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NALLAMUTHU GOUNDER MAHALINGAM COLLEGE

An Autonomous Institution, Affiliated to Bharathiar University, An ISO 9001:2015 Certified Institution,
Pollachi-642001



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One day International Conference

EMERGING TRENDS IN SCIENCE AND TECHNOLOGY (ETIST-2021)

27th October 2021

Jointly Organized by

Department of Biological Science, Physical Science and Computational Science

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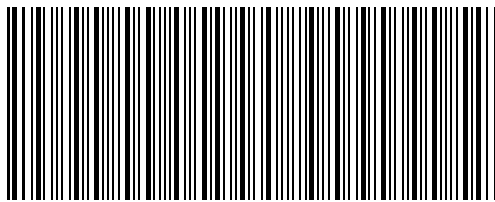
Proceeding of the
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ABOUT THE INSTITUTION

A nation's growth is in proportion to education and intelligence spread among the masses. Having this idealistic vision, two great philanthropists late. S.P. Nallamuthu Gounder and Late. Arutchelver Padmabhushan Dr.N.Mahalingam formed an organization called Pollachi Kalvi Kazhagam, which started NGM College in 1957, to impart holistic education with an objective to cater to the higher educational needs of those who wish to aspire for excellence in knowledge and values. The College has achieved greater academic distinctions with the introduction of autonomous system from the academic year 1987-88. The college has been Re-Accredited by NAAC and it is ISO 9001 : 2015 Certified Institution. The total student strength is around 6000. Having celebrated its Diamond Jubilee in 2017, the college has blossomed into a premier Post-Graduate and Research Institution, offering 26 UG, 12 PG, 13 M.Phil and 10 Ph.D Programmes, apart from Diploma and Certificate Courses. The college has been ranked within Top 100 (72nd Rank) in India by NIRF 2021.

ABOUT CONFERENCE

The International conference on “Emerging Trends in Science and Technology (ETIST-2021)” is being jointly organized by Departments of Biological Science, Physical Science and Computational Science - Nallamuthu Gounder Mahalingam College, Pollachi along with ISTE, CSI, IETE, IEE & RIYASA LABS on 27th OCT 2021. The Conference will provide common platform for faculties, research scholars, industrialists to exchange and discuss the innovative ideas and will promote to work in interdisciplinary mode.

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Nallamuthu Gounder Mahalingam College, Affiliated to Bharathiar University, Tamilnadu, India.

Interval Valued Pythagorean Fuzzy Soft Sets and Their Properties

P. Rajarajeswari¹, T. Mathi Sujitha² and R. Santhi³

¹Asst. Prof., Department of Mathematics, Chikkanna Govt Arts College, Tirupur, India,

p.rajarajeswari29@gmail.com

²Scholar, Department of Mathematics, Chikkanna Govt Arts College, Tirupur, India, mathisujitharms@gmail.com,

³Asst. Prof., Department of Mathematics, Nallamuthu Gounder Mahalingam College, Pollachi, India,

santhifuzzy@yahoo.co.in,

ABSTRACT: The Pythagorean soft set theory is a mathematical model for dealing with uncertainty and vagueness in multi criteria decision making problems. In this paper, we introduce the concept of interval valued Pythagorean fuzzy soft set theory which is a combination of interval valued Pythagorean fuzzy set and soft set theory. Some operations such as complement, union, intersection, necessity and possibility operations are defined on the interval valued Pythagorean fuzzy soft set. Also some of their properties are studied.

Keywords: Soft sets, fuzzy soft sets, Pythagorean fuzzy sets, Pythagorean soft sets, Pythagorean fuzzy soft sets, interval valued Pythagorean fuzzy sets, interval valued Pythagorean fuzzy soft sets

1. INTRODUCTION

Soft set theory, a parameterization of objects has been introduced by Molodtsov [1] which helps in dealing with uncertainty. Later on Maji P.K., Biswas R., Roy A.R., [3] proposed the theory of fuzzy soft set. Atanassov [2] extended fuzzy soft sets to intuitionistic fuzzy soft sets. The characteristic that sum of membership and non membership degree in intuitionistic fuzzy soft sets are less than or equal to one is insufficient for multi criteria decision making problems. Hence Yager R.R., Abbasov A.M. [8] introduced the concept of Pythagorean fuzzy sets which satisfies the case. Since a crisp value cannot quantify the opinions made by experts in decision making, interval valued Pythagorean fuzzy set theory has been developed by Peng, X. and Yang, Y. [6], some operations, their properties were discussed in it.

In this paper, we propose interval valued Pythagorean fuzzy soft set theory which is a combination of interval valued Pythagorean fuzzy set and soft sets. Some basic operations were defined and its properties were discussed.

2. PRELIMINARIES

P. Rajarajeswari¹, Mathematics, Chikkanna Govt Arts College, Tirupur, Tamilnadu, India, p.rajarajeswari29@gmail.com

T. Mathi Sujitha², Mathematics, Chikkanna Govt Arts College, Tirupur, Tamilnadu, India, mathisujitharms@gmail.com

R. Santhi³, Mathematics, Nallamuthu Gounder Mahalingam College, Pollachi, Tamilnadu, India, santhifuzzy@yahoo.co.in

In this section, we recall some basic definitions such as Pythagorean fuzzy set, Pythagorean fuzzy soft set and interval valued Pythagorean fuzzy set.

Definition 2.1[8]: Pythagorean fuzzy set, A is defined as a set of ordered pairs over a universal set X given by $A = \{ \langle x, \mu_A(x), \vartheta_A(x) \rangle \mid x \in X \}$, where $\mu_A, \vartheta_A: X \rightarrow [0, 1]$ are the degrees of membership and nonmembership of the element $x \in X$, respectively, with the condition that $(\mu_A(x))^2 + (\vartheta_A(x))^2 \leq 1$. Corresponding to its membership functions, the degree of indeterminacy is given by $\pi_A(x) = \sqrt{1 - (\mu_A(x))^2 - (\vartheta_A(x))^2}$.

