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Interval-Valued Fuzzy Extremally Disconnected Spaces

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ABSTRACT: In this paper, we have study the characterizations of submaximal spaces and extremally disconnected spaces in interval-valued fuzzy topological spaces.

Key Words: Topological spaces, IVF open set, IVF regular open set.

Contents

1. Introduction

The concept of a fuzzy subset was introduced and studied by L. A. Zadeh [9] in the year 1965. The subsequent research activities in this area and related areas have found applications in many branches of science and engineering. C. L. Chang [3] introduced and studied fuzzy topological spaces in 1968 as a generalization of topological spaces. Many researchers like this concept and many others have contributed to the development of fuzzy topological spaces. M. B. Gorzalczany [4] introduced the concept of interval-valued fuzzy set which is a generalization of fuzzy sets. T. K. Mondal and S. K. Samantha [8] introduced the topology of interval valued fuzzy sets. Y. B. Jun et. al. [5] introduced the concepts of IVF semiopen sets, IVF preopen sets and IVF α-open (=IVF strongly semiopen [6]) sets and studied some results about them. In this paper, we have study the characterizations of submaximal spaces and extremally disconnected spaces in interval-valued fuzzy topological spaces.

2. Preliminaries

Let $D[0,1]$ be the set of all closed subintervals of the unit interval $[0,1]$. The elements of $D[0,1]$ are generally denoted by capital letters $M, N, ...$, and note that $M = [M^L, M^U]$, where M^L and M^U are the lower and the upper end points respectively. Especially, we denote $\mathbf{0} = [0,0]$, $\mathbf{1} = [1,1]$, and $\mathbf{a} = [a,a]$ for every $a \in (0,1)$. We also note that (i) $(\forall M, N \in D[0,1])(M = N \Leftrightarrow M^L = N^L, M^U = N^U)$. (ii) $(\forall M, N \in D[0,1])(M \subseteq N \Leftrightarrow M^L \subseteq N^L, M^U \subseteq N^U)$. For every $M \in D[0,1]$, the complement of M, denoted by M^c, is defined by $M^c = 1 - M = [1 - M^U, 1 - M^L]$. Let X be a nonempty set. A mapping $A : X \to D[0,1]$ is called an interval-valued fuzzy set (briefly, an IVF set) in X. For each $x \in X$, $A(x)$ is a closed interval whose lower and upper end points are denoted by $A(x)^L$ and $A(x)^U$espectively. For any $[a,b] \in D[0,1]$, the IVF set whose value is the interval $[a,b]$ for all $x \in X$ is denoted by $\widetilde{[a,b]}$. In particular, for any $a \in [0,1]$, the IVF set whose value is $\mathbf{a} = [a,a]$ for all $x \in X$ is denoted by simply $\widetilde{a}$. For a point $p \in X$ and for $[a,b] \in D[0,1]$ with $b > 0$, the IVF set which takes the value $[a,b]$ at p and $\mathbf{0}$ elsewhere in X is called an interval-valued fuzzy point (briefly, an IVF point) and is denoted by $[a,b]_p$. In particular, if $b = a$, then it is also denoted by a_p. Denote by $IVF(X)$ the set of all IVF sets in X. For every $\mathcal{A}, \mathcal{B} \in IVF(X)$, we define

$$\mathcal{A} = \mathcal{B} \Leftrightarrow (\forall x \in X)([\mathcal{A}(x)]^L = [\mathcal{B}(x)]^L \ and \ [\mathcal{A}(x)]^U = [\mathcal{B}(x)]^U),$$

$$\mathcal{A} \subset \mathcal{B} \Leftrightarrow (\forall x \in X)([\mathcal{A}(x)]^L \subseteq [\mathcal{B}(x)]^L \ and \ [\mathcal{A}(x)]^U \subseteq [\mathcal{B}(x)]^U).$$

