

BIPOLAR INTERVAL VALUED INTUITIONISTIC FUZZY NECESSITY OPERATOR

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Abstract

In this paper we have introduced the necessity operator on a Bipolar Interval Valued Intuitionistic Fuzzy Subset of a Bipolar Interval Valued Intuitionistic Fuzzy Topological space and verified its property.

Keyword

Bipolar Interval Valued Intuitionistic Fuzzy Topological Space, Bipolar Interval Valued Intuitionistic Fuzzy Set.

1. Introduction:

Lee introduced the concept of Bipolar fuzzy set. In Bipolar Intuitionistic Fuzzy Topology the membership and non-membership degree of the fuzzy set lies in the range [0,1] and [-1,0][21]. In this paper we have introduced the Bipolar Interval Valued Intuitionistic Fuzzy necessity operator on a Bipolar Interval Valued Intuitionistic Fuzzy Subset of a Bipolar Interval Valued Intuitionistic Fuzzy Topological space and verified that the necessity operator on a Bipolar Interval Valued Intuitionistic Fuzzy Subset itself forms a Bipolar Interval Valued Intuitionistic Fuzzy Topological space.

2. Definition:

Let X be a non-empty set, and let A be a Bipolar interval valued intuitionistic fuzzy set on a Bipolar Interval Valued Intuitionistic Topological Space BIVIFTS(X), then the necessity operator on A is defined as

$$\text{i. } []A = \left\{ \left\langle x, \begin{bmatrix} \underline{\underline{\underline{\underline{P}}}}(x), \underline{\underline{\underline{\underline{P}}}}(x) \\ \underline{\underline{\underline{\underline{AL}}}}(x), \underline{\underline{\underline{\underline{AU}}}}(x) \end{bmatrix}, \begin{bmatrix} 1 - \underline{\underline{\underline{\underline{P}}}}(x), 1 - \underline{\underline{\underline{\underline{P}}}}(x) \\ 1 + \underline{\underline{\underline{\underline{AL}}}}(x), 1 + \underline{\underline{\underline{\underline{AU}}}}(x) \end{bmatrix} \right\rangle \mid x \in X \right\}$$

2.1. Theorem:

Let (X, \mathbb{I}) be a Bipolar Interval Valued Intuitionistic Fuzzy Topological Space (BIVIFTS). Based on the necessity operator on a Bipolar Interval Valued Intuitionistic Fuzzy set A on X, we can also construct several BIVIFTSs on X as

$$\mathbb{Q}_N = \{ []A \mid A \sqsubseteq \mathbb{Q} \}$$

i.e., the necessity operator defined in the above definition itself forms a topology.

Proof:

In order to prove the topology we have to prove the following

Let S be a set and \mathcal{A} be a family of bipolar interval valued intuitionistic fuzzy subset of S. The family is called a Bipolar Interval Valued Intuitionistic Fuzzy Topology (BIVIFT) on S if satisfies the following axioms

i. $0_s, 1_s \in \mathbb{Q}$

ii. If $\{A_i; i \in I\} \subseteq \mathbb{Q}$, then $\bigcup_{i=1}^{\square} A_i \subseteq \mathbb{Q}$

iii. If $A_1, A_2, A_3 \dots A_n \subseteq \mathbb{Q}$, then $\bigcap_{i=1}^n A_i \subseteq \mathbb{Q}$

Let A_1, A_2, \dots, A_n be Bipolar interval valued intuitionistic fuzzy subsets on a Bipolar Interval Valued Intuitionistic Topological Space BIVIFTS(X).

To prove necessity operator is a Bipolar Interval Valued Intuitionistic Topological Space BIVIFTS(X)

i. obviously $0_s, 1_s \in \mathbb{Q}_N$

ii.