Definition 2.2[4]: A pair (F,E) is called Pythagorean fuzzy soft set if a map $F : E \rightarrow P^U$ defined as $F_{u_i}(\epsilon_j) = \{ (u_i, \zeta_j(u_i), \vartheta_j(u_i)) : u_i \in U \}$ where P^U is the Pythagorean fuzzy subset of U and ζ, ϑ satisfies $\zeta^2 + \vartheta^2 \leq 1$ for all $u_i \in U$.

A pair (F,E) is termed as Pythagorean soft set and denote $F_{u_i}(\epsilon_j) = \{ (u_i, \zeta_j(u_i), \vartheta_j(u_i)) \}$ called as Pythagorean fuzzy soft number (PFSN) with $\zeta_{F(\epsilon_j)}^2 + \vartheta_{F(\epsilon_j)}^2 \leq 1$ for $\zeta_{F(\epsilon_j)}^2, \vartheta_{F(\epsilon_j)}^2 \in [0,1]$.

Definition 2.3[6]: Let X is the universe of discourse. An interval-valued Pythagorean fuzzy set (IVPFS) A defined in X is given as $A = \{ (x, [\mu_A^L(x), \mu_A^U(x)], [\vartheta_A^L(x), \vartheta_A^U(x)]) : x \in X \}$, where $0 \leq \mu_A^L(x) \leq \mu_A^U(x) \leq 1$, $0 \leq \vartheta_A^L(x) \leq \vartheta_A^U(x) \leq 1$ and $(\mu_A^U(x))^2 + (\vartheta_A^U(x))^2 \leq 1$ for all $x \in X$. Similar to PFSs, corresponding to interval-valued membership values, its hesitation interval relative to A is given as $\pi_A(x) = \left[\sqrt{1 - (\mu_A^U(x))^2 - (\vartheta_A^U(x))^2}, \sqrt{1 - (\mu_A^L(x))^2 - (\vartheta_A^L(x))^2} \right]$.

If for every $x \in X$, $\mu_A(x) = \mu_A^L(x) = \mu_A^U(x)$, $\vartheta_A(x) = \vartheta_A^L(x) = \vartheta_A^U(x)$, then IVPFS reduces to PFS. For an IVPFS A, the pair $\langle [\mu_A^L(x), \mu_A^U(x)], [\vartheta_A^L(x), \vartheta_A^U(x)] \rangle$ is called an interval-valued Pythagorean fuzzy number (IVPFN). For convenience, this pair is often denoted by $\alpha = \langle [a, b], [c, d] \rangle$, where $[a, b] \subseteq [0, 1]$, $[c, d] \subseteq [0, 1]$, and $b^2 + d^2 \leq 1$.

3. MAJOR SECTION

Definition 3.1: Let the parameter set be \mathbb{E} . Let $\mathcal{A} \subseteq \mathbb{E}$. A pair (f, \mathcal{A}) is called an interval-valued Pythagorean fuzzy soft set (IVPFSS) over \mathbb{U} , where \mathbb{U} is the universe and f is a mapping given by $f: \mathcal{A} \rightarrow IP^{\mathbb{U}}$, where $IP^{\mathbb{U}}$ denotes the collection of all interval-valued Pythagorean fuzzy subsets of \mathbb{U} .

Definition 3.2: Let \mathbb{U} be the universe and the parameter set be \mathbb{E} . Let $\mathcal{A}, \mathcal{B} \subseteq \mathbb{E}$, (f, \mathcal{A}) and (g, \mathcal{B}) be two IVPSS, then (f, \mathcal{A}) is an interval-valued Pythagorean fuzzy soft subset of (g, \mathcal{B}) if and only if

1. $\mathcal{A} \subseteq \mathcal{B}$,
2. $\forall \epsilon \in \mathcal{A}, f(\epsilon)$ is an interval-valued Pythagorean fuzzy soft subsets of $g(\epsilon)$. i.e., $\forall x \in \mathbb{U}$ and $\epsilon \in \mathcal{A}$, $\mu_{f(\epsilon)}^L(x) \leq \mu_{g(\epsilon)}^L(x), \mu_{f(\epsilon)}^U(x) \leq \mu_{g(\epsilon)}^U(x), \vartheta_{f(\epsilon)}^L(x) \geq \vartheta_{g(\epsilon)}^L(x), \vartheta_{f(\epsilon)}^U(x) \geq \vartheta_{g(\epsilon)}^U(x)$ and is denoted by $(f, \mathcal{A}) \subseteq (g, \mathcal{B})$. Similarly, (f, \mathcal{A}) is said to be an interval-valued Pythagorean fuzzy soft superset of (g, \mathcal{B}) , if (g, \mathcal{B}) is an interval-valued Pythagorean fuzzy soft subset of (f, \mathcal{A}) and is denoted by $(f, \mathcal{A}) \supseteq (g, \mathcal{B})$.

Definition 3.3: Let (f, \mathcal{A}) and (g, \mathcal{B}) be two IVPFSS over \mathbb{U} . (f, \mathcal{A}) and (g, \mathcal{B}) are said to be interval-valued Pythagorean fuzzy soft equal if and only if (f, \mathcal{A}) is an interval-valued Pythagorean fuzzy soft subset of (g, \mathcal{B}) and vice – versa.

Definition 3.4: Let $\mathbb{E} = \{e_1, e_2, e_3, \dots, e_n\}$ be a parameter set. The Not set of \mathbb{E} is denoted by $\neg \mathbb{E}$, defined as $\neg \mathbb{E} = \{\neg e_1, \neg e_2, \neg e_3, \dots, \neg e_n\}$ where $\neg e_i$ is note $_i$.

