topological space the following properties are hold:

1. $HK_A^* - FG_A^* = (HK_A - FG_A)^* - HK_A^* \subset (HK_A - FG_A)^*$
2. $HK_A \cap FG_A^* \subset (HK_A \cap FG_A)^*$ for each $HK_A \in StT_E$
3. $(FG_A^*)^* \subset FG_A^*)$

Proof .

1. Since $FG_A = (HK_A - FG_A) \cup (HK_A \cap FG_A)$ by proof (4) $FG_A^* = (HK_A - FG_A)^* \cup (HK_A - FG_A)^*$, $FG_A^* - HK_A^* = FG_A^* \cap (X_{DS} - HK_A^*)$ so we get
$= (FG_A - HK_A)^* \cup (HK_A \cap FG_A)^* \cap (X_{DS} - HK_A^*)$
$= (FG_A - HK_A)^* \cap (X_{DS} - HK_A^*) \cup (HK_A \cap FG_A)^* \cap (X_{DS} - HK_A^*)$
$= ((FG_A - HK_A)^* - HK_A^*) \cup \emptyset \subset (FG_A - HK_A)^*$.
2. Let $e_{xy} \in HK_A \cap FG_A^*$ then $e_{xy} \in HK_A$ and $e_{xy} \in FG_A^*$ for each $HK_A \in StT_E(e_{xy})$ then $HK_A \cap FG_A^* \notin II_{(U_1,U_2)}$ for if possible then $e_{xy} \notin (HK_A \cap FG_A)^*$ then there exist $LG_{1V} \in StT_E(e_{xy})$ such that $LM_A \cap (HK_A \cap FG_A) \in II_{(U_1,U_2)}$ then $(LM_A \cap HK_A) \cap FG_A \in II_{(U_1,U_2)}$ which contradiction then $e_{xy} \in (HK_A \cap FG_A)^*$ hence $HK_A \cap FG_A^* \subset (HK_A \cap FG_A)^*$ for each $HK_A \in StT_E$.
3. Let $e_{xy} \in (FG_A^*)^*$ then for every $HK_A \in StT_E$, $FG_A^* \cap HK_A \notin II_{(U_1,U_2)}$ and hence $FG_A^* \cap HK_A \neq \emptyset$ for every $HK_A \in StT_E$ thus we have $FG_A \cap HK_A \notin II_{(U_1,U_2)}$ and $e_{xy} \in (FG_A^*)^*$.

□

The following example show that the converse of properties (1) is not true.

Example 3.6. Let $X = \{x_1, x_2\}, Y = \{y_1, y_2\}, E = \{e_1, e_2, e_3\}, A = \{e_1, e_2\}$

$StT_E = \{\emptyset_{DS}, X_{DS}, LM_A, L_1M_{1\ A1}, L_2M_{2\ A2}, L_3M_{3\ A3}\}$ from example 3.2

$FG_A = \{(e_1, \{x_1\}, \{y_1\}), (e_2, \{x_2\}, \emptyset), (e_3, \emptyset, \emptyset)\}$

$FG_A^* = \{(e_1, X, \{y_1\}), (e_1, \{x_2\}, \{y_1\}), (e_1, \{x_1\}, \emptyset), (e_2, X, \{y_2\}), (e_2, X, Y)\}$.

$HK_A = \{(e_1, \{x_1\}, \{y_2\}), (e_2, \{x_2\}, \{y_1\}), (e_3, \emptyset, \emptyset)\}$

$HK_A^* = \{(e_1, \{x_1\}, \emptyset), (e_2, \{x_2\}, \emptyset), (e_2, X, Y)\}$

$FG_A^* - HK_A^* = \{(e_1, X, \{y_1\}), (e_1, \{x_2\}, \{y_1\}), (e_2, X, \{y_2\})\}$

