International Journal of Pure and Applied Mathematics
Volume 118 No. 6 2018, 175-183
ISSN: 1311-8080 (printed version); ISSN: 1314-3395 (on-line version)
url: http://www.ijpam.eu
Special Issue
ijpam.eu

Decision Making On Trapezoidal Type-2 Fuzzy Soft Set

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Abstract

Molodtsov.D initiated the concept of soft set theory, which can be used as a generic mathematical tool for dealing with uncertainty. Especially, fuzzy soft set theory is used to solve decision making problems. In this work, we have used trapezoidal type-2 fuzzy soft sets and its complement to obtain the relationship between similarity measure, inclusion measure and entropy measure. The derived relationship is used to solve a decision making problem.

AMS Subject Classification(2010) 05C72

Key Words: Trapezoidal type-2 fuzzy soft sets, complement of trapezoidal type-2 fuzzy soft sets, similarity measure, inclusion measure, entropy measure.

1 Introduction

The theory of fuzzy sets was introduced by L.A.Zadeh in 1965[6]. It was progressing rapidly over the years. Soft set theory, originally proposed by Molodtsov.D [5], has become an effective mathematical tool to deal with uncertainty. P.K.Maji et al[4] first defined the soft sets and its operation into the decision making problem.

A type-2 fuzzy set is characterized by a fuzzy membership function, which can provide us with more degrees of freedom to represent the uncertainty and vagueness of the real world. The type-2 fuzzy set can be used to represent the fuzziness of evaluation of parameters directly. The soft set and its existing extensions can not be used to deal with such parameters that involve uncertain words and linguistic terms. Hence, it is necessary to extend soft set theory using type-2 fuzzy sets.

Zhiming Zhang and Shouhua Zhang [8], [9] first introduced the concept of type-2 fuzzy soft sets and trapezoidal interval type-2 fuzzy soft sets. Furthermore, some operations on trapezoidal interval type-2 fuzzy soft sets are defined and their properties are investigated.

We propose the notion of trapezoidal type-2 fuzzy soft sets and its complement.The inter relationship between similarity measure, inclusion measure and entropy measure are developed by trapezoidal type-2 fuzzy soft sets. We have solved a decision making problem using this relationship.

This paper is organized as follows: In section 2, some basic definitions and few operations of Trapezoidal type-2 fuzzy soft sets are given. In section 3, the inter relationship between similarity measure, inclusion measure and entropy measure of trapezoidal type-2 fuzzy soft set is defined. In section 4, a decision making problem is solved through this relationship.

2 Basic definitions

2.1 Definition

A soft set (P, E) is a set of all parameterized family of subsets of the non-empty universe X. For every $e \in E$ there exists $P(e)$ such that $P : E \to \rho(X)$, where $\rho(X)$ is a power set of X.

2.2 Definition

A fuzzy number $A = (a, b, c, d)$ is said to be a trapezoidal fuzzy number if its membership function is given by

$$\mu_A(X) = \begin{cases} \frac{(x-a)}{(b-a)}, & a \leqslant x \leqslant b \\ 1, & b \leqslant x \leqslant c \\ \frac{(d-x)}{(d-c)}, & c \leqslant x \leqslant d \\ 0, & otherwise \end{cases}$$

where $a, b, c, d \in R$

A set with trapezoidal fuzzy numbers is called trapezoidal fuzzy set[10].

2.3 Definition

Let X be a non-empty finite set, which is referred as the universal set. A type-2 fuzzy set A,is characterized by a type-2 membership function $\mu_A(x, u) : X \times I \to I$ where $x \in X, I = [0, 1]$ and $u \in J_x \subseteq I$ that is $A = \{((x, u); \mu_A(x, u))/x \in X, u \in J_x\}$ where $0 \leqslant \mu_A(x, u) \leqslant 1$.

A can also be expressed as $A = \int_{x\in X} \int_{u\in J_x} \frac{\mu_A(x,u)}{(x,u)} = \frac{p_x(u)/u}{x}; J_x \subseteq I$ where $p_x(u) = \mu_A(x, u)$

The type-2 trapezoidal number is defined by trapezoidal membership function and is denoted by $A = ([a_1, a_2, a_3, a_4], [b_1, b_2, b_3, b_4], [c_1, c_2, c_3, c_4], [d_1, d_2, d_3, d_4])$. A set with type-2 trapezoidal fuzzy numbers is called trapezoidal type-2 fuzzy set. The class of all trapezoidal type-2 fuzzy set of the universe X is denoted by $P_{TzT2}(X)$.