Definition 3.5: The complement of an IVPFSS (f, \mathcal{A}) is denoted by $(f, \mathcal{A})^c$, defined as $(f, \mathcal{A})^c = (f^c, \neg \mathcal{A})$, where $f^c: \neg \mathcal{A} \rightarrow \mathbb{IP}^{\mathbb{U}}$, where $\mathbb{IP}^{\mathbb{U}}$ denotes the collection of all interval-valued Pythagorean fuzzy subsets of \mathbb{U} and the mapping is given by $f^c(\varepsilon) = (x, \vartheta_{f(\neg \varepsilon)}(x), \mu_{f(\neg \varepsilon)}(x)) \forall x \in \mathbb{U}$ and $\varepsilon \in \neg \mathcal{A}$.

Definition 3.6: An IVPFSS (f, \mathcal{A}) over \mathbb{U} is said to be a null IVPFSS denoted by \emptyset , if $\forall \varepsilon \in \mathcal{A}, \mu_{f(\varepsilon)}(x) = [0, 0], \vartheta_{f(\varepsilon)}(x) = [1, 1], x \in \mathbb{U}$.

Definition 3.7: An IVPFSS (f, \mathcal{A}) over \mathbb{U} is said to be a absolute IVPFSS denoted by Σ , if $\forall \varepsilon \in \mathcal{A}, \mu_{f(\varepsilon)}(x) = [1, 1], \vartheta_{f(\varepsilon)}(x) = [0, 0], x \in \mathbb{U}$.

Definition 3.8: The union of two IVPFSS (f, \mathcal{A}) and (g, \mathcal{B}) over a universe \mathbb{U} is an IVPFSS (h, \mathcal{C}) where $\mathcal{C} = \mathcal{A} \cup \mathcal{B}$ and $\forall \varepsilon \in \mathcal{C}$.

$$\mu_{h(\varepsilon)}(x) = \begin{cases} \mu_{f(\varepsilon)}(x) & \text{if } \varepsilon \in \mathcal{A} - \mathcal{B}, x \in \mathbb{U} \\ \mu_{g(\varepsilon)}(x) & \text{if } \varepsilon \in \mathcal{B} - \mathcal{A}, x \in \mathbb{U} \\ \left[\sup(\mu_{f(\varepsilon)}^L(x), \mu_{g(\varepsilon)}^L(x)), \sup(\mu_{f(\varepsilon)}^U(x), \mu_{g(\varepsilon)}^U(x)) \right], & \text{if } \varepsilon \in \mathcal{A} \cap \mathcal{B}, x \in \mathbb{U} \end{cases}$$

$$\vartheta_{h(\varepsilon)}(x) = \begin{cases} \vartheta_{f(\varepsilon)}(x) & \text{if } \varepsilon \in \mathcal{A} - \mathcal{B}, x \in \mathbb{U} \\ \vartheta_{g(\varepsilon)}(x) & \text{if } \varepsilon \in \mathcal{B} - \mathcal{A}, x \in \mathbb{U} \\ \left[\inf(\vartheta_{f(\varepsilon)}^L(x), \vartheta_{g(\varepsilon)}^L(x)), \inf(\vartheta_{f(\varepsilon)}^U(x), \vartheta_{g(\varepsilon)}^U(x)) \right], & \text{if } \varepsilon \in \mathcal{A} \cap \mathcal{B}, x \in \mathbb{U} \end{cases},$$

denoted by $(f, \mathcal{A}) \cup (g, \mathcal{B}) = (h, \mathcal{C})$.

Definition 3.9: The intersection of two IVPFSS (f, \mathcal{A}) and (g, \mathcal{B}) over a universe \mathbb{U} is an IVPFSS (h, \mathcal{C}) where $\mathcal{C} = \mathcal{A} \cap \mathcal{B}$ and $\forall \varepsilon \in \mathcal{C}$.

$$\mu_{h(\varepsilon)}(x) = \begin{cases} \mu_{f(\varepsilon)}(x) & \text{if } \varepsilon \in \mathcal{A} - \mathcal{B}, x \in \mathbb{U} \\ \mu_{g(\varepsilon)}(x) & \text{if } \varepsilon \in \mathcal{B} - \mathcal{A}, x \in \mathbb{U} \\ \left[\inf(\mu_{f(\varepsilon)}^L(x), \mu_{g(\varepsilon)}^L(x)), \inf(\mu_{f(\varepsilon)}^U(x), \mu_{g(\varepsilon)}^U(x)) \right], & \text{if } \varepsilon \in \mathcal{A} \cap \mathcal{B}, x \in \mathbb{U} \end{cases}$$

$$\vartheta_{h(\varepsilon)}(x) = \begin{cases} \vartheta_{f(\varepsilon)}(x) & \text{if } \varepsilon \in \mathcal{A} - \mathcal{B}, x \in \mathbb{U} \\ \vartheta_{g(\varepsilon)}(x) & \text{if } \varepsilon \in \mathcal{B} - \mathcal{A}, x \in \mathbb{U} \\ \left[\sup(\vartheta_{f(\varepsilon)}^L(x), \vartheta_{g(\varepsilon)}^L(x)), \sup(\vartheta_{f(\varepsilon)}^U(x), \vartheta_{g(\varepsilon)}^U(x)) \right], & \text{if } \varepsilon \in \mathcal{A} \cap \mathcal{B}, x \in \mathbb{U} \end{cases},$$

denoted by $(f, \mathcal{A}) \cap (g, \mathcal{B}) = (h, \mathcal{C})$.

