A Comparative Study on the Teaching Methods in Schools Using Similarity Measures on Fuzzy Soft Sets

Research Article∗

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Abstract: In this paper, we have made decision making using the concept of Similarity measures between two Fuzzy soft sets. There are three types of Similarity measures namely Similarity measure based on (i) set theoretic approach (ii) matching function and (iii) distance. We have applied the Similarity measure based on set theoretic approach and matching function to compare the different teaching methods in schools. We have made decision making on the best teaching method with respect to few attributes.

Keywords: Fuzzy soft sets, Similarity measures, teaching methods and decision making.

1.   Introduction

Fuzzy sets acts as a valuable tool to deal with imprecise and uncertain data. Lotfi A.Zadeh and Dieter Klaua [6] introduced Fuzzy sets in 1965. It is an extension of the classical set theory. But it has some difficulties probably due to the lack of the parameterization tools. Molodtsov introduced the soft sets in 1999 to deal with uncertainty.In many cases, it is frequently important to compare two sets [2] that may be fuzzy, vague etc. Researchers like Chen, Hong and Kim, Li and Xu, C.P.Pappis and many others have made a study on the problems using similarity measures between fuzzy sets, vague sets and fuzzy numbers. Similarity measures find a wide application in so many areas such as decision making, pattern recognition, handwriting recognition, image processing, coding theory, psychology etc.

In this chapter, we have compared the four different methods of teaching in class room using the similarity measure on set theoretic approach and matching function. There are several types of teaching methods which can be categorized into four broad types. These are teacher-centered methods, content-focused methods, learner-centered methods and interactive/participative methods. Let us now discuss about the four methods below:

1.1.   Instructor/Teacher Centered Methods

In this method the teacher is considered as the master of the subject. The students totally believe the teacher and looks upon the teachers as an expert in the subject. For these reasons the above methods are called "closed-ended". Expository or lecture methods are examples of this method.

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Lecture Method: A lecture is nothing but a presentation of information verbally by the teacher. The teacher is very active throughout the class, giving entire lecture. On the other hand, the students are very passive and just listening to the lectures.

1.2. Student-Centered Methods

In student-centered methods, the teacher or the instructor acts as both as a teacher and as a learner simultaneously. Through this process, the teacher learns many new things. Discussion method, discovery or inquiry based approach are some examples of the learner centered method.

Discussion method Both the teachers and the students participating are called as a discussion in classroom situation. The teacher spends some time listening to the students and the students spend some time talking.

1.3. Content-Focused Methods

In the content-focused method of teaching, both the student and the teacher have to fit into the content that is taught. In general, this means the information to be taught and trained are regarded very important. A lot of emphasis is laid on the precision and careful analysis of content.

1.4. Interactive/Participative Methods

Interactive or participatory method gives importance to all the three aspect namely teacher, student and content and hence it is a combination of all three above mentioned types of teaching methods. Given the current situation of students and the teacher these methods act accordingly by the situational analysis of what is the most suitable thing for us to learn or do now. They need a participatory understanding of all types of domains and factors.

2. Definitions

In this section, we shall discuss some definition necessary for our problem:

Definition 2.1. *Let X be the universal set, E the set of parameters, A subset of E and I^X denotes the set of all fuzzy subsets of X. Then (F, A) is called a fuzzy soft set over X where $F : A \to I^X$.*

Definition 2.2. *Consider two Fuzzy soft sets (P, A) and (Q, B). Then the operation '(P, A) AND (Q, B)' denoted by $(P, A) \wedge (Q, B)$ is a fuzzy soft set given by $(P, A) \wedge (Q, B) = (R, A \times B)$, where $R(a, b) = P(a) \cap Q(b) \ \forall \ a \in A$ and $b \in B$. Here $\cap$ represents the usual fuzzy intersection of two fuzzy sets.*

Definition 2.3. *Consider two Fuzzy soft sets (P, A) and (Q, B). Then the operation '(P, A) OR (Q, B)' denoted by $(P, A) \vee (Q, B)$ is given by the fuzzy soft set $(P, A) \vee (Q, B) = (S, A \times B)$, where $S(a, b) = P(a) \cup Q(b) \ \forall \ a \in A$ and $b \in B$.*