2.4 Definition

A trapezoidal type-2 fuzzy soft set $(\mathscr{P}, A)$ over the universal set X is a set of all parameterized family of subsets of the trapezoidal type-2 fuzzy set A. For every $e \in A, A \subseteq E$ there exists a mapping $\mathscr{P}(e)$ such that $\mathscr{P} : A \to P_{TzT2}(A)$ where $P_{TzT2}(A)$ denotes the set of all trapezoidal type-2 fuzzy set.

2.5 Definition

The union of two type-2 fuzzy soft sets $(\mathscr{P}, A)$ and $(\mathscr{Q}, B)$ over the same universe X is a type-2 fuzzy soft set $(\mathscr{R}, C)$, where $C = A \cup B$ and for all $\epsilon \in C$,

$$(\mathscr{R}, C) = \begin{cases} \mathscr{P}(e), & if \epsilon \in A - B \\ \mathscr{Q}(e), & if \epsilon \in B - A \\ \mathscr{P}(e) \vee \mathscr{Q}(e), & if \epsilon \in A \cap B \end{cases}$$

It is denoted by $(\mathscr{P}, A) \cup (\mathscr{Q}, B) = (\mathscr{R}, C)$

2.6 Definition

The intersection of two type-2 fuzzy soft sets $(\mathscr{P}, A)$ and $(\mathscr{Q}, B)$ over the same universe X is a type-2 fuzzy soft set $(\mathscr{S}, C)$, where $C = A \cup B$ and for all $\epsilon \in C$,

$$(\mathscr{S}, C) = \begin{cases} \mathscr{P}(e), & if \epsilon \in A - B \\ \mathscr{Q}(e), & if \epsilon \in B - A \\ \mathscr{P}(e) \wedge \mathscr{Q}(e), & if \epsilon \in A \cap B \end{cases}$$

It is denoted by $(\mathscr{P}, A) \cap (\mathscr{Q}, B) = (\mathscr{S}, C)$

2.7 Definition

The complement of a trapezoidal type-2 fuzzy soft set $(\mathscr{P}, A)$ is denoted by $(\mathscr{P}, A^c)$, and is defined by $(\mathscr{P}(\neg\epsilon), A) = (\mathscr{P}, A^c)$, $\mathscr{P}(\neg\epsilon)$is a mapping given by $\mathscr{P}(\neg\epsilon) : A^c \to P_{TzT2}(A^c)$ where $\mathscr{P}(\epsilon) = \mathscr{P}(\neg\epsilon)$ for all $\epsilon \in A^c$.

2.8 Definition

For a trapezoidal type-2 fuzzy number
$A = ([a_1, a_2, a_3, a_4], [b_1, b_2, b_3, b_4], [c_1, c_2, c_3, c_4], [d_1, d_2, d_3, d_4])$, the ranking function R is given by

$$\mathbf{R}(a) = \frac{1}{36}(a_1+2a_2+2a_3+a_4+2b_1+4b_2+4b_3+2b_4+2c_1+4c_2+4C_3+2c_4+d_1+2d_2+2d_3+d_4)$$

3 Similarity Measure, Inclusion Measure, entropy measure and their relationship

3.1 Similarity measure for type-2 fuzzy soft set

Let $M_1((\mathscr{P},A),(\mathscr{Q},B))$ denotes the similarity measure between the two trapezoidal type-2 fuzzy soft sets $(\mathscr{P},A)$ and $(\mathscr{Q},B)$.Then we define

$$M_1((\mathscr{P},A),(\mathscr{Q},B)) = max_j\left\{M_{1_j}((\mathscr{P},A),(\mathscr{Q},B)) = \begin{cases} \frac{\sum_{i=1}^{m}(\mathscr{P}(\epsilon_{ij})\cap\mathscr{Q}(\epsilon_{ij}))}{\sum_{i=1}^{m}(\mathscr{P}(\epsilon_{ij})\cup\mathscr{Q}(\epsilon_{ij}))} & \text{if } \epsilon\in A\cap B \\ 0 & \text{Otherwise} \end{cases}\right\}$$

Where $j=1$ to n $M_{1_j}((\mathscr{P},A),(\mathscr{Q},B))$ denotes the similarity measure between the ϵ_j-th approximations of $\mathscr{P}(\epsilon_{ij})$ and $\mathscr{Q}(\epsilon_{ij}),\mathscr{P}(\epsilon_{ij})=\mathscr{P}(\epsilon_j)(x_i)\in I$ and $\mathscr{Q}(\epsilon_{ij})=\mathscr{Q}(\epsilon_j)(x_i)\in I$.