$$A \sqsubseteq B = \left\langle \begin{array}{l} \left[\mathbb{Q}_{(A \sqsubseteq B)L}(x), \mathbb{Q}_{(A \sqsubseteq B)U}(x) \right], \left[\mathbb{Q}_{(A \sqsubseteq B)L}^N(x), \mathbb{Q}_{(A \sqsubseteq B)U}^N(x) \right], \\ \left[\mathbb{Q}_{(A \sqsubseteq B)L}^P(x), \mathbb{Q}_{(A \sqsubseteq B)U}^P(x) \right], \left[\mathbb{Q}_{(A \sqsubseteq B)L}^N(x), \mathbb{Q}_{(A \sqsubseteq B)U}^N(x) \right] \end{array} \right\rangle \mid x \in X$$

where

$$\mathbb{Q}_{(A \sqsubseteq B)L}^P(x) = \min \{ \mathbb{Q}_{(A \sqsubseteq B)L}(x), \mathbb{Q}_{(A \sqsubseteq B)U}(x) \}$$

$$\begin{aligned}\mathbb{E}_{(A \square B)U}^P(x) &= \max \left\{ \mathbb{E}_{AU}^P(x), \mathbb{E}_{BU}^P(x) \right\} \\ \mathbb{E}_{(A \square B)L}^N(x) &= \max \left\{ \mathbb{E}_{AL}^N(x), \mathbb{E}_{BL}^N(x) \right\}\end{aligned}$$

$$\mathbb{E}_{(A \square B)U}^N(x) = \min \left\{ \mathbb{E}_{AU}^N(x), \mathbb{E}_{BU}^N(x) \right\}$$

$$\mathbb{E}_{(A \square B)L}^P(x) = \min \left\{ \mathbb{E}_{AL}^P(x), \mathbb{E}_{BL}^P(x) \right\}$$

$$\begin{aligned}\mathbb{E}_{(A \square B)U}^P(x) &= \max \left\{ \mathbb{E}_{AU}^P(x), \mathbb{E}_{BU}^P(x) \right\} \\ \mathbb{E}_{(A \square B)L}^N(x) &= \max \left\{ \mathbb{E}_{AL}^N(x), \mathbb{E}_{BL}^N(x) \right\}\end{aligned}$$

$$\mathbb{E}_{(A \square B)U}^N(x) = \min \left\{ \mathbb{E}_{AU}^N(x), \mathbb{E}_{BU}^N(x) \right\}$$

$$\square [] A \square [] A = \begin{cases} \begin{aligned} &\left[x, \mathbb{E}_{\square [] A_1 \square [] A_2}^P(x), \mathbb{E}_{\square [] A_1 \square [] A_2}^N(x) \right], \\ &\left[\mathbb{E}_{\square [] A_1 \square [] A_2}^P(x), \mathbb{E}_{\square [] A_1 \square [] A_2}^N(x) \right], \\ &\left[\mathbb{E}_{\square [] A_1 \square [] A_2}^P(x), \mathbb{E}_{\square [] A_1 \square [] A_2}^P(x) \right], \\ &\left[\mathbb{E}_{\square [] A_1 \square [] A_2}^P(x), \mathbb{E}_{\square [] A_1 \square [] A_2}^N(x) \right] \end{aligned} & | x \square X \\ \square & \end{cases}$$

where

$$\mathbb{E}_{\square [] A_1 \square [] A_2}^P(x) = \min \left\{ \mathbb{E}_{[] A_1 L}^P(x), \mathbb{E}_{[] A_2 L}^P(x) \right\}$$

$$\mathbb{E}_{\square [] A_1 \square [] A_2}^N(x) = \max \left\{ \mathbb{E}_{[] A_1 U}^N(x), \mathbb{E}_{[] A_2 U}^N(x) \right\}$$

$$\mathbb{E}_{\square [] A_1 \square [] A_2}^N(x) = \max \left\{ \mathbb{E}_{[] A_1 L}^N(x), \mathbb{E}_{[] A_2 L}^N(x) \right\}$$

$$\mathbb{E}_{\square [] A_1 \square [] A_2}^P(x) = \min \left\{ \mathbb{E}_{[] A_1 U}^P(x), \mathbb{E}_{[] A_2 U}^P(x) \right\}$$

$$\mathbb{E}_{\square [] A_1 \square [] A_2}^P(x) = \min \left\{ \mathbb{E}_{[] A_1 L}^P(x), \mathbb{E}_{[] A_2 L}^P(x) \right\}$$

$$\mathbb{E}_{\square [] A_1 \square [] A_2}^N(x) = \max \left\{ \mathbb{E}_{[] A_1 U}^N(x), \mathbb{E}_{[] A_2 U}^N(x) \right\}$$

$$\mathbb{E}_{\square [] A_1 \square [] A_2}^N(x) = \max \left\{ \mathbb{E}_{[] A_1 L}^N(x), \mathbb{E}_{[] A_2 L}^N(x) \right\}$$