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The complement $\mathcal{A}^c$ of $\mathcal{A}$ is defined by

$$[\mathcal{A}^c(x)]^L = 1 - [\mathcal{A}(x)]^U \quad and \quad [\mathcal{A}^c(x)]^U = 1 - [\mathcal{A}(x)]^L$$

for all $x \in X$. For a family of IVF sets $\{\mathcal{A}_i : i \in A\}$, where Λ is an index set, the union $G = \bigcup_{i\in\Lambda} \mathcal{A}_i$ and the intersection $F = \bigcap_{i\in\Lambda} \mathcal{A}_i$ are defined by

$$(\forall x \in X)([G(x)]^L = \sup_{i\in\Lambda}[\mathcal{A}_i(x)]^L, [G(x)]^U = \sup_{i\in\Lambda}[\mathcal{A}_i(x)]^U),$$

$$(\forall x \in X)([G(x)]^L = \inf_{i\in\Lambda}[\mathcal{A}_i(x)]^L, [G(x)]^U = \inf_{i\in\Lambda}[\mathcal{A}_i(x)]^U),$$

respectively.

Definition 2.1 *[8] A family τ of IVF sets in X is called an interval-valued fuzzy topology (briefly, IVF topology) for X if it satisfies:*

1. $\mathbf{0}, \mathbf{1} \in \tau$,
2. $\mathcal{A}, \mathcal{B} \in \tau \Rightarrow \mathcal{A} \cap \mathcal{B} \in \tau$,
3. $\mathcal{A}_i \in \tau$, $i \in \Lambda \Rightarrow \bigcup_{i\in\Lambda} \mathcal{A}_i \in \tau$.

Every member of τ is called an IVF open set. An IVF set $\mathcal{A}$ in X is called an IVF closed set if the complement of $\mathcal{A}$ is an IVF open set, that is, $\mathcal{A}^c \in \tau$. Moreover, (X, τ) is called an interval-valued fuzzy topological space (briefly, IVF topological space).

Definition 2.2 *[8] For an IVF set $\mathcal{A}$ in an IVF topological space (X, τ), the IVF closure and the IVF interior of $\mathcal{A}$, denoted by $\mathrm{Cl}(\mathcal{A})$, $\mathrm{Int}(\mathcal{A})$espectively, are defined as $\mathrm{Cl}(\mathcal{A}) = \cap\{\mathcal{B} \in I^X : \mathcal{B}$ is IVF closed and $\mathcal{A} \subset \mathcal{B}\}$, $\mathrm{Int}(\mathcal{A}) = \cup\{\mathcal{B} \in I^X : \mathcal{B}$ is IVF open and $\mathcal{B} \subset \mathcal{A}\}$, respectively. Note that $\mathrm{Int}(\mathcal{A})$ is the largest IVF open set which is contained in $\mathcal{A}$, and that $\mathcal{A}$ is IVF open if and only if $\mathcal{A} = \mathrm{Int}(\mathcal{A})$.*

Definition 2.3 *[2,4,5,7] An IVF set $\mathcal{A}$ of an IVF topological space (X, τ) is said to be*

1. *strongly semiopen if* $\mathcal{A} \subseteq \mathrm{Int}(\mathrm{Cl}(\mathrm{Int}(\mathcal{A})))$,
2. *semiopen if* $\mathcal{A} \subseteq \mathrm{Cl}(\mathrm{Int}(\mathcal{A}))$,
3. *preopen if* $\mathcal{A} \subseteq \mathrm{Int}(\mathrm{Cl}(\mathcal{A}))$,
4. *semi-preopen if* $\mathcal{A} \subseteq \mathrm{Cl}(\mathrm{Int}(\mathrm{Cl}(\mathcal{A})))$.
5. *t-set if* $\mathrm{Int}(\mathcal{A}) = \mathrm{Int}(\mathrm{Cl}(\mathcal{A}))$.
6. *semiregular set if $\mathcal{A}$ is an IVF t-set and IVF semiopen.*
7. *AB-set if $\mathcal{A} = \mathcal{B} \cap \mathcal{C}$, where $\mathcal{B} \in \tau$ and $\mathcal{C}$ is γ-semiregular.*
8. *dense if* $\mathrm{Cl}(\mathcal{A}) = X$.

The complement of an IVF strongly semiopen (resp. semiopen, preopen, semi-preopen) set is called an IVF strongly semiclosed (resp. semiclosed, preclosed, semi-preclosed) set. The family of all IVF regular open (resp. IVF preopen, IVF semiopen, IVF β-open) sets of (X, τ) is denoted by $RO(X)$ (resp. $PO(X)$, $SO(X)$, $\beta O(X)$).