Theorem 3.1: Let the parameter set be $\mathbb{E}, \mathcal{A} \subseteq \mathbb{E}$. If \emptyset is a null IVPFSS, Σ an absolute IVPFSS and (f, \mathcal{A}) and (f, \mathbb{E}) be two IVPFSS over \mathbb{U} , then

1. $(f, \mathcal{A}) \cup (f, \mathcal{A}) = (f, \mathcal{A})$
2. $(f, \mathcal{A}) \cap (f, \mathcal{A}) = (f, \mathcal{A})$
3. $(f, \mathbb{E}) \cup \emptyset = (f, \mathbb{E})$
4. $(f, \mathbb{E}) \cap \emptyset = \emptyset$

5. $(f, \mathbb{E}) \cup \Sigma = \Sigma$
6. $(f, \mathbb{E}) \cap \Sigma = (f, \mathbb{E})$

Proof: Theorem proof can be derived from the Definition 3.8 and Definition 3.9.

Theorem 3.2: If (f, \mathcal{A}) and (g, \mathcal{B}) be two IVPFSS over \mathbb{U} , then

1. $((f, \mathcal{A}) \cup (g, \mathcal{B}))^c = (f, \mathcal{A})^c \cap (g, \mathcal{B})^c$,
2. $((f, \mathcal{A}) \cap (g, \mathcal{B}))^c = (f, \mathcal{A})^c \cup (g, \mathcal{B})^c$

Proof: 1. By Definition 3.8, $(f, \mathcal{A}) \cup (g, \mathcal{B}) = (h, \mathcal{C})$, then $((f, \mathcal{A}) \cup (g, \mathcal{B}))^c = (h, \mathcal{C})^c = (h^c, \mathcal{C}^c)$, $h^c(\neg\varepsilon) = (x, \vartheta_{h(\varepsilon)}(x), \mu_{h(\varepsilon)}(x)) \forall x \in \mathbb{U}$ and $\neg\varepsilon \in \mathcal{C}^c = \neg(\mathcal{A} \cup \mathcal{B}) = \neg\mathcal{A} \cap \neg\mathcal{B}$. Therefore,

$$\mu_{h^c(\neg\varepsilon)}(x) = \begin{cases} \vartheta_{f(\varepsilon)}(x) & \text{if } \varepsilon \in \mathcal{A} - \mathcal{B}, \quad x \in \mathbb{U} \\ \vartheta_{g(\varepsilon)}(x) & \text{if } \varepsilon \in \mathcal{B} - \mathcal{A}, \quad x \in \mathbb{U} \\ \left[\inf(\vartheta_{f(\varepsilon)}^L(x), \vartheta_{g(\varepsilon)}^L(x)), \inf(\vartheta_{f(\varepsilon)}^U(x), \vartheta_{g(\varepsilon)}^U(x)) \right], & \text{if } \varepsilon \in \mathcal{A} \cap \mathcal{B}, x \in \mathbb{U} \end{cases}$$

$$\vartheta_{h^c(\neg\varepsilon)}(x) = \begin{cases} \mu_{f(\varepsilon)}(x) & \text{if } \varepsilon \in \mathcal{A} - \mathcal{B}, \quad x \in \mathbb{U} \\ \mu_{g(\varepsilon)}(x) & \text{if } \varepsilon \in \mathcal{B} - \mathcal{A}, \quad x \in \mathbb{U} \\ \left[\sup(\mu_{f(\varepsilon)}^L(x), \mu_{g(\varepsilon)}^L(x)), \sup(\mu_{f(\varepsilon)}^U(x), \mu_{g(\varepsilon)}^U(x)) \right], & \text{if } \varepsilon \in \mathcal{A} \cap \mathcal{B}, x \in \mathbb{U} \end{cases}$$

Since $(f, \mathcal{A})^c = (f^c, \neg\mathcal{A})$ and $(g, \mathcal{B})^c = (g^c, \neg\mathcal{B})$, then $(f, \mathcal{A})^c \cap (g, \mathcal{B})^c = (f^c, \neg\mathcal{A}) \cap (g^c, \neg\mathcal{B})$. Let $(f^c, \neg\mathcal{A}) \cap (g^c, \neg\mathcal{B}) = (i, \mathcal{D})$ where $\mathcal{D} = \neg\mathcal{C} = \neg(\mathcal{A} \cup \mathcal{B}) = \neg\mathcal{A} \cap \neg\mathcal{B}$ and $\neg\varepsilon \in \mathcal{D}$.

$$\mu_{i(\neg\varepsilon)}(x) = \begin{cases} \vartheta_{f(\varepsilon)}(x) & \text{if } \varepsilon \in \mathcal{A} - \mathcal{B}, \quad x \in \mathbb{U} \\ \vartheta_{g(\varepsilon)}(x) & \text{if } \varepsilon \in \mathcal{B} - \mathcal{A}, \quad x \in \mathbb{U} \\ \left[\inf(\vartheta_{f(\varepsilon)}^L(x), \vartheta_{g(\varepsilon)}^L(x)), \inf(\vartheta_{f(\varepsilon)}^U(x), \vartheta_{g(\varepsilon)}^U(x)) \right], & \text{if } \varepsilon \in \mathcal{A} \cap \mathcal{B}, x \in \mathbb{U} \end{cases}$$

$$\vartheta_{i(\neg\varepsilon)}(x) = \begin{cases} \mu_{f(\varepsilon)}(x) & \text{if } \varepsilon \in \mathcal{A} - \mathcal{B}, \quad x \in \mathbb{U} \\ \mu_{g(\varepsilon)}(x) & \text{if } \varepsilon \in \mathcal{B} - \mathcal{A}, \quad x \in \mathbb{U} \\ \left[\sup(\mu_{f(\varepsilon)}^L(x), \mu_{g(\varepsilon)}^L(x)), \sup(\mu_{f(\varepsilon)}^U(x), \mu_{g(\varepsilon)}^U(x)) \right], & \text{if } \varepsilon \in \mathcal{A} \cap \mathcal{B}, x \in \mathbb{U} \end{cases}$$

Hence h^c and i are the same operators and $((f, \mathcal{A}) \cup (g, \mathcal{B}))^c = (f, \mathcal{A})^c \cap (g, \mathcal{B})^c$. Similarly we can prove 2.