$$\mathbb{E}_{\square [] A_1 \square [] A_2}^P(x) = \min \left\{ \mathbb{E}_{[] A_1 U}^P(x), \mathbb{E}_{[] A_2 U}^P(x) \right\}$$

then

$$\mathbb{E}_{\square [] A_1 \square [] A_2}^P(x) = \min \left\{ \mathbb{E}_{[] A_1 L}^P(x), \mathbb{E}_{[] A_2 L}^P(x) \right\}$$

$$\mathbb{E}_{\square [] A_1 \square [] A_2}^N(x) = \max \left\{ \mathbb{E}_{[] A_1 L}^N(x), \mathbb{E}_{[] A_2 L}^N(x) \right\}$$

$$\mathbb{E}_{\square [] A_1 \square [] A_2}^N(x) = \max \left\{ \mathbb{E}_{[] A_1 U}^N(x), \mathbb{E}_{[] A_2 U}^N(x) \right\}$$

$$\mathbb{E}_{(\square_{A_1 \square} \square_{A_2})U}^N(x) = \min \left\{ \mathbb{E}_{A_1 U}^N(x), \mathbb{E}_{A_2 U}^N(x) \right\}$$

$$\begin{aligned} 1 \square \mathbb{E}_{(\square_{A_1 \square} \square_{A_2})L}^p(x) &= \min \left\{ 1 \square \mathbb{E}_{A_1 L}^p(x), 1 \square \mathbb{E}_{A_2 L}^p(x) \right\} \\ 1 \square \mathbb{E}_{(\square_{A_1 \square} \square_{A_2})U}^p(x) &= \max \left\{ 1 \square \mathbb{E}_{A_1 U}^p(x), 1 \square \mathbb{E}_{A_2 U}^p(x) \right\} \end{aligned}$$

$$1 \square \mathbb{E}_{(\square_{A_1 \square} \square_{A_2})L}^N(x) = \max \left\{ 1 \square \mathbb{E}_{A_1 L}^N(x), 1 \square \mathbb{E}_{A_2 L}^N(x) \right\}$$

$$1 \square \mathbb{E}_{(\square_{A_1 \square} \square_{A_2})U}^N(x) = \min \left\{ 1 \square \mathbb{E}_{A_1 U}^N(x), 1 \square \mathbb{E}_{A_2 U}^N(x) \right\}$$

$$\begin{aligned} \square_{[\square_{A_1} \square_{A_2}]} &= \left\langle \begin{array}{l} \left[x, \mathbb{E}_{(\square_{A_1 \square} \square_{A_2})L}^p(x), \mathbb{E}_{(\square_{A_1 \square} \square_{A_2})U}^p(x) \right], \\ \left[\mathbb{E}_{(\square_{A_1 \square} \square_{A_2})L}^N(x), \mathbb{E}_{(\square_{A_1 \square} \square_{A_2})U}^N(x) \right], \\ \left[1 \square \mathbb{E}_{(\square_{A_1 \square} \square_{A_2})L}^p(x), 1 \square \mathbb{E}_{(\square_{A_1 \square} \square_{A_2})U}^p(x) \right] \end{array} \right\rangle | x \square X \\ \square_{[\square_{A_1} \square_{A_2} \square_{A_3} \dots \square_{A_i}]} &= \left\langle \begin{array}{l} \left[\mathbb{E}_{(\square_{A_1 \square} \square_{A_2} \square_{A_3} \dots \square_{A_i})L}^p(x), \mathbb{E}_{(\square_{A_1 \square} \square_{A_2} \square_{A_3} \dots \square_{A_i})U}^p(x) \right], \\ \left[\mathbb{E}_{(\square_{A_1 \square} \square_{A_2} \square_{A_3} \dots \square_{A_i})L}^N(x), \mathbb{E}_{(\square_{A_1 \square} \square_{A_2} \square_{A_3} \dots \square_{A_i})U}^N(x) \right], \\ \left[1 \square \mathbb{E}_{(\square_{A_1 \square} \square_{A_2} \square_{A_3} \dots \square_{A_i})L}^p(x), 1 \square \mathbb{E}_{(\square_{A_1 \square} \square_{A_2} \square_{A_3} \dots \square_{A_i})U}^p(x) \right], \\ \left[\mathbb{E}_{(\square_{A_1 \square} \square_{A_2} \square_{A_3} \dots \square_{A_i})L}^p(x), \mathbb{E}_{(\square_{A_1 \square} \square_{A_2} \square_{A_3} \dots \square_{A_i})U}^p(x) \right], \\ \left[\mathbb{E}_{(\square_{A_1 \square} \square_{A_2} \square_{A_3} \dots \square_{A_i})L}^N(x), \mathbb{E}_{(\square_{A_1 \square} \square_{A_2} \square_{A_3} \dots \square_{A_i})U}^N(x) \right] \end{array} \right\rangle | x \square X \end{aligned}$$