3.2 Inclusion Measure for Type-2 Fuzzy Soft Set:

Let $M_2((\mathscr{P},A),(\mathscr{Q},B))$ denotes the inclusion measure between the two trapezoidal type-2 fuzzy soft sets $(\mathscr{P},A)$ and $(\mathscr{Q},B)$.Then we define

$$M_2((\mathscr{P},A),(\mathscr{Q},B)) = max_j\left\{M_{2_j}((\mathscr{P},A),(\mathscr{Q},B)) = \begin{cases} \frac{\sum_{i=1}^{m}(\mathscr{P}(\epsilon_{ij})\cap\mathscr{Q}(\epsilon_{ij}))}{\sum_{i=1}^{m}(\mathscr{P}(\epsilon_{ij})} & \text{if } \epsilon\in A\cap B \\ 0 & \text{Otherwise} \end{cases}\right\}$$

Where $j=1$ to n and $M_{2_j}((\mathscr{P},A),(\mathscr{Q},B))$ denotes the inclusion measure between the two ϵ_j-th approximations of $\mathscr{P}(\epsilon_{ij})$ and $\mathscr{Q}(\epsilon_{ij}),\mathscr{P}(\epsilon_{ij})=\mathscr{P}(\epsilon_j)(x_i)\in I$ and $\mathscr{Q}(\epsilon_{ij})=\mathscr{Q}(\epsilon_j)(x_i)\in I$.

3.3 Entropy Measure for Type-2 Fuzzy Soft Set:

Let $M_3((\mathscr{P},A),(\mathscr{Q},B))$ denotes the entropy measure between a trapezoidal type-2 fuzzy soft sets (P,A) and $(\mathscr{P},A^C)$.Then we define

$$M_3((\mathscr{P},A),(\mathscr{P},A^C)) = max_j\left\{M_{3_j}((\mathscr{P},A),(\mathscr{P},A^c)) = \left\{\frac{\sum_{i=1}^{m}(\mathscr{P}(\epsilon_{ij})\cap\mathscr{P}(\epsilon_{ij}^c))}{\sum_{i=1}^{m}(\mathscr{P}(\epsilon_{ij})\cup\mathscr{P}(\epsilon_{ij}^c))}; j=1,2,3,...n\right\}\right.$$

Where $M_{3_j}((\mathscr{P},A),(\mathscr{Q},B))$ denotes the entropy measure between the two ϵ_j-th approximations of $\mathscr{P}(\epsilon_{ij})$ and $\mathscr{P}(\epsilon_{ij})^c,\mathscr{P}(\epsilon_{ij})=\mathscr{P}(\epsilon_j)(x_i)\in I$ and $\mathscr{P}(\epsilon_{ij}^c)=\mathscr{P}(\epsilon_j^c)(x_i)\in I$.

3.4 Relationship Between Similarity Measure, Inclusion Measure and Entropy Measure

- The relationship between similarity Measure and inclusion measure is given by
  $M_1((\mathscr{P},A),(\mathscr{Q},B)) = min\{M_2((\mathscr{P},A),(\mathscr{Q},B)),M_2((\mathscr{Q},A),(\mathscr{P},B))\}$
- The relationship between entropy measure and inclusion measure is given by
  $M_3((\mathscr{P},A),(\mathscr{P},A^c)) = M_2((\mathscr{P},A\cup A^c),(\mathscr{P},A\cap A^c))$
- The relationship between Similarity Measure and entropy measure is given by
  $M_3((\mathscr{P},A),(\mathscr{P},A^c)) = M_1((\mathscr{P},A),(\mathscr{P},A^c))$

4 Numerical Example

Suppose that a car company is decided to select the most appropriate robot for its manufacturing process. The company has to choose two sets of three robots $\{r_1, r_2, r_3\}$under consideration. They consider four characteristics of robots as parameters, as follows:

- load capacity (ϵ_1)
- repeatability (ϵ_2)
- Speed (ϵ_3) and
- memory capacity (ϵ_4)

From the above informations the company has to choose robots with best characteristic.
Here we are going to choose a best parameter with these two sets of robots. Now all the available information on robots under consideration can be formulated as trapezoidal type-2 fuzzy soft set. These two sets are tabulated as follows:

$(\mathscr{P}, A)$	ϵ_1	ϵ_2	ϵ_3	ϵ_4
r_1	([0.4, 0.5, 0.6, 0.7], [0.2, 0.4, 0.6, 0.8], [0.3, 0.5, 0.7, 0.9], [0.1, 0.3, 0.5, 0.7])	([0.1, 0.3, 0.5, 0.7], [0.2, 0.4, 0.6, 0.8], [0.5, 0.6, 0.7, 0.8], [0.0, 0.3, 0.6, 0.9])	([0.2, 0.4, 0.6, 0.8], [0.2, 0.3, 0.4, 0.5], [0.5, 0.6, 0.7, 0.8], [0.6, 0.7, 0.8, 0.9])	([0.2, 0.4, 0.6, 0.8], [0.2, 0.3, 0.4, 0.5], [0.5, 0.6, 0.7, 0.8], [0.6, 0.7, 0.8, 0.9])
r_2	([0.1, 0.2, 0.3, 0.4], [0.0, 0.2, 0.4, 0.6], [0.2, 0.4, 0.6, 0.8], [0.5, 0.6, 0.7, 0.8])	([0.3, 0.5, 0.7, 0.9], [0.1, 0.2, 0.3, 0.4], [0.0, 0.2, 0.4, 0.6], [0.6, 0.7, 0.8, 0.9])	([0.0, 0.3, 0.6, 0.9], [0.1, 0.2, 0.3, 0.4], [0.5, 0.6, 0.7, 0.8], [0.4, 0.6, 0.8, 1.0])	([0.0, 0.1, 0.2, 0.3], [0.2, 0.3, 0.4, 0.5], [0.4, 0.5, 0.6, 0.7], [0.6, 0.7, 0.8, 0.9])
r_3	([0.1, 0.3, 0.5, 0.7], [0.3, 0.5, 0.7, 0.9], [0.5, 0.6, 0.7, 0.8], [0.2, 0.3, 0.4, 0.5])	([0.0, 0.1, 0.2, 0.3], [0.6, 0.7, 0.8, 0.9], [0.2, 0.3, 0.4, 0.5], [0.4, 0.5, 0.6, 0.7])	([0.2, 0.3, 0.4, 0.5], [0.3, 0.5, 0.7, 0.9], [0.5, 0.6, 0.7, 0.8], [0.0, 0.1, 0.2, 0.3])	([0.2, 0.3, 0.4, 0.5], [0.4, 0.5, 0.6, 0.7], [0.7, 0.8, 0.9, 1.0], [0.1, 0.3, 0.5, 0.7])

Table 4.1:Tabular representation of the trapezoidal type-2 fuzzy soft set $(\mathscr{P}, A)$