Definition 3.10: The necessity operation on an IVPFSS (f, \mathcal{A}) is denoted by

$\square(f, \mathcal{A}) = \{(x, \mu_{\square f(\varepsilon)}(x), \vartheta_{\square f(\varepsilon)}(x)) : x \in \mathbb{U} \text{ and } \varepsilon \in \mathcal{A}\}$ where $\mu_{\square f(\varepsilon)}(x) = [\mu_{f(\varepsilon)}^L(x), \mu_{f(\varepsilon)}^U(x)]$ is the interval valued fuzzy membership degree that the object x holds on the parameter ε , $\vartheta_{\square f(\varepsilon)}(x) = \left[\sqrt{1 - (\mu_{f(\varepsilon)}^U(x))^2}, \sqrt{1 - (\mu_{f(\varepsilon)}^L(x))^2} \right]$ is the interval valued fuzzy membership degree that the

object x does not hold on the parameter ε and f is a mapping $f: \mathcal{A} \rightarrow IP^{\mathbb{U}}$ where $IP^{\mathbb{U}}$ is the interval-valued Pythagorean fuzzy subsets of \mathbb{U} .

Theorem: 3.3: Let (f, \mathcal{A}) and (g, \mathcal{B}) be two IVPFSS over \mathbb{U} , then the following properties hold:

1. $\square((f, \mathcal{A}) \cup (g, \mathcal{B})) = \square(f, \mathcal{A}) \cup \square(g, \mathcal{B})$
2. $\square((f, \mathcal{A}) \cap (g, \mathcal{B})) = \square(f, \mathcal{A}) \cap \square(g, \mathcal{B})$
3. $\square\square(f, \mathcal{A}) = \square(f, \mathcal{A})$.

Proof: 1. By Definition 3.8, we have $\square((f, \mathcal{A}) \cup (g, \mathcal{B})) = \square(h, \mathcal{C})$ where $\mathcal{C} = \mathcal{A} \cup \mathcal{B}$ and $\forall \varepsilon \in \mathcal{C}$. By the Definition 3.10, we have

$$\mu_{\square h(\varepsilon)}(x) = \begin{cases} \mu_{f(\varepsilon)}(x) & \text{if } \varepsilon \in \mathcal{A} - \mathcal{B}, x \in \mathbb{U} \\ \mu_{g(\varepsilon)}(x) & \text{if } \varepsilon \in \mathcal{B} - \mathcal{A}, x \in \mathbb{U} \\ \left[\sup(\mu_{f(\varepsilon)}^L(x), \mu_{g(\varepsilon)}^L(x)), \sup(\mu_{f(\varepsilon)}^U(x), \mu_{g(\varepsilon)}^U(x)) \right], & \text{if } \varepsilon \in \mathcal{A} \cap \mathcal{B}, x \in \mathbb{U} \end{cases}$$

$$\vartheta_{\square h(\varepsilon)}(x) = \begin{cases} \left[\sqrt{1 - (\mu_{f(\varepsilon)}^U(x))^2}, \sqrt{1 - (\mu_{f(\varepsilon)}^L(x))^2} \right] & \text{if } \varepsilon \in \mathcal{A} - \mathcal{B}, x \in \mathbb{U} \\ \left[\sqrt{1 - (\mu_{g(\varepsilon)}^U(x))^2}, \sqrt{1 - (\mu_{g(\varepsilon)}^L(x))^2} \right] & \text{if } \varepsilon \in \mathcal{B} - \mathcal{A}, x \in \mathbb{U} \\ \left[\sqrt{1 - \sup(\mu_{f(\varepsilon)}^U(x), \mu_{g(\varepsilon)}^U(x))}, \sqrt{1 - \sup(\mu_{f(\varepsilon)}^L(x), \mu_{g(\varepsilon)}^L(x))} \right], & \text{if } \varepsilon \in \mathcal{A} \cap \mathcal{B}, x \in \mathbb{U} \end{cases}$$

Assume $\square(f, \mathcal{A}) = \left\{ \left(x, [\mu_{f(\varepsilon)}^L(x), \mu_{f(\varepsilon)}^U(x)], \left[\sqrt{1 - (\mu_{f(\varepsilon)}^U(x))^2}, \sqrt{1 - (\mu_{f(\varepsilon)}^L(x))^2} \right] \right) : x \in \mathbb{U} \text{ and } \varepsilon \in \mathcal{A} \right\}$ and

$\square(g, \mathcal{B}) = \left\{ \left(x, [\mu_{g(\varepsilon)}^L(x), \mu_{g(\varepsilon)}^U(x)], \left[\sqrt{1 - (\mu_{g(\varepsilon)}^U(x))^2}, \sqrt{1 - (\mu_{g(\varepsilon)}^L(x))^2} \right] \right) : x \in \mathbb{U} \text{ and } \varepsilon \in \mathcal{B} \right\}$. Hence

$\square(f, \mathcal{A}) \cup (g, \mathcal{B}) = (o, \mathcal{C})$ where $\mathcal{C} = \mathcal{A} \cup \mathcal{B}$ and $\varepsilon \in \mathcal{C}$.