The similarity measures based on matching function of fuzzy soft sets is as follows:

Definition 2.4. *Let X be the universe and E be the set of parameters. Let $(F, E) = \{F(e_i), \ i = 1, 2, 3, \ldots, n\}$ and $(G, E) = \{G(e_i), \ i = 1, 2, 3, \ldots, n\}$ be two fuzzy soft sets over X where $F(e_i)$ and $G(e_i)$ denotes the e_i approximations of (F, E) and (G, E) respectively. The similarity between them is denoted by M(F, G) or $M_{F,G}$ and is given by*

$$M_{F,G} = \frac{\sum\limits_{j=1}^{n} \{F(e_i)(x_j) . G(e_i)(x_j)\}}{\sum\limits_{j=1}^{n} \{(F(e_i)(x_j))^2 \vee (G(e_i)(x_j))^2\}}$$

Definition 2.5. *Let $X = \{x_1, x_2, \ldots, x_n\}$ be the universal set of elements and $E = \{e_1, e_2, \ldots, e_m\}$ be the set of parameters. Let $\widehat{F} = (F, E) = \{F(e_i), \ i = 1, 2, 3, \ldots, n\}$ and $\widehat{G} = (G, E) = \{G(e_i), \ i = 1, 2, 3, \ldots, n\}$ be two fuzzy soft sets over (X, E) where $F(e_i)$ and $G(e_i)$ denotes the e_i approximations of (F, E) and (G, E) respectively.*

Let $S(\widehat{F}, \ \widehat{G})$ indicates the similarity measure based on set theoretic approach between the fuzzy soft sets $\widehat{F}$ and $\widehat{G}$. To find the similarity between $\widehat{F}$ and $\widehat{G}$, first we have to find the similarity between their e-approximations.

Let $S_i(\widehat{F}, \widehat{G}$ denote the similarity between the two e_i-th approximations $F(e_j)$ and $G(e_j)$. Then we define similarity measure based on set theoretic approach [2] as follows

$$S_i(\widehat{F}, \widehat{G}) = \frac{\sum\limits_{j=1}^{n} F_{ij} \wedge G_{ij}}{\sum\limits_{j=1}^{n} F_{ij} \vee G_{ij}}$$

Where $F_{ij} = F(e_i)(x_j)$ and $G_{ij} = G(e_i)(x_j)$. Then $S_{F,G} = \max_i\{S_i(\widehat{F}, \widehat{G})/1, 2, \ldots, n\}$.

3. Application of Similarity on Decision Making

In this section, we determine the best method of teaching in class room by constructing a decision making method based on the similarity measures based on set theoretic approach and matching function between two fuzzy soft sets. The algorithm of the decision making method and the mathematical modeling of the problem is discussed in this section.

3.1. Algorithm

1. Construct a fuzzy soft set (F, E) for the best teaching method over the universe X.

2. Construct fuzzy soft sets for the four teaching methods (G, E), (H, E), (I, E), (J, E) respectively for instructor/teacher centered methods, learner centered methods, content focused method and interactive/ participative method

3. Calculate the similarity between e_j-th approximations of $\widehat{F}$ and the corresponding e_j-th approximation of the four methods of teaching one by one for the set theoretic approach.

4. Calculate the similarity measure based on set theoretic approach between the fuzzy soft set (F, E) and the fuzzy soft sets corresponding to the four methods of teaching one by one by taking the maximum of all the similarities of e_j-th approximation.

5. Calculate the similarity measure based on matching function by direct application of the formula

6. Estimate result based on the similarity. The one with value greater than 0.5 corresponds to the best teaching method.

3.2. Application

1. Consider the four methods of teaching G, H, I and J were

   G - Instructor/Teacher centered method

   H - Learner centered method

   I - Content centered method and

   J - Interactive/ Participative method

2. The universal set contains only three elements namely teachers view 't', students view 's' and parents view 'p'. (i.e.) $X = \{t, s, p\}$.