where

$$\begin{aligned} \mathbb{E}_{(\square_{A_1 \square} \square_{A_2} \square_{A_3} \dots \square_{A_i})L}^p(x) &= \min \left\{ \mathbb{E}_{A_1 L}^p(x), \mathbb{E}_{A_2 L}^p(x), \dots, \mathbb{E}_{A_i L}^p(x) \right\} \\ \mathbb{E}_{(\square_{A_1 \square} \square_{A_2} \square_{A_3} \dots \square_{A_i})U}^p(x) &= \max \left\{ \mathbb{E}_{A_1 U}^p(x), \mathbb{E}_{A_2 U}^p(x), \dots, \mathbb{E}_{A_i U}^p(x) \right\} \end{aligned}$$

$$\mathbb{E}_{(\square_{A_1 \square} \square_{A_2} \square_{A_3} \dots \square_{A_i})L}^N(x) = \max \left\{ \mathbb{E}_{A_1 L}^N(x), \mathbb{E}_{A_2 L}^N(x), \dots, \mathbb{E}_{A_i L}^N(x) \right\}$$

$$\mathbb{E}_{(\square_{A_1 \square} \square_{A_2} \square_{A_3} \dots \square_{A_i})U}^N(x) = \min \left\{ \mathbb{E}_{A_1 U}^N(x), \mathbb{E}_{A_2 U}^N(x), \dots, \mathbb{E}_{A_i U}^N(x) \right\}$$

$$\mathbb{E}_{(\square_{A_1 \square} \square_{A_2} \square_{A_3} \dots \square_{A_i})L}^p(x) = \min \left\{ \mathbb{E}_{A_1 L}^p(x), \mathbb{E}_{A_2 L}^p(x), \dots, \mathbb{E}_{A_i L}^p(x) \right\}$$

$$\mathbb{E}_{(\square_{A_1 \square} \square_{A_2} \square_{A_3} \dots \square_{A_i})U}^p(x) = \max \left\{ \mathbb{E}_{A_1 U}^p(x), \mathbb{E}_{A_2 U}^p(x), \dots, \mathbb{E}_{A_i U}^p(x) \right\}$$

$$\mathbb{E}_{(\square_{A_1 \square} \square_{A_2} \square_{A_3} \dots \square_{A_i})L}^N(x) = \max \left\{ \mathbb{E}_{A_1 L}^N(x), \mathbb{E}_{A_2 L}^N(x), \dots, \mathbb{E}_{A_i L}^N(x) \right\}$$

$$\mathbb{E}_{(\square_{A_1 \square} \square_{A_2} \square_{A_3} \dots \square_{A_i})U}^N(x) = \min \left\{ \mathbb{E}_{A_1 U}^N(x), \mathbb{E}_{A_2 U}^N(x), \dots, \mathbb{E}_{A_i U}^N(x) \right\}$$

then

$$\mathbb{E}_{(\square_{A_1 \square} \square_{A_2} \square_{A_3} \dots \square_{A_i})L}^p(x) = \min \left\{ \mathbb{E}_L^p(x), \mathbb{E}_L^p(x), \dots, \mathbb{E}_L^p(x) \right\}$$

Hence the arbitrary union of Bipolar Interval Valued Intuitionistic Necessity Operators is in Bipolar Interval Valued Intuitionistic Fuzzy Topology τ .

iii.