$$\mu_{o(\varepsilon)}(x) = \begin{cases} \mu_{f(\varepsilon)}(x) & \text{if } \varepsilon \in \mathcal{A} - \mathcal{B}, x \in \mathbb{U} \\ \mu_{g(\varepsilon)}(x) & \text{if } \varepsilon \in \mathcal{B} - \mathcal{A}, x \in \mathbb{U} \\ \left[\sup(\mu_{f(\varepsilon)}^L(x), \mu_{g(\varepsilon)}^L(x)), \sup(\mu_{f(\varepsilon)}^U(x), \mu_{g(\varepsilon)}^U(x)) \right], & \text{if } \varepsilon \in \mathcal{A} \cap \mathcal{B}, x \in \mathbb{U} \end{cases}$$

$$\vartheta_{o(\varepsilon)}(x) = \begin{cases} \left[\sqrt{1 - (\mu_{f(\varepsilon)}^U(x))^2}, \sqrt{1 - (\mu_{f(\varepsilon)}^L(x))^2} \right] & \text{if } \varepsilon \in \mathcal{A} - \mathcal{B}, x \in \mathbb{U} \\ \left[\sqrt{1 - (\mu_{g(\varepsilon)}^U(x))^2}, \sqrt{1 - (\mu_{g(\varepsilon)}^L(x))^2} \right] & \text{if } \varepsilon \in \mathcal{B} - \mathcal{A}, x \in \mathbb{U} \\ \left[\left(\inf \sqrt{1 - (\mu_{f(\varepsilon)}^U(x))^2}, \sqrt{1 - (\mu_{g(\varepsilon)}^U(x))^2} \right), \inf \left(\sqrt{1 - (\mu_{f(\varepsilon)}^L(x))^2}, \sqrt{1 - (\mu_{g(\varepsilon)}^L(x))^2} \right) \right], & \text{if } \varepsilon \in \mathcal{A} \cap \mathcal{B}, x \in \mathbb{U} \end{cases}$$

$$= \begin{cases} \left[\sqrt{1 - (\mu_{f(\varepsilon)}^U(x))^2}, \sqrt{1 - (\mu_{f(\varepsilon)}^L(x))^2} \right] & \text{if } \varepsilon \in \mathcal{A} - \mathcal{B}, x \in \mathbb{U} \\ \left[\sqrt{1 - (\mu_{g(\varepsilon)}^U(x))^2}, \sqrt{1 - (\mu_{g(\varepsilon)}^L(x))^2} \right] & \text{if } \varepsilon \in \mathcal{B} - \mathcal{A}, x \in \mathbb{U} \\ \left[\sqrt{1 - \sup(\mu_{f(\varepsilon)}^U(x), \mu_{g(\varepsilon)}^U(x))}, \sqrt{1 - \sup(\mu_{f(\varepsilon)}^L(x), \mu_{g(\varepsilon)}^L(x))} \right], & \text{if } \varepsilon \in \mathcal{A} \cap \mathcal{B}, x \in \mathbb{U} \end{cases}$$

Hence $\square(h, \mathcal{C}) = (o, \mathcal{C})$. Thus we have proved 1. Similarly we can prove 2 and 3.

Definition 3.11: The possibility operation on an IVPFSS (f, \mathcal{A}) is denoted by $\diamond(f, \mathcal{A}) = \{(x, \mu_{\diamond f(\varepsilon)}(x), \vartheta_{\diamond f(\varepsilon)}(x)) : x \in \mathbb{U} \text{ and } \varepsilon \in \mathcal{A}\}$ where $\vartheta_{\diamond f(\varepsilon)}(x) = [\vartheta_{f(\varepsilon)}^L(x), \vartheta_{f(\varepsilon)}^U(x)]$ is the interval valued fuzzy membership degree that the object x does not hold on the parameter ε ,

$\mu_{\diamond f(\varepsilon)}(x) = \left[\sqrt{1 - (\vartheta_{f(\varepsilon)}^U(x))^2}, \sqrt{1 - (\vartheta_{f(\varepsilon)}^L(x))^2} \right]$ is the interval valued fuzzy membership degree that the

object x hold on the parameter ε and f is a mapping $f : \mathcal{A} \rightarrow IP^{\mathbb{U}}$, where $IP^{\mathbb{U}}$ is the interval-valued Pythagorean fuzzy subsets of \mathbb{U} .

Theorem 3.4: Let (f, \mathcal{A}) and (g, \mathcal{B}) be two IVPFSS over \mathbb{U} , then the following properties hold:

1. $\diamond((f, \mathcal{A}) \cup (g, \mathcal{B})) = \diamond(f, \mathcal{A}) \cup \diamond(g, \mathcal{B})$
2. $\diamond((f, \mathcal{A}) \cap (g, \mathcal{B})) = \diamond(f, \mathcal{A}) \cap \diamond(g, \mathcal{B})$
3. $\diamond\diamond(f, \mathcal{A}) = \diamond(f, \mathcal{A})$

Proof: 1. By Definition 3.8, we have $\diamond((f, \mathcal{A}) \cup (g, \mathcal{B})) = \diamond(h, \mathcal{C})$. By Definition 3.11,

$$\mu_{\diamond h(\varepsilon)}(x) = \begin{cases} \left[\sqrt{1 - (\vartheta_{f(\varepsilon)}^U(x))^2}, \sqrt{1 - (\vartheta_{f(\varepsilon)}^L(x))^2} \right] & \text{if } \varepsilon \in \mathcal{A} - \mathcal{B}, \quad x \in \mathbb{U} \\ \left[\sqrt{1 - (\vartheta_{g(\varepsilon)}^U(x))^2}, \sqrt{1 - (\vartheta_{g(\varepsilon)}^L(x))^2} \right] & \text{if } \varepsilon \in \mathcal{B} - \mathcal{A}, \quad x \in \mathbb{U} \\ \left[\sqrt{1 - \inf(\vartheta_{f(\varepsilon)}^U(x), \vartheta_{g(\varepsilon)}^U(x))}, \sqrt{1 - \inf(\vartheta_{f(\varepsilon)}^L(x), \vartheta_{g(\varepsilon)}^L(x))} \right], & \text{if } \varepsilon \in \mathcal{A} \cap \mathcal{B}, x \in \mathbb{U} \end{cases}$$

$$\vartheta_{\diamond h(\varepsilon)}(x) = \begin{cases} \vartheta_{f(\varepsilon)}(x) & \text{if } \varepsilon \in \mathcal{A} - \mathcal{B}, \quad x \in \mathbb{U} \\ \vartheta_{g(\varepsilon)}(x) & \text{if } \varepsilon \in \mathcal{B} - \mathcal{A}, \quad x \in \mathbb{U} \\ \left[\inf(\vartheta_{f(\varepsilon)}^L(x), \vartheta_{g(\varepsilon)}^L(x)), \inf(\vartheta_{f(\varepsilon)}^U(x), \vartheta_{g(\varepsilon)}^U(x)) \right], & \text{if } \varepsilon \in \mathcal{A} \cap \mathcal{B}, x \in \mathbb{U} \end{cases}$$