$(\mathscr{P}, A^c)$	ϵ_1	ϵ_2	ϵ_3	ϵ_4
r_1	([0.5, 0.4, 0.3, 0.2], [0.8, 0.7, 0.6, 0.5], [0.7, 0.5, 0.3, 0.1], [0.9, 0.8, 0.7, 0.6])	([0.6, 0.5, 0.4, 0.3], [0.8, 0.6, 0.4, 0.2], [0.7, 0.5, 0.3, 0.1], [0.9, 0.7, 0.5, 0.3])	([0.9, 0.7, 0.5, 0.3], [0.8, 0.6, 0.4, 0.2], [0.5, 0.4, 0.3, 0.2], [1.0, 0.7, 0.4, 0.1])	([0.8, 0.6, 0.4, 0.2], [0.8, 0.7, 0.6, 0.5], [0.5, 0.4, 0.3, 0.2], [0.4, 0.3, 0.2, 0.1])
r_2	([0.9, 0.8, 0.7, 0.6], [1.0, 0.8, 0.6, 0.4], [0.8, 0.6, 0.4, 0.2], [0.5, 0.4, 0.3, 0.2])	([0.7, 0.5, 0.3, 0.1], [0.9, 0.8, 0.7, 0.6], [1.0, 0.8, 0.6, 0.4], [0.4, 0.3, 0.2, 0.1])	([1.0, 0.7, 0.4, 0.1], [0.9, 0.8, 0.7, 0.6], [0.5, 0.4, 0.3, 0.2], [0.6, 0.4, 0.2, 0.0])	([1.0, 0.9, 0.8, 0.7], [0.8, 0.7, 0.6, 0.5], [0.6, 0.5, 0.4, 0.3], [0.4, 0.3, 0.2, 0.1])
r_3	([0.9, 0.7, 0.5, 0.3], [0.7, 0.5, 0.3, 0.1], [0.5, 0.4, 0.3, 0.2], [0.8, 0.7, 0.6, 0.5])	([1.0, 0.9, 0.8, 0.7], [0.4, 0.3, 0.2, 0.1], [0.8, 0.7, 0.6, 0.5], [0.6, 0.5, 0.4, 0.3])	([0.8, 0.7, 0.6, 0.5], [0.7, 0.5, 0.3, 0.1], [0.5, 0.4, 0.3, 0.2], [1.0, 0.9, 0.8, 0.7])	([0.8, 0.7, 0.6, 0.5], [0.6, 0.5, 0.4, 0.3], [0.3, 0.2, 0.1, 0.0], [0.9, 0.7, 0.5, 0.3])

Table 4.2: Tabular representation of the complement of trapezoidal type-2 fuzzy soft set $(\mathscr{P}, A^c)$

$(\mathscr{Q}, B)$	ϵ_1	ϵ_2	ϵ_3	ϵ_4
r_1	$([0.6, 0.7, 0.8, 0.9],$ $[0.0, 0.3, 0.6, 0.9],$ $[0.2, 0.4, 0.6, 0.8],$ $[0.1, 0.3, 0.5, 0.7])$	$([0.2, 0.3, 0.4, 0.5],$ $[0.5, 0.6, 0.7, 0.8],$ $[0.1, 0.4, 0.7, 1.0],$ $[0.4, 0.6, 0.8, 1.0])$	$([0.3, 0.5, 0.7, 0.9],$ $[0.1, 0.4, 0.7, 1.0],$ $[0.2, 0.4, 0.6, 0.8],$ $[0.7, 0.8, 0.9, 1.0])$	$([0.1, 0.4, 0.7, 1.0],$ $[0.2, 0.4, 0.6, 0.8],$ $[0.3, 0.5, 0.7, 0.9],$ $[0.7, 0.8, 0.9, 1.0])$
r_2	$([0.3, 0.5, 0.7, 0.9],$ $[0.2, 0.4, 0.6, 0.8],$ $[0.1, 0.2, 0.3, 0.4],$ $[0.5, 0.6, 0.7, 0.8])$	$([0.3, 0.4, 0.5, 0.6],$ $[0.4, 0.6, 0.8, 1.0],$ $[0.2, 0.3, 0.4, 0.5],$ $[0.5, 0.6, 0.7, 0.8])$	$([0.2, 0.3, 0.4, 0.5],$ $[0.4, 0.6, 0.8, 1.0],$ $[0.5, 0.6, 0.7, 0.8],$ $[0.2, 0.4, 0.6, 0.8])$	$([0.2, 0.3, 0.4, 0.5],$ $[0.6, 0.7, 0.8, 0.9],$ $[0.3, 0.4, 0.5, 0.6],$ $[0.2, 0.4, 0.6, 0.8])$
r_3	$([0.1, 0.3, 0.5, 0.7],$ $[0.2, 0.4, 0.6, 0.8],$ $[0.5, 0.6, 0.7, 0.8],$ $[0.4, 0.6, 0.8, 1.0])$	$([0.1, 0.4, 0.7, 1.0],$ $[0.3, 0.4, 0.5, 0.6],$ $[0.6, 0.7, 0.8, 0.9],$ $[0.2, 0.3, 0.4, 0.5])$	$([0.2, 0.3, 0.4, 0.5],$ $[0.1, 0.3, 0.5, 0.7],$ $[0.3, 0.4, 0.5, 0.6],$ $[0.6, 0.7, 0.8, 0.9])$	$([0.2, 0.3, 0.4, 0.5],$ $[0.3, 0.5, 0.7, 0.9],$ $[0.2, 0.4, 0.6, 0.8],$ $[0.6, 0.7, 0.8, 0.9])$