$$A \square B = \left\langle \begin{array}{l} \left[x, \square^{\rho_{(A \square B)}_L}(x), \square^{\rho_{(A \square B)}_U}(x) \right], \left[\square^N(x), \square^{N_{(A \square B)}_U}(x) \right], \\ \left[\square^P_{(A \square B)_L}(\chi), \square^P_{(A \square B)_U}(\chi) \right] \left[\square^N_{(A \square B)_L}(\chi), \square^N_{(A \square B)_U}(\chi) \right] \end{array} \right\rangle | x \square X$$

where

$$\exists^p_{(A \square B)_L}(x) = \max \left\{ \exists^p_{AL}(x), \exists^p_{BL}(x) \right\}$$

$$\exists^p_{(A \square B)U}(x) = \min \left\{ \exists^p_{AU}(x), \exists^p_{BU}(x) \right\}$$

$$\min_{\substack{AL \\ BL}} \left\{ \mathbb{E}^N(x), \mathbb{E}^N(x) \right\}$$

$$\bigvee_{(A \square B)U}^N(x) = \max \left\{ \bigvee_{AU}^N(x), \bigvee_{BU}^N(x) \right\}$$

$$\mathbb{I}_{(A \square B)_L}^p(x) = \max \left\{ \mathbb{I}_{A_L}^p(x), \mathbb{I}_{B_L}^p(x) \right\}$$

$$\mathbb{I}_{(A \square B)U}^p(x) = \min \left\{ \mathbb{I}_U^p(x), \mathbb{I}_B^p(x) \right\}$$

$$\min_{\substack{(A \square B)L \\ AL \\ BL}} \{ \mathbb{I}^N(x), \mathbb{I}^N(x) \}$$

$$\mathbb{E}_{(A \square B)U}^N(x) = \max \left\{ \mathbb{E}_{AU}^N(x), \mathbb{E}_{BU}^N(x) \right\}$$

then

$$(\begin{bmatrix} A_1 & A_2 \end{bmatrix}) = \begin{cases} \begin{bmatrix} \mathbb{E}_{A_1 L}^p(x), \mathbb{E}_{A_2 L}^p(x) \\ \mathbb{E}_{A_1 U}^p(x), \mathbb{E}_{A_2 U}^p(x) \\ \mathbb{E}_{A_1 L}^N(x), \mathbb{E}_{A_2 L}^N(x) \\ \mathbb{E}_{A_1 U}^N(x), \mathbb{E}_{A_2 U}^N(x) \end{bmatrix}, & |x| \leq X \\ \begin{bmatrix} \mathbb{E}_{A_1 L}^p(x), \mathbb{E}_{A_2 L}^p(x) \\ \mathbb{E}_{A_1 U}^p(x), \mathbb{E}_{A_2 U}^p(x) \\ \mathbb{E}_{A_1 L}^N(x), \mathbb{E}_{A_2 L}^N(x) \\ \mathbb{E}_{A_1 U}^N(x), \mathbb{E}_{A_2 U}^N(x) \end{bmatrix}, & |x| > X \end{cases}$$

where

$$\begin{aligned} \mathbb{E}_{A_1 L}^p(x) &= \max \left\{ \mathbb{E}_{A_1 L}^p(x), \mathbb{E}_{A_2 L}^p(x) \right\} \\ \mathbb{E}_{A_1 U}^p(x) &= \min \left\{ \mathbb{E}_{A_1 U}^p(x), \mathbb{E}_{A_2 U}^p(x) \right\} \\ \mathbb{E}_{A_1 L}^N(x) &= \min \left\{ \mathbb{E}_{A_1 L}^N(x), \mathbb{E}_{A_2 L}^N(x) \right\} \\ \mathbb{E}_{A_1 U}^N(x) &= \max \left\{ \mathbb{E}_{A_1 U}^N(x), \mathbb{E}_{A_2 U}^N(x) \right\} \\ \mathbb{E}_{A_2 L}^p(x) &= \max \left\{ \mathbb{E}_{A_1 L}^p(x), \mathbb{E}_{A_2 L}^p(x) \right\} \\ \mathbb{E}_{A_2 U}^p(x) &= \min \left\{ \mathbb{E}_{A_1 U}^p(x), \mathbb{E}_{A_2 U}^p(x) \right\} \\ \mathbb{E}_{A_2 L}^N(x) &= \min \left\{ \mathbb{E}_{A_1 L}^N(x), \mathbb{E}_{A_2 L}^N(x) \right\} \\ \mathbb{E}_{A_2 U}^N(x) &= \max \left\{ \mathbb{E}_{A_1 U}^N(x), \mathbb{E}_{A_2 U}^N(x) \right\} \end{aligned}$$