Assume $\diamond(f, \mathcal{A})$ and $\diamond(g, \mathcal{B})$ by Definition 3.11 and by Definition 3.8, we have $\diamond(f, \mathcal{A}) \cup \diamond(g, \mathcal{B}) = (o, \mathcal{C})$, where $\mathcal{C} = \mathcal{A} \cup \mathcal{B}$ and $\varepsilon \in \mathcal{C}$.

$$\mu_{o(\varepsilon)}(x) = \begin{cases} \left[\sqrt{1 - (\vartheta_{f(\varepsilon)}^U(x))^2}, \sqrt{1 - (\vartheta_{f(\varepsilon)}^L(x))^2} \right] & \text{if } \varepsilon \in \mathcal{A} - \mathcal{B}, \quad x \in \mathbb{U} \\ \left[\sqrt{1 - (\vartheta_{g(\varepsilon)}^U(x))^2}, \sqrt{1 - (\vartheta_{g(\varepsilon)}^L(x))^2} \right] & \text{if } \varepsilon \in \mathcal{B} - \mathcal{A}, \quad x \in \mathbb{U} \\ \left[\left(\sup \sqrt{1 - (\vartheta_{f(\varepsilon)}^U(x))^2}, \sqrt{1 - (\vartheta_{g(\varepsilon)}^U(x))^2} \right), \sup \left(\sqrt{1 - (\vartheta_{f(\varepsilon)}^L(x))^2}, \sqrt{1 - (\vartheta_{g(\varepsilon)}^L(x))^2} \right) \right], & \text{if } \varepsilon \in \mathcal{A} \cap \mathcal{B}, x \in \mathbb{U} \end{cases}$$

$$= \begin{cases} \left[\sqrt{1 - (\vartheta_{f(\varepsilon)}^U(x))^2}, \sqrt{1 - (\vartheta_{f(\varepsilon)}^L(x))^2} \right] & \text{if } \varepsilon \in \mathcal{A} - \mathcal{B}, \quad x \in \mathbb{U} \\ \left[\sqrt{1 - (\vartheta_{g(\varepsilon)}^U(x))^2}, \sqrt{1 - (\vartheta_{g(\varepsilon)}^L(x))^2} \right] & \text{if } \varepsilon \in \mathcal{B} - \mathcal{A}, \quad x \in \mathbb{U} \\ \left[\sqrt{1 - \inf(\vartheta_{f(\varepsilon)}^U(x), \vartheta_{g(\varepsilon)}^U(x))}, \sqrt{1 - \inf(\vartheta_{f(\varepsilon)}^L(x), \vartheta_{g(\varepsilon)}^L(x))} \right], & \text{if } \varepsilon \in \mathcal{A} \cap \mathcal{B}, x \in \mathbb{U} \end{cases}$$

$$\vartheta_{o(\varepsilon)}(x) = \begin{cases} \vartheta_{f(\varepsilon)}(x) & \text{if } \varepsilon \in \mathcal{A} - \mathcal{B}, \quad x \in \mathbb{U} \\ \vartheta_{g(\varepsilon)}(x) & \text{if } \varepsilon \in \mathcal{B} - \mathcal{A}, \quad x \in \mathbb{U} \\ \left[\inf(\vartheta_{f(\varepsilon)}^L(x), \vartheta_{g(\varepsilon)}^L(x)), \inf(\vartheta_{f(\varepsilon)}^U(x), \vartheta_{g(\varepsilon)}^U(x)) \right], & \text{if } \varepsilon \in \mathcal{A} \cap \mathcal{B}, x \in \mathbb{U} \end{cases}$$

Hence $\diamond(h, \mathcal{C})$ and (o, \mathcal{C}) are same IVPFSS. Hence (i). Similarly we can prove 2 and 3.

Theorem 3.5: Let (f, \mathcal{A}) be an IVPFSS over \mathbb{U} , then we have the following properties

1. $\square(f, \mathcal{A}) \subset (f, \mathcal{A}) \subset \diamond(f, \mathcal{A})$;
2. $\diamond \square(f, \mathcal{A}) = \square(f, \mathcal{A})$;
3. $\square \diamond(f, \mathcal{A}) = \diamond(f, \mathcal{A})$

Proof: 1. Suppose that $(f, \mathcal{A}) = \{(x, [\mu_{f(\varepsilon)}^L(x), \mu_{f(\varepsilon)}^U(x)], [\vartheta_{f(\varepsilon)}^L(x), \vartheta_{f(\varepsilon)}^U(x)]) : x \in \mathbb{U} \text{ and } \varepsilon \in \mathcal{A}\}$. Hence by Definition 3.10 and Definition 3.11, define $\square(f, \mathcal{A})$ and $\diamond(f, \mathcal{A})$. Since $((\mu_{f(\varepsilon)}^U(x))^2) + ((\vartheta_{f(\varepsilon)}^U(x))^2) \leq 1$, then

$$\sqrt{1 - (\mu_{f(\varepsilon)}^U(x))^2} \geq \vartheta_{f(\varepsilon)}^U(x) \geq \vartheta_{f(\varepsilon)}^L(x) \quad \text{and} \quad \sqrt{1 - (\mu_{f(\varepsilon)}^L(x))^2} \geq \sqrt{1 - (\mu_{f(\varepsilon)}^U(x))^2} \geq \vartheta_{f(\varepsilon)}^U(x). \quad \text{Since}$$