3. On interval-valued fuzzy submaximal spaces

Definition 3.1 *An IVF topological space (X, τ) is said to be IVF submaximal if every IVF dense subset of X is IVF open.*

Lemma 3.1 *If (X, τ) is IVF submaximal, then $\tau = PO(X)$.*

Proof: Clearly $\tau \subset PO(X)$. Now, $\mathcal{A} \in PO(X)$, then $\mathcal{A} = \mathcal{B} \cap \mathcal{C}$ for some $\mathcal{B} \in \tau$ and dense set $\mathcal{C}$ of X. Therefore, if (X, τ) is IVF submaximal, $\mathcal{C} \in \tau$, then $\mathcal{A} \in \tau$. □

Theorem 3.1 *For an IVF topological space (X, τ), the following are equivalent:*

1. *X is IVF submaximal.*
2. *Every IVF preopen set is IVF open.*
3. *Every IVF preopen set is IVF semiopen and every IVF strongly semiopen set is IVF open.*

Proof: (1) $\Rightarrow$ (2): It follows from Lemma 3.1.
(2) $\Rightarrow$ (3): Suppose that every IVF preopen set is IVF open. Then every IVF preopen set is IVF semiopen.
(3) $\Rightarrow$ (1): Let $\mathcal{A}$ be a dense subset of X. Since $\mathrm{Cl}(\mathcal{A}) = X$, then $\mathcal{A}$ is IVF preopen. By (3), $\mathcal{A}$ is IVF semiopen. Since a set is IVF strongly semiopen if and only if it is IVF preopen and IVF semiopen, then $\mathcal{A}$ is IVF strongly semiopen. Thus, by (3), $\mathcal{A}$ is IVF open; hence X is IVF submaximal. □

Theorem 3.2 *For an IVF topological space (X, τ), the following are equivalent:*

1. *X is IVF submaximal.*
2. *Every IVF preopen set is an IVF $\mathcal{AB}$-set.*
3. *Every IVF dense set is an IVF $\mathcal{AB}$-set.*

Proof: (1) $\Rightarrow$ (2): Let $\mathcal{A}$ be an IVF preopen set. Since X is IVF submaximal, by Theorem 3.1, $\mathcal{A}$ is IVF open. Since X is both IVF open and IVF semiregular, every IVF open set is IVF $\mathcal{AB}$-set. It follows that $\mathcal{A}$ is an IVF $\mathcal{AB}$-set.
(2) $\Rightarrow$ (3): Let $\mathcal{A}$ be an IVF dense set. Since every IVF dense set is IVF preopen, by (2) $\mathcal{A}$ is an IVF $\mathcal{AB}$-set.
(3) $\Rightarrow$ (1): Let $\mathcal{A}$ be an IVF dense set. By (3), $\mathcal{A}$ is an IVF $\mathcal{AB}$-set. Since every IVF dense set is IVF preopen, $\mathcal{A}$ is IVF preopen. Then $\mathcal{A} \subset \mathrm{Int}(\mathrm{Cl}(\mathcal{A}))$. Furthermore, because $\mathcal{A}$ is an IVF $\mathcal{AB}$-set, we have $\mathcal{A} = \mathcal{B} \cap \mathcal{C}$, where $\mathcal{B} \in \tau$ and $\mathcal{C}$ is IVF semiregular. Then $\mathcal{A} \subset \mathrm{Int}(\mathrm{Cl}(\mathcal{B} \cap \mathcal{C})) = \mathrm{Int}(\mathrm{Cl}(\mathcal{B}) \cap \mathrm{Cl}(\mathcal{C})) = \mathrm{Int}(\mathrm{Cl}(\mathcal{B})) \cap \mathrm{Int}(\mathrm{Cl}(\mathcal{C}))$. Since $\mathcal{C}$ is IVF semiregular, $\mathcal{C}$ is also IVF t-set. Then we have $\mathcal{A} \subset \mathrm{Int}(\mathrm{Cl}(\mathcal{B})) \cap \mathrm{Int}(\mathcal{C})$. Also $\mathcal{A} = \mathcal{B} \cap \mathcal{A} \subset \mathcal{B} \cap (\mathrm{Int}(\mathrm{Cl}(\mathcal{B})) \cap \mathrm{Int}(\mathcal{C})) = \mathcal{B} \cap (\mathrm{Int}(\mathrm{Cl}(\mathcal{B}))) \cap \mathrm{Int}(\mathcal{C}) = \mathcal{B} \cap \mathrm{Int}(\mathcal{C}) = \mathrm{Int}(\mathcal{B} \cap \mathcal{C}) = \mathrm{Int}(\mathcal{A})$. Hence, $\mathcal{A} \in \tau$. Therefore, X is IVF submaximal. □