Table 4.3: Tabular representation of the complement of trapezoidal type-2 fuzzy soft set $(\mathscr{Q}, B)$

$(\mathscr{Q}, B^c)$	ϵ_1	ϵ_2	ϵ_3	ϵ_4
r_1	$([0.4, 0.3, 0.2, 0.1],$ $[1.0, 0.7, 0.4, 0.1],$ $[0.8, 0.6, 0.4, 0.2],$ $[0.9, 0.7, 0.5, 0.3])$	$([0.8, 0.7, 0.6, 0.5],$ $[0.5, 0.4, 0.3, 0.2],$ $[0.9, 0.6, 0.3, 0.0],$ $[0.6, 0.4, 0.2, 0.0])$	$([0.7, 0.5, 0.3, 0.1],$ $[0.9, 0.6, 0.3, 0.0],$ $[0.8, 0.6, 0.4, 0.2],$ $[0.3, 0.2, 0.1, 0.0])$	$([0.9, 0.6, 0.3, 0.0],$ $[0.8, 0.6, 0.4, 0.2],$ $[0.7, 0.5, 0.3, 0.1],$ $[0.3, 0.2, 0.1, 0.0])$
r_2	$([0.7, 0.5, 0.3, 0.1],$ $[0.8, 0.6, 0.4, 0.2],$ $[0.9, 0.8, 0.7, 0.6],$ $[0.5, 0.4, 0.3, 0.2])$	$([0.7, 0.6, 0.5, 0.4],$ $[0.6, 0.4, 0.2, 0.0],$ $[0.8, 0.7, 0.6, 0.5],$ $[0.5, 0.4, 0.3, 0.2])$	$([0.8, 0.7, 0.6, 0.5],$ $[0.6, 0.4, 0.2, 0.0],$ $[0.5, 0.4, 0.3, 0.2],$ $[0.8, 0.6, 0.4, 0.2])$	$([0.8, 0.7, 0.6, 0.5],$ $[0.4, 0.3, 0.2, 0.1],$ $[0.7, 0.6, 0.5, 0.4],$ $[0.8, 0.6, 0.4, 0.2])$
r_3	$([0.9, 0.7, 0.5, 0.3],$ $[0.8, 0.6, 0.4, 0.2],$ $[0.5, 0.4, 0.3, 0.2],$ $[0.6, 0.4, 0.2, 0.0])$	$([0.9, 0.6, 0.3, 0.0],$ $[0.7, 0.6, 0.5, 0.4],$ $[0.4, 0.3, 0.2, 0.1],$ $[0.8, 0.7, 0.6, 0.5])$	$([0.8, 0.7, 0.6, 0.5],$ $[0.9, 0.7, 0.5, 0.3],$ $[0.7, 0.6, 0.5, 0.4],$ $[0.4, 0.3, 0.2, 0.1])$	$([0.8, 0.7, 0.6, 0.5],$ $[0.7, 0.5, 0.3, 0.1],$ $[0.8, 0.6, 0.4, 0.2],$ $[0.4, 0.3, 0.2, 0.1])$

Table 4.4: Tabular representation of the complement of trapezoidal type-2 fuzzy soft set $(\mathscr{Q}, B^c)$

Using the above mentioned definitions, we find the similarity measure, inclusion measure and entropy measure between trapezoidal type-2 fuzzy soft sets. The calculated measure values are tabulated as below.