$$\mu_{f(\varepsilon)}^L(x) \geq \mu_{f(\varepsilon)}^U(x) \quad \text{and} \quad \mu_{f(\varepsilon)}^U(x) \geq \mu_{f(\varepsilon)}^L(x). \quad \text{Hence} \quad \square(f, \mathcal{A}) \subset (f, \mathcal{A}). \quad \text{Now,}$$

$$\sqrt{1 - (\vartheta_{f(\varepsilon)}^U(x))^2} \geq \mu_{f(\varepsilon)}^U(x) \geq \mu_{f(\varepsilon)}^L(x) \quad \text{and} \quad \sqrt{1 - (\vartheta_{f(\varepsilon)}^L(x))^2} \geq \sqrt{1 - (\vartheta_{f(\varepsilon)}^U(x))^2} \geq \mu_{f(\varepsilon)}^U(x). \quad \text{Since}$$

$$\vartheta_{f(\varepsilon)}^L(x) \geq \vartheta_{f(\varepsilon)}^U(x) \quad \text{and} \quad \vartheta_{f(\varepsilon)}^U(x) \geq \vartheta_{f(\varepsilon)}^L(x), \text{ hence } (f, \mathcal{A}) \subset \diamond(f, \mathcal{A}).$$

Assume definition 3.10. Then

$$\diamond \square(f, \mathcal{A}) = \left\{ \left(x, \left[\sqrt{1 - \left(\sqrt{1 - (\mu_{f(\varepsilon)}^L(x))^2} \right)}, \sqrt{1 - \left(\sqrt{1 - (\mu_{f(\varepsilon)}^U(x))^2} \right)} \right], \left[\sqrt{1 - (\mu_{f(\varepsilon)}^U(x))^2}, \sqrt{1 - (\mu_{f(\varepsilon)}^L(x))^2} \right] \right) : x \in \mathbb{U} \text{ and } \varepsilon \in \mathcal{A} \right\}$$

$$= \left\{ \left(x, [\mu_{f(\varepsilon)}^L(x), \mu_{f(\varepsilon)}^U(x)], \left[\sqrt{1 - (\mu_{f(\varepsilon)}^U(x))^2}, \sqrt{1 - (\mu_{f(\varepsilon)}^L(x))^2} \right] \right) : x \in \mathbb{U} \text{ and } \varepsilon \in \mathcal{A} \right\}$$

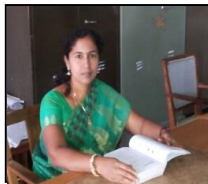
$$= \square(f, \mathcal{A}).$$

Similarly we can prove 2 as 3.

References

- [1] Molodtsov D., Soft set theory—first results, Computers & Mathematics with Applications, (1999), 37(4 - 5), 19 – 31.
- [2] Atanassov K., Intuitionistic fuzzy sets, Fuzzy Sets and Systems, (1986), 20(1), 87 – 96.
- [3] Maji P.K., Biswas R., Roy A.R., Fuzzy soft sets, Journal of Fuzzy Mathematics, (2001), 9(3), 589 – 602.
- [4] Maji P.K., Biswas R., Roy A.R., Soft set theory, Computers & Mathematics with Applications, (2003), 45 (4 – 5), 555–562.
- [5] Peng X., Yang Y. Some results for Pythagorean fuzzy sets, International Journal of Intelligent Systems, (2015), 30(11), 1133 – 1160.
- [6] Peng, X. and Yang, Y. Fundamental properties of interval-valued Pythagorean fuzzy aggregation operators, International Journal of Intelligent Systems, (2015), 31(5), 444 - 487.
- [7] Yang X. B., Lin T.Y., Yang J.Y., Li Y., Yu D., Combination of interval-valued fuzzy set and soft set, Computers & Mathematics with Applications, (2009), 58(3), 521 – 527.
- [8] Yager R.R., Abbasov A.M., Pythagorean membership grades, complex numbers, and decision making. International Journal of Intelligent Systems, (2013), 28(5), 436–452.
- [9] Yager R.R., Pythagorean fuzzy subsets. In: Proc Joint IFSA World Congress and NAFIPS Annual Meeting, Edmonton, Canada, (24 – 28 June 2013), 57 – 61.
- [1] Yager R.R., Pythagorean membership grades in multicriteria decision making. IEEE Transactions on Fuzzy Systems, (2014), 22(4), 958 – 965.

Biography



Dr. P. Rajarjeswari M. Sc., M. Phil., Ph.D., MCA, PGDOR presently working as an Assitant Professor of Mathematics in Chikkanna Government Arts College, Tiruppur, Tamilnadu, India. She had 23 years of teaching experience and 11 years of experience in research. Her area of research is Fuzzy sets, Topology, Operations Research. So far she has guided 6 M. Phil and 11 Ph. D candidates. She had published 112 research articles in national and international journals and presented more than 31 papers in national and international conferences. She is a life member of Indian Science Congress Association and ISTE.



T. Mathi Sujitha M. Sc., M. Phil., presently pursuing Ph. D degree at Chikkanna Government Arts College, Tiruppur, Tamilnadu, India. She had 6 years of teaching experience. Her area of research is Topology and Fuzzy sets. She has guided 1 M. Phil candidate and published 2 research articles.



Dr. R. Santhi M. Sc., M. Phil., Ph.D., PGDCA presently working as an Assistant Professor of Mathematics, Nallamuthu Gounder Mahalingam College, Pollachi, Coimbatore, Tamilnadu, India . She has published 56 papers in national and international journals. Her area of research is Topology, Fuzzy Topology and Intuitionistic Fuzzy Topology. She has 23 years of teaching experience and 19 years of research experience. She is a life member of Indian Science Congress Association, Kerala Mathematical Association and Ramanujan Mathematical Society.