Definition 3.2 *An IVF topological space (X, τ) is said to be IVF extremally disconnected if $\mathrm{Cl}(\mathcal{A}) \in \tau$ for every $\mathcal{A} \in \tau$.*

Theorem 3.3 *For an IVF topological space (X, τ), the following are equivalent:*

1. *X is IVF extremally disconnected.*
2. *$\mathrm{Int}(\mathcal{A})$ is IVF closed for every IVF closed subset $\mathcal{A}$ of X.*
3. *$\mathrm{Cl}(\mathrm{Int}(\mathcal{A})) \subset \mathrm{Int}(\mathrm{Cl}(\mathcal{A}))$ for every $\mathcal{A} \in I^X$.*
4. *Every IVF semiopen set is IVF preopen.*

5. *The IVF closure of every IVF β-open subset of X is IVF open.*

6. *Every IVF β-open set is IVF preopen.*

7. *For every $\mathcal{A} \in I^X$, $\mathcal{A}$ is IVF strongly semiopen if and only if it is IVF semiopen.*

Proof: (1) $\Rightarrow$ (2): Let $\mathcal{A}$ be an IVF closed set. Then $\mathbf{1} - \mathcal{A}$ is IVF open. By (1), $\mathrm{Cl}(\mathbf{1} - \mathcal{A}) = \mathbf{1} - \mathrm{Int}(\mathcal{A})$ is IVF open. Thus, $\mathrm{Int}(\mathcal{A})$ is IVF closed.
(2) $\Rightarrow$ (3): Let $\mathcal{A} \in I^X$. Then $\mathbf{1} - \mathrm{Int}(\mathcal{A})$ is IVF closed in X and by (2) $\mathrm{Int}(\mathbf{1} - \mathrm{Int}(\mathcal{A}))$ is IVF closed in X. Therefore, $\mathrm{Cl}(\mathrm{Int}(\mathcal{A}))$ is IVF open in X and hence, $\mathrm{Cl}(\mathrm{Int}(\mathcal{A})) \subset \mathrm{Int}(\mathrm{Cl}(\mathcal{A}))$.
(3) $\Rightarrow$ (4): Let $\mathcal{A}$ be IVF semiopen. By (3), we have $\mathcal{A} \subset \mathrm{Cl}(\mathcal{A}) \subset \mathrm{Int}(\mathrm{Cl}(\mathcal{A}))$. Thus, $\mathcal{A}$ is IVF preopen.
(4) $\Rightarrow$ (5): Let $\mathcal{A}$ be an IVF β-open set. Then $\mathrm{Cl}(\mathcal{A})$ is IVF semiopen. By (4), $\mathrm{Cl}(\mathcal{A})$ is IVF preopen. Thus, $\mathrm{Cl}(\mathcal{A}) \subset \mathrm{Int}(\mathrm{Cl}(\mathcal{A}))$ and hence $\mathrm{Cl}(\mathcal{A})$ is IVF open.
(5) $\Rightarrow$ (6): Let $\mathcal{A}$ be IVF β-open. By (5), $\mathrm{Cl}(\mathcal{A}) = \mathrm{Int}(\mathrm{Cl}(\mathcal{A}))$ and hence $\mathcal{A}$ is IVF preopen.
(6) $\Rightarrow$ (7): Let $\mathcal{A}$ be IVF semiopen set. Since an IVF semiopen set is IVF β-open, then by (6), it is IVF preopen. Since $\mathcal{A}$ is IVF semiopen and IVF preopen, $\mathcal{A}$ is IVF strongly semiopen.
(7) $\Rightarrow$ (1): Let $\mathcal{A}$ be an IVF open set of X. Then $\mathrm{Cl}(\mathcal{A})$ is IVF semiopen and by (7) $\mathrm{Cl}(\mathcal{A})$ is IVF strongly semiopen. Therefore, $\mathrm{Cl}(\mathcal{A}) \subset \mathrm{Int}(\mathrm{Cl}(\mathrm{Int}(\mathrm{Cl}(\mathcal{A})))) = \mathrm{Int}(\mathrm{Cl}(\mathcal{A}))$ and hence, $\mathrm{Cl}(\mathcal{A}) = \mathrm{Int}(\mathrm{Cl}(\mathcal{A}))$. Hence $\mathrm{Cl}(\mathcal{A})$ is IVF open and X is IVF extremally disconnected. □