$FG_A - HK_A = \{(e_1, \{x_1\}, \{y_1\}), (e_2, \{x_2\}, \emptyset)\}$

$(FG_A - HK_A)^* = \{(e_1, \{x_2\}, \{y_2\}), (e_1, \{x_1\}, \emptyset), (e_1, X, \{y_1\}), (e_2, X, \{y_2\}), (e_2, X, Y)\}$

$(FG_A - HK_A)^* - HK_A^* = \{(e_1, \{x_1\}, \{y_2\}), (e_1, X, \{y_1\}), (e_2, X, \{y_2\})\}$

Therefore $(FG_A - HK_A)^* \nsubseteq FG_A^* - HK_A^* = (FG_A - HK_A)^* - HK_A^*$.

The following example show that the converse of properties (2) is not true.

Example 3.7. Let $X = \{x_1, x_2\}, Y = \{y_1, y_2\}, E = \{e_1, e_2, e_3\}, A = \{e_1, e_2\}$

$StT_E = \{\emptyset_{DS}, X_{DS}, HK_A, H_1K_{1\ A1}, H_2K_{2\ A2}, H_3K_{3\ A3}\}$ from example 3.2

$FG_A = \{(e_1, \{x_1\}, \{y_1\}), (e_2, \{x_2\}, \emptyset), (e_3, \emptyset, \emptyset)\}$

$FG_A^* = \{(e_1, X, \{y_1\}), (e_1, \{x_2\}, \{y_1\}), (e_1, \{x_1\}, \emptyset), (e_2, X, \{y_2\}), (e_2, X, Y)\}$.

$HK_A = \{(e_1, \{x_2\}, \{y_1\}), (e_2, X, \{y_2\}), (e_3, \emptyset, \emptyset)\}$

$HK_A \cap FG_A^* = \{(e_1, \{x_2\}, \{y_1\}), (e_2, X, \{y_2\})\}$

$(HK_A \cap FG_A)^* = \{(e_1, \{x_2\}, \{y_1\}), (e_2, X, \{y_2\}), (e_2, X, Y)\}$

$(HK_A \cap FG_A)^* \nsubseteq HK_A \cap FG_A^*$

The following example show that the converse of properties (3) is not true.

Example 3.8. Let $X = \{x_1, x_2\}, Y = \{y_1, y_2\}, E = \{e_1, e_2, e_3\}, A = \{e_1, e_2\}$

$StT_E = \{\emptyset_{DS}, X_{DS}, HK_A, H_1K_{1\ A1}, H_2K_{2\ A2}, H_3K_{3\ A3}\}$ from example 3.2

$FG_A = \{(e_1, \{x_1\}, \{y_1\}), (e_2, \{x_2\}, \emptyset), (e_3, \emptyset, \emptyset)\}$

$FG^*_A = \{(e_1, X, \{y_1\}), (e_1, \{x_2\}, \{y_1\}), (e_1, \{x_1\}, \emptyset), (e_2, X, \{y_2\}), (e_2, X, Y)\}$.

$(FG^*_A)^* = \{(e_1, \{x_2\}, \{y_2\}), (e_1, X, \emptyset), (e_2, X, \{y_2\}), (e_2, X, Y)\}$.

Therefore, $FG^*_A \nsubseteq (FG^*_A)^*$.

Theorem 3.9. Let $(X_{Ds}, StT_E, II_{(U_1,U_2)})$ be a dual soft ideal topological space the following properties are hold:

1. $(FG_A - FG^*_A) \cap (FG_A - FG^*_A)^* = \emptyset$
2. If $HK_A \in StT_E$ then $HK_A \cap FG^*_A \subset (HK_A \cap FG_A)^*$
3. For each $II_{(U_1,U_2)} \in II_{2(U_1,U_2)}$ then $IIU^*_A = \emptyset$
4. For $IIU_A \in II_{1(U_1,U_2)}$ then $(FG_A - FG^*_A)^* = FG^*_A = (FG_A - IIU^*_A)^*$

Proof .