then

$$\begin{aligned} \mathbb{E}_{A_1 L}^p(x) &= \max \left\{ \mathbb{E}_{AL}^p(x), \mathbb{E}_{AL}^p(x) \right\} \\ \mathbb{E}_{A_1 U}^p(x) &= \min \left\{ \mathbb{E}_{AU}^p(x), \mathbb{E}_{AU}^p(x) \right\} \\ \mathbb{E}_{A_1 L}^N(x) &= \min \left\{ \mathbb{E}_{AL}^N(x), \mathbb{E}_{AL}^N(x) \right\} \\ \mathbb{E}_{A_1 U}^N(x) &= \max \left\{ \mathbb{E}_{AU}^N(x), \mathbb{E}_{AU}^N(x) \right\} \\ 1 \square \mathbb{E}_{A_1 L}^p(x) &= \max \left\{ 1 \square \mathbb{E}_{AL}^p(x), 1 \square \mathbb{E}_{AL}^p(x) \right\} \\ 1 \square \mathbb{E}_{A_1 U}^p(x) &= \min \left\{ 1 \square \mathbb{E}_{AU}^p(x), 1 \square \mathbb{E}_{AU}^p(x) \right\} \\ 1 \square \mathbb{E}_{A_1 L}^N(x) &= \min \left\{ 1 \square \mathbb{E}_{AL}^N(x), 1 \square \mathbb{E}_{AL}^N(x) \right\} \end{aligned}$$

$$1 \sqcup \bigoplus_{\{A_1, A_2\} \in \binom{[N]}{2}} U(x) = \max \left\{ 1 \sqcup \bigoplus_{A_1 \in \binom{[N]}{1}} U(x), 1 \sqcup \bigoplus_{A_2 \in \binom{[N]}{2}} U(x) \right\}$$

$$\square [] A \square [] A_1 = \left\{ \begin{array}{l} x, \square \square p \\ (\square [] A_1 \square [] A_2) L \\ \square \square N (\square [] A_1 \square [] A_2) L \\ \square \square \square \square p (\square [] A_1 \square [] A_2) L \\ \square \square \square \square N (\square [] A_1 \square [] A_2) L \\ \square \square \square \square (\square [] A_1 \square [] A_2) L \end{array} \right. ,$$

$$\square [] A \square [] A_2 = \left\{ \begin{array}{l} (\square [] A_1 \square [] A_2) U \\ (\square [] A_1 \square [] A_2) U \\ (\square [] A_1 \square [] A_2) U \\ (\square [] A_1 \square [] A_2) U \\ (\square [] A_1 \square [] A_2) U \end{array} \right. ,$$

$$\square [] A \square [] A_1 \dots [] A_i = \left\{ \begin{array}{l} x, \square \square p \\ (\square [] A_1 \square [] A_2 \square \dots [] A_i) L \\ \square \square N (\square [] A_1 \square [] A_2 \square \dots [] A_i) L \\ \square \square \square \square p (\square [] A_1 \square [] A_2 \square \dots [] A_i) L \\ \square \square \square \square N (\square [] A_1 \square [] A_2 \square \dots [] A_i) L \\ \square \square \square \square (\square [] A_1 \square [] A_2 \square \dots [] A_i) L \end{array} \right. ,$$

$$\square [] A \square [] A_2 \dots [] A_i = \left\{ \begin{array}{l} (\square [] A_1 \square [] A_2 \square \dots [] A_i) U \\ (\square [] A_1 \square [] A_2 \square \dots [] A_i) U \\ (\square [] A_1 \square [] A_2 \square \dots [] A_i) U \\ (\square [] A_1 \square [] A_2 \square \dots [] A_i) U \\ (\square [] A_1 \square [] A_2 \square \dots [] A_i) U \end{array} \right. ,$$

where

$$\max \left\{ \left[\begin{array}{c} \vdash \\ []_{A_1} \square []_{A_2} \square \dots []_{A_i} L \end{array} \right] x, \left[\begin{array}{c} \vdash \\ []_{A_1 L} \end{array} \right] x, \left[\begin{array}{c} \vdash \\ []_{A_2 L} \end{array} \right] x, \dots, \left[\begin{array}{c} \vdash \\ []_{A_i L} \end{array} \right] x \right\}$$