Lemma 3.2 *A subset $\mathcal{A}$ of an IVF topological space (X, τ) is IVF semiopen if and only if* $\mathrm{Cl}(\mathcal{A}) = \mathrm{Cl}(\mathrm{Int}(\mathcal{A}))$.

Proof: Let $\mathcal{A}$ be an IVF semiopen set. We have $\mathcal{A} \subset \mathrm{Cl}(\mathrm{Int}(\mathcal{A}))$ and hence $\mathrm{Cl}(\mathcal{A}) \subset \mathrm{Cl}(\mathrm{Int}(\mathcal{A}))$. Since $\mathrm{Cl}(\mathrm{Int}(\mathcal{A})) \subset \mathrm{Cl}(\mathcal{A})$, $\mathrm{Cl}(\mathcal{A}) = \mathrm{Cl}(\mathrm{Int}(\mathcal{A}))$. Conversely, since $\mathrm{Cl}(\mathcal{A}) = \mathrm{Cl}(\mathrm{Int}(\mathcal{A}))$, $\mathcal{A} \subset \mathrm{Cl}(\mathcal{A}) = \mathrm{Cl}(\mathrm{Int}(\mathcal{A}))$. Thus, $\mathcal{A}$ is IVF semiopen. □

Theorem 3.4 *For an IVF topological space (X, τ), the following properties are equivalent:*

1. *X is IVF submaximal and IVF extremally disconnected.*

2. *Any subset of X is IVF β-open if and only if IVF open.*

Proof: (1) $\Rightarrow$ (2): Let X be IVF submaximal and IVF extremally disconnected. By Theorem 3.3, every IVF β-open set is IVF preopen. By Theorem 3.1, every IVF preopen set is IVF open. Thus, every IVF β-open set is IVF open. The converse follows from the fact that every IVF open set is IVF β-open.
(2) $\Rightarrow$ (1): Suppose that any subset of X is IVF β-open if and only if it is IVF open. Since every IVF β-open set is IVF open and so IVF preopen, by Theorem 3.3, X is IVF extremally disconnected. Since every IVF preopen set is IVF open, by Theorem 3.1 X is IVF submaximal. □

Corollary 3.1 *For a IVF submaximal and IVF extremally disconnected space (X, τ), the following properties are equivalent:*

1. *$\mathcal{A}$ is IVF β-open,*

2. *$\mathcal{A}$ is IVF semiopen,*

3. *$\mathcal{A}$ is IVF preopen,*

4. *$\mathcal{A}$ is IVF strongly semiopen,*

5. *$\mathcal{A}$ is IVF open.*

Proof: The proof follows from Theorem 3.4. □

Theorem 3.5 *An IVF topological space (X, τ) is IVF extremally disconnected if and only if every IVF regular open sets coincide with IVF regular closed sets.*