1. Let $e_{xy} \in (FG_A - FG^*_A)$ and $e_{xy} \in (FG_A - FG^*_A)^*$ then $e_{xy} \in FG_A$ then there exist $HK_A \in StT_E(e_{xy})$ such that $HK_A \cap FG_A \in II_{(U_1,U_2)}$, let $e_{xy} \in (FG_A - FG^*_A)^*$ for each $H_1K_{1_A} \in StT_E(e_{xy})$ so $H_1K_{1_A} \cap (FG_A - FG^*_A)^* \notin II_{(U_1,U_2)}$, $(H_1K_{1_A} \cap FG_A) \cap (FG^*_A)^c \subseteq H_1K_{1_A} \cap FG_A$ hence $HK_A \cap FG_A \notin II_{(U_1,U_2)}$ which contradiction thus $(FG_A - FG^*_A) \cap (FG_A - FG^*_A)^* = \emptyset$.
2. Let $e_{xy} \in HK_A \cap FG^*_A$ then $e_{xy} \in HK_A$ and $e_{xy} \in FG^*_A$ then $LU_A \cap FG_A \notin II_{(U_1,U_2)}$ if possible that then $e_{xy} \notin (HK_A \cap FG_A)^*$ then there exist $(L_1V_{1_A})$ such that $(HK_A \cap FG_A) \cap L_1V_{1_A} \in II_{(U_1,U_2)}$ so $(HK_A \cap L_1V_{1_A}) \cap FG_A \in II_{(U_1,U_2)}$, $HK_A \cap FG_A \in II_{(U_1,U_2)}$ which contradiction then $e_{xy} \in (HK_A \cap FG_A)^*$.
3. Let $II_{1(U_1,U_2)} \in II_{2(U_1,U_2)}$ and suppose that $e_{xy} \in II^*_{1(U_1,U_2)}$ then there exist $HK_A \in StT_E(e_{xy})$ such that $HK_A \cap II_{1(U_1,U_2)} \notin II_{2(U_1,U_2)}$ then $II_{1(U_1,U_2)} \notin II_{2(U_1,U_2)}$ which contradiction thus $II^*_{1(U_1,U_2)} = \emptyset$ for each $II_{1(U_1,U_2)} \in II_{2(U_1,U_2)}$.
4. $(FG_A \cup II)^* \subset FG^*_A$ let $e_{ey} \in (FG_A \cup II)^*$ then $(FG_A \cup II_{(U_1,U_2)}) \cap HK_A \notin II_{1(U_1,U_2)}$, for each $HK_A \in StT_E(e_{xy})$ if possible that $e_{xy} \notin FG^*_A$ then there exist $H_1K_{1_A} \in StT_E(e_{xy})$ such that $II \in II_1$ and $H_1K_A \cap II_{(U_1,U_2)} \subseteq II_{1(U_1,U_2)}$ then $(H_1K_{1_A} \cap FG_A) \cup (H_1K_{1_A} \cap II_{(U_1,U_2)}) \in II_{1(U_1,U_2)}$ hence $e_{xy} \notin (FG_A \cup II_{(U_1,U_2)})^*$ which contradiction thus $e_{xy} \in FG^*_A$ so $(FG_A \cup II_{(U_1,U_2)})^* = FG^*_A$. Now since $FG_A - II^*_{(U_1,U_2)} \subseteq FG_A$ then $(FG_A - II_{(U_1,U_2)})^* \subseteq FG^*_A$, let $e_{xy} \in FG^*_A$ so $HK_B \cap FG_A \notin II_{1(U_1,U_2)}$ then there exist $HK_A \in StT_E(e_{xy})$ if possible that $e_{xy} \notin (FG_A \cup II_{(U_1,U_2)})^*$ there exist $H_1K_{1_A} \in StT_E(e_{xy})$, $(FG_A - II^c_{(U_1,U_2)}) \cap H_1K_{1_A} \in II_{1(U_1,U_2)}$. But $(FG_A - II_{(U_1,U_2)}) \cap H_1K_{1_A} = (FG_A - II^c_{(U_1,U_2)}) \cap H_1K_{1_A} = (FG_A \cap H_1K_{1_A} \cap H_1K^c_{1_A})$, $(FG_A \cap H_1K_{1_A} \cap (II^c_{(U_1,U_2)} \cup H_1K^c_{1_A})) = FG_A \cap H_1K_{1_A} \cap (H_1K_{1_A} \cap II_{(U_1,U_2)})^c$ since $II_{(U_1,U_2)} \in II_{1(U_1,U_2)}$ and $II_{1(U_1,U_2)} \cap H_1K_{1_A} \subseteq II_{(U_1,U_2)}$, $H_1K_{1_A} \cap II_{(U_1,U_2)} \in II_{(U_1,U_2)}$ by (1) and (4) $(FG_A \cap H_1K_{1_A}) \cap (II \cap H_1K_{1_A})^C \cup (II \cap H_1K_{1_A}) \in II_1 = (FG_A \cap H_1K_{1_A}) \cup (II \cap H_1K_{1_A}) \cap (II \cap H_1K_{1_{A_1}}) \in II_{1(U_1,U_2)}$ but $FG_A \cap H_1K_{1_A} \subset (FG_A \cap H_1K_{1_A}) \in II_{1(U_1,U_2)}$ but $(FG_A \cap H_1K_{1_A} \subset (FG_A \cap H_1K_{1_A}) \cup (II \cap H_1K_{1_A}))$ hence $FG_A \cap H_1K_{1_A} \in II$ which contradiction thus $e_{xy} \in (FG_A - II)^*$, $FG^*_A \subseteq (FG_A - II)^*$ there for $FG^*_A = (FG_A - II_{(U_1,U_2)})^*$.