$$\min \left\{ \mathbb{E}^P_{A_1 U} (x), \mathbb{E}^P_{A_2 U} (x), \dots, \mathbb{E}^P_{A_d U} (x) \right\}$$

$$\min \left\{ \left[\begin{array}{c} x \\ \vdots \\ x \end{array} \right]_{A_1 L}, \left[\begin{array}{c} x \\ \vdots \\ x \end{array} \right]_{A_2 L}, \dots, \left[\begin{array}{c} x \\ \vdots \\ x \end{array} \right]_{A_i L} \right\}$$

$$\mathbb{E}^N_{\left(\int_{A_1 \square \dots \square A_2 \square \dots \square A_i}\right)U}(x) = \max \left\{ \mathbb{E}^N_{\int_{A_1 U}}(x), \mathbb{E}^N_{\int_{A_2 U}}(x), \dots, \mathbb{E}^N_{\int_{A_i U}}(x) \right\}$$

$$\max_{\left(\int_0^p \int_{A_1} \square \int_0^p \int_{A_2} \square \dots \int_0^p \int_{A_d}\right)_L} (x) = \max \left\{ \int_0^p \int_{A_1 L} (x), \int_0^p \int_{A_2 L} (x), \dots, \int_0^p \int_{A_d L} (x) \right\}$$

$$\mathbb{I}_{\left(\bigcup_{A_1}^p \bigcap_{A_2}^p \dots \bigcap_{A_i}^p\right)U}(x) = \min \left\{ \mathbb{I}_{A_1 U}^p(x), \mathbb{I}_{A_2 U}^p(x), \dots, \mathbb{I}_{A_i U}^p(x) \right\}$$

$$\mathbb{E}^N_{\left(\int_0^{\cdot} \mathbb{1}_{A_1} d \cdot, \int_0^{\cdot} \mathbb{1}_{A_2} d \cdot, \dots, \int_0^{\cdot} \mathbb{1}_{A_L} d \cdot\right)_L} (x) = \min \left\{ \mathbb{E}^N_{\int_0^{\cdot} \mathbb{1}_{A_1 L} d \cdot}(x), \mathbb{E}^N_{\int_0^{\cdot} \mathbb{1}_{A_2 L} d \cdot}(x), \dots, \mathbb{E}^N_{\int_0^{\cdot} \mathbb{1}_{A_L L} d \cdot}(x) \right\}$$

$$\max_{\{\mathbb{I}_{[1,4]}, \mathbb{I}_{[1,4]}, \mathbb{I}_{[1,4]} \}^U} (x) = \max \left\{ \mathbb{I}_{[1,4]_U}^N(x), \mathbb{I}_{[1,4]_U}^N(x), \dots, \mathbb{I}_{[1,4]_U}^N(x) \right\}$$

then

$$\max_{\{A_1L, A_2L, \dots, A_rL\}} \left(x \right) = \max \left\{ \max_{A_1L} \left(x \right), \max_{A_2L} \left(x \right), \dots, \max_{A_rL} \left(x \right) \right\}$$