Proof: Suppose $\mathcal{A}$ is a IVF regular open subset of X. Since IVF regular open sets are IVF open, by (1), $A = \mathrm{Cl}(\mathcal{A}) = \mathrm{Cl}(\mathrm{Int}(\mathcal{A}))$ and so $\mathcal{A}$ is IVF regular closed. If $\mathcal{A}$ is IVF regular closed, then $A = \mathrm{Cl}(\mathrm{Int}(\mathcal{A})) = \mathrm{Int}(\mathrm{Cl}(\mathrm{Int}(\mathcal{A}))) = \mathrm{Int}(\mathcal{A})$ so $\mathcal{A}$ is IVF open. Also, $A = \mathrm{Cl}(\mathrm{Int}(\mathcal{A})) = \mathrm{Int}(\mathrm{Cl}(\mathrm{Int}(\mathcal{A}))) = \mathrm{Int}(\mathrm{Cl}(\mathcal{A}))$. Hence $\mathcal{A}$ is IVF regular open. Conversely, let $\mathcal{A}$ be a IVF open subset of X. Then $\mathrm{Int}(\mathrm{Cl}(\mathcal{A}))$ is IVF regular open and so it is IVF regular closed. Hence $\mathrm{Int}(\mathrm{Cl}(\mathrm{Int}(\mathrm{Cl}((\mathcal{A}))))) = \mathrm{Int}(\mathrm{Cl}(\mathcal{A}))$ which implies that $\mathrm{Cl}(\mathrm{Int}(\mathrm{Cl}(\mathcal{A}))) = \mathrm{Int}(\mathrm{Cl}(\mathcal{A}))$. Therefore, $\mathrm{Cl}(\mathcal{A}) = \mathrm{Cl}(\mathrm{Int}(\mathcal{A})) \subset \mathrm{Cl}(\mathrm{Int}(\mathrm{Cl}(\mathcal{A}))) = \mathrm{Int}(\mathrm{Cl}(\mathcal{A}))$ and so $\mathrm{Cl}(\mathcal{A}) = \mathrm{Cl}(\mathrm{Int}(\mathcal{A}))$. Hence $\mathrm{Cl}(\mathcal{A})$ is IVF open. This shows that X is IVF extremally disconnected. □

Theorem 3.6 *An IVF topological space (X, τ) is IVF extremally disconnected if and only if every IVF regular closed sets is IVF preopen.*

Proof: The proof follows from the fact that every IVF regular open set is IVF preopen set. Conversely, if $\mathcal{A}$ is IVF open, then $\mathrm{Cl}(\mathrm{Int}(\mathcal{A}))$ is IVF regular closed and so it is IVF preopen. Therefore, $\mathrm{Cl}(\mathcal{A}) = \mathrm{Cl}(\mathrm{Int}(\mathcal{A})) \subset \mathrm{Int}(\mathrm{Cl}(\mathrm{Cl}(\mathrm{Int}(\mathcal{A})))) = \mathrm{Int}(\mathrm{Cl}(\mathrm{Int}(\mathcal{A}))) = \mathrm{Int}(\mathrm{Cl}(\mathcal{A}))$. Thus, $\mathrm{Cl}(\mathcal{A}) = \mathrm{Int}(\mathrm{Cl}(\mathcal{A}))$ which implies that $\mathrm{Cl}(\mathcal{A})$ is IVF open. Hence X is IVF extremally disconnected. □

References

1. M. Ali, A. Kılıçman and A.Z. Khameneh, *Separation Axioms of Interval-Valued Fuzzy Soft Topology via Quasi-Neighborhood Structure*, Mathematics, 8 (2020), 178.
2. S. Al Ghour, J. Princivishvamalar and N. Rajesh, *Interval-valued fuzzy b-open sets* (under preparation).
3. C.L. Chang, *Fuzzy topological spaces*, J. Math. Anal. Appl., 24 (1968), 182-190.
4. M. B. Gorzalczany, *A method of inference in approximate reasoning based on interval-valued fuzzy sets*, J. Fuzzy Math., 21 (1987), 1-17.
5. Y. B. Jun, G. C. Kang and M. A. Ozturk, *Interval-valued fuzzy semiopen, preopen and α-open mappings*, Honam Math. J., 28 (2) (2006), 241-259.
6. Y. B. Jun, J. H. Bae, S. H. Choand C. S. Kim, *Interval-valued fuzzy strong semiopen sets East Asian Math. J.*, 23 (1) (2007), 45-58.
7. Y. B. Jun, S. S. Kim and C. S. Kim, *Interval-valued fuzzy semi-preopen sets and interval-valued semi-precontinuous mappings*, Honam Math. J., 29 (2) (2007), 223-244.
8. T. K. Mondal and S. K. Samanta, *Topology of interval-valued fuzzy sets*, Indian J. Pure Appl. Math., 30(1) (1999), 23-38.
9. L. A. Zadeh, *Fuzzy sets*, Information and Control, 8 (1965), 338-353.

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