□

Through features of the dual soft ideal and soft local function we can generate topology refine than original topology on X_{DS}. By a closure operator as follows $cl^*FG_A = FG_A \cup FG^*_A$ that is $StT^*_E = \{FG_A \subseteq X_{DS} : cl^*(X_{DS} - FG_A) = X_{DS} - FG_A\}$ in other words ,the dual soft closure satisfies.

1. $cl^*\emptyset_{DS} = \emptyset_{DS}$, $cl^*X_{DS} = X_{DS}$
2. $FG_A \subseteq cl^*FG_A$, for each $FG_A \subseteq X_{DS}$
3. $cl^*(FG_A \cup HK_A) = cl^*(FG_A) \cup cl^*(HK_A)$
4. $cl^*(cl^*(FG_A)) = cl^*(FG_A)$

So form this fact we have for each dual soft sets FG_A is dual closed if and only if $FG_A \subseteq FG^*_A$ and can prove that.

Proposition 3.10. For any dual soft ideal topological space $(X_{DS}, StT_E, II_{1(U_1,U_2)})$, if $FG_A \in StT^*_E$, then for any $e_{xy} \in FG_A$, there exist $V_1G_{1_A} \in StT_E(e_{xy})$ and $IIU_A \in II_{1(U_1,U_2)}$ satisfy $VG_A \cap (X_{DS} - IIU_A) \subseteq FG_A$.

(From definition 2.1, 2.2 and proposition 3.10 we get the main theorem).

Theorem 3.11. For dual soft ideal topological space $(X_{DS}, StT_E, II_{(U_1,U_2)})$, the family

$\beta(U_1, U_2) = \{F_1V_A - II_1U_A; F_1V_A \in StT_E \text{ and } II_1U_A \in II_{(U_1,U_2)}\}$ is basis for the dual soft topology StT^*_E.

4 Conclusion

By definition 2.1, we can construct a new dual soft points in order to extract concepts corresponding to the concept of dual soft separation axioms.

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