$$\begin{aligned}
 & \min_{\left(\left[\begin{array}{c} A_1 \\ A_2 \\ \vdots \\ A_i \end{array}\right] U\right)}^{\mathbb{B}^P}(x) = \min \left\{ \min_{A_1 U}^{\mathbb{B}^P}(x), \min_{A_2 U}^{\mathbb{B}^P}(x), \dots, \min_{A_i U}^{\mathbb{B}^P}(x) \right\} \\
 & \min_{\left(\left[\begin{array}{c} A_1 \\ A_2 \\ \vdots \\ A_i \end{array}\right] L\right)}^{\mathbb{B}^N}(x) = \min \left\{ \min_{A_1 L}^{\mathbb{B}^N}(x), \min_{A_2 L}^{\mathbb{B}^N}(x), \dots, \min_{A_i L}^{\mathbb{B}^N}(x) \right\} \\
 & \max_{\left(\left[\begin{array}{c} A_1 \\ A_2 \\ \vdots \\ A_i \end{array}\right] U\right)}^{\mathbb{B}^N}(x) = \max \left\{ \max_{A_1 U}^{\mathbb{B}^N}(x), \max_{A_2 U}^{\mathbb{B}^N}(x), \dots, \max_{A_i U}^{\mathbb{B}^N}(x) \right\} \\
 & \max_{\left(\left[\begin{array}{c} A_1 \\ A_2 \\ \vdots \\ A_i \end{array}\right] L\right)}^{\mathbb{B}^P}(x) = \max \left\{ \max_{A_1 L}^{\mathbb{B}^P}(x), \max_{A_2 L}^{\mathbb{B}^P}(x), \dots, \max_{A_i L}^{\mathbb{B}^P}(x) \right\} \\
 & \min_{\left(\left[\begin{array}{c} A_1 \\ A_2 \\ \vdots \\ A_i \end{array}\right] U\right)}^{1 \square \mathbb{B}^P}(x) = \min \left\{ \min_{A_1 U}^{1 \square \mathbb{B}^P}(x), \min_{A_2 U}^{1 \square \mathbb{B}^P}(x), \dots, \min_{A_i U}^{1 \square \mathbb{B}^P}(x) \right\} \\
 & \min_{\left(\left[\begin{array}{c} A_1 \\ A_2 \\ \vdots \\ A_i \end{array}\right] L\right)}^{1 \square \mathbb{B}^P}(x) = \min \left\{ \min_{A_1 L}^{1 \square \mathbb{B}^P}(x), \min_{A_2 L}^{1 \square \mathbb{B}^P}(x), \dots, \min_{A_i L}^{1 \square \mathbb{B}^P}(x) \right\} \\
 & \max_{\left(\left[\begin{array}{c} A_1 \\ A_2 \\ \vdots \\ A_i \end{array}\right] L\right)}^{1 \square \mathbb{B}^N}(x) = \max \left\{ \max_{A_1 L}^{1 \square \mathbb{B}^N}(x), \max_{A_2 L}^{1 \square \mathbb{B}^N}(x), \dots, \max_{A_i L}^{1 \square \mathbb{B}^N}(x) \right\} \\
 & \max_{\left(\left[\begin{array}{c} A_1 \\ A_2 \\ \vdots \\ A_i \end{array}\right] U\right)}^{1 \square \mathbb{B}^N}(x) = \max \left\{ \max_{A_1 U}^{1 \square \mathbb{B}^N}(x), \max_{A_2 U}^{1 \square \mathbb{B}^N}(x), \dots, \max_{A_i U}^{1 \square \mathbb{B}^N}(x) \right\} \\
 & \square [] A_1 \square [] A_2 \square \dots \square [] A_i = \square \left[\begin{array}{c} \square x, \min_{\left(\left[\begin{array}{c} A_1 \\ A_2 \\ \vdots \\ A_i \end{array}\right] L\right)}^{\mathbb{B}^P}(x), \min_{\left(\left[\begin{array}{c} A_1 \\ A_2 \\ \vdots \\ A_i \end{array}\right] U\right)}^{\mathbb{B}^P}(x) \\ \min_{\left(\left[\begin{array}{c} A_1 \\ A_2 \\ \vdots \\ A_i \end{array}\right] L\right)}^{\mathbb{B}^N}(x), \min_{\left(\left[\begin{array}{c} A_1 \\ A_2 \\ \vdots \\ A_i \end{array}\right] U\right)}^{\mathbb{B}^N}(x) \\ \max_{\left(\left[\begin{array}{c} A_1 \\ A_2 \\ \vdots \\ A_i \end{array}\right] L\right)}^{1 \square \mathbb{B}^P}(x), \max_{\left(\left[\begin{array}{c} A_1 \\ A_2 \\ \vdots \\ A_i \end{array}\right] U\right)}^{1 \square \mathbb{B}^P}(x) \\ \max_{\left(\left[\begin{array}{c} A_1 \\ A_2 \\ \vdots \\ A_i \end{array}\right] L\right)}^{1 \square \mathbb{B}^N}(x), \max_{\left(\left[\begin{array}{c} A_1 \\ A_2 \\ \vdots \\ A_i \end{array}\right] U\right)}^{1 \square \mathbb{B}^N}(x) \end{array} \right] \square X
 \end{aligned}$$

Hence the finite intersection of Bipolar Interval Valued Intuitionistic Necessity Operators is in Bipolar Interval Valued Intuitionistic Fuzzy Topology τ .

Hence the Bipolar Interval Valued Intuitionistic Necessity Operators itself forms a Bipolar Interval Valued Intuitionistic Fuzzy Topology τ .

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