Parameters	ϵ_1	ϵ_2	ϵ_3	ϵ_4	Max.Value	Sel.parameter
$M_1((\mathscr{P}, A), (\mathscr{Q}, B))$	2.2163	1.8669	2.0103	2.1331	**2.2163**	ϵ_1
$M_2((\mathscr{P}, A), (\mathscr{Q}, B))$	2.6428	2.5027	2.5144	2.5804	**2.6428**	ϵ_1
$M_2((\mathscr{Q}, B), (\mathscr{P}, A))$	2.4548	2.1294	3.3160	2.4070	**2.4548**	ϵ_1
$M_1((\mathscr{P}, A^c), (\mathscr{Q}, B^c))$	2.3761	1.8609	1.9282	1.9715	**2.3761**	ϵ_1
$M_2((\mathscr{P}, A^c), (\mathscr{Q}, B^c))$	2.6080	2.1230	2.2586	2.3065	**2.6080**	ϵ_1
$M_2((\mathscr{Q}, B^c), (\mathscr{P}, A^c))$	2.7967	2.4980	2.5054	2.5010	**2.7967**	ϵ_1
$M_3((\mathscr{P}, A), (\mathscr{P}^c, A^c))$	1.4354	1.3174	1.3339	1.4036	**1.4354**	ϵ_1
$M_3((\mathscr{Q}, B), (\mathscr{Q}, B^c))$	1.3452	1.4096	1.3871	1.3880	**1.4096**	ϵ_2
$M_2(\mathscr{P} \cup \mathscr{P}^c, \mathscr{P} \cap \mathscr{P}^c)$	1.4354	1.3174	1.3339	1.4036	**1.4354**	ϵ_1
$M_2(\mathscr{Q} \cup \mathscr{Q}^c, \mathscr{Q} \cap \mathscr{Q}^c)$	1.3452	1.4096	1.3871	1.3880	**1.4096**	ϵ_2

Table4.5: Calculated values of similarity measure, inclusion measure and entropy measure.

- The similarity measure values of trapezoidal type-2 fuzzy soft set and its complement are the same. symbolically,
  $M_1((\mathscr{P}, A), (\mathscr{Q}, B)) = M_1((\mathscr{P}, A^c), (\mathscr{Q}, B^c))$

- The inclusion measure values of trapezoidal type-2 fuzzy soft set and its complement are the same. symbolically,
  $M_2((\mathscr{P}, A), (\mathscr{Q}, B)) = M_2((\mathscr{P}, A^c), (\mathscr{Q}, B^c))$
- The minimum value of all parameters in the entropy measure $M_3((\mathscr{P}, A), (\mathscr{P}, A^c))$ is equivalent to the maximum value of all parameters in the entropy measure
  $M_3((\mathscr{Q}, B), (\mathscr{Q}, B^c))$.symbolically
  $min\{M_{3_j}((\mathscr{P}, A), (\mathscr{P}, A^c))\} = max\{M_{3_j}((\mathscr{Q}, B), (\mathscr{Q}, B^c))\}$
- The similarity measure is equivalent to the following entropy measure of ϵ-th parameters
  $M_1((\mathscr{P}, A^c), (\mathscr{Q}, B^c)) = max\{M_{3_j}((\mathscr{P}, A), (\mathscr{P}, A^c))\} = min\{M_{3_j}((\mathscr{Q}, B), (\mathscr{Q}, B^c))\}$.
- The inter relationships between similarity measure, inclusion measure and entropy measure are verified, which are given in sec. 3.4.

$$min\{M_2((\mathscr{P}, A), (\mathscr{Q}, B)), M_2((\mathscr{Q}, A), (\mathscr{P}, B))\} = M_1((\mathscr{P}, A), (\mathscr{Q}, B))$$
$$min\{M_2((\mathscr{P}, A^c), (\mathscr{Q}, B^c)), M_2((\mathscr{Q}, B^c), (\mathscr{P}, A^c))\} = M_1((\mathscr{P}, A^c), (\mathscr{Q}, B^c))$$
$$M_3((\mathscr{P}, A), (\mathscr{P}, A^c)) = M_2((\mathscr{P}, A \cup A^c), (\mathscr{P}, A \cap A^c))$$
$$M_3((\mathscr{Q}, B), (\mathscr{Q}, B^c)) = M_2((\mathscr{Q}, B \cup B^c), (\mathscr{Q}, B \cap B^c)$$
$$M_3((\mathscr{P}, A), (\mathscr{P}, A^c)) = M_1((\mathscr{P}, A), (\mathscr{P}, A^c))$$
$$M_3((\mathscr{Q}, B), (\mathscr{Q}, B^c)) = M_1((\mathscr{Q}, B), (\mathscr{Q}, B^c))$$

The parameter ϵ_1 is having maximum measure value among four parameters. So that, the robots with load capacity (ϵ_1) is selected from the set of robots.

5 Conclusion

In this paper, we have proved that the inter relationship between similarity measure, inclusion measure and entropy measure on trapezoidal type-2 fuzzy soft sets. A decision making problem is solved to illustrate this relationship.In future work, other types of measures can also be used to find the solution of any decision making problem.

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