3. $E = \{e_1, e_2, e_3, e_4\}$ is the set of parameters where

   e_1 - Intellectual growth

   e_2 - Creativity

   e_3 - developing Communication skills

   e_4 - motivation

4. We construct the fuzzy soft set (F,E) for the best teaching method as follows:

$$(F, E) = \begin{array}{c} \\ t \\ s \\ p \end{array}\begin{array}{cccc} e_1 & e_2 & e_3 & e_4 \\ \left(\begin{array}{cccc} 1 & 0.8 & 0.7 & 0.9 \\ 0.8 & 0.9 & 0.8 & 1 \\ 0.9 & 0.7 & 1 & 0.7 \end{array}\right) \end{array}$$

We construct the fuzzy soft sets (G, E), (H, E), (I, E) and (J, E) for the four different types of teaching methods respectively

$$(G, E) = \begin{array}{c} \\ t \\ s \\ p \end{array}\begin{array}{cccc} e_1 & e_2 & e_3 & e_4 \\ \left(\begin{array}{cccc} 0.4 & 0.3 & 0.4 & 0.2 \\ 0.2 & 0.1 & 0.6 & 0.5 \\ 0.6 & 0.3 & 0.1 & 0.5 \end{array}\right) \end{array}$$

$$(H, E) = \begin{array}{c} \\ t \\ s \\ p \end{array}\begin{array}{cccc} e_1 & e_2 & e_3 & e_4 \\ \left(\begin{array}{cccc} 0.2 & 0.4 & 0.3 & 0.2 \\ 0.1 & 0.3 & 0.1 & 0.2 \\ 0.4 & 0.2 & 0.3 & 0.1 \end{array}\right) \end{array}$$

$$(I, E) = \begin{array}{c} \\ t \\ s \\ p \end{array}\begin{array}{cccc} e_1 & e_2 & e_3 & e_4 \\ \left(\begin{array}{cccc} 0.2 & 0 & 0.4 & 0 \\ 0.4 & 0.1 & 0 & 0.2 \\ 0.3 & 0.1 & 0 & 0 \end{array}\right) \end{array}$$

$$(J, E) = \begin{array}{c} \\ t \\ s \\ p \end{array}\begin{array}{cccc} e_1 & e_2 & e_3 & e_4 \\ \left(\begin{array}{cccc} 0.7 & 0.6 & 0.8 & 0.7 \\ 1 & 0.7 & 0.6 & 0.8 \\ 0.8 & 0.9 & 0.6 & 1 \end{array}\right) \end{array}$$

5. We now calculate the similarity measure based on set theoretic approach between these as follow:

Consider (F, E) and (G, E):

$$S_1(\widehat{F}, \widehat{G}) = \frac{\sum_{j=1}^{n} F_{ij} \wedge G_{ij}}{\sum_{j=1}^{n} F_{ij} \vee G_{ij}} = \frac{1.2}{2.7} = 0.44$$

$$S_2(\widehat{F}, \widehat{G}) = \frac{\sum_{j=1}^{n} F_{ij} \wedge G_{ij}}{\sum_{j=1}^{n} F_{ij} \vee G_{ij}} = \frac{0.7}{2.4} = 0.29$$

$$S_3(\widehat{F}, \widehat{G}) = \frac{\sum_{j=1}^{n} F_{ij} \wedge G_{ij}}{\sum_{j=1}^{n} F_{ij} \vee G_{ij}} = \frac{1.1}{2.5} = 0.44$$

$$S_4(\widehat{F}, \widehat{G}) = \frac{\sum_{j=1}^{n} F_{ij} \wedge G_{ij}}{\sum_{j=1}^{n} F_{ij} \vee G_{ij}} = \frac{1.2}{2.6} = 0.46$$

$$S_{F,G} = \max_{j}\{M_j(\widehat{F}, \widehat{G})/1, 2, \ldots, n\} = 0.46 < \frac{1}{2}$$

Consider (F,E) and (H,E):

$$S_1(\widehat{F}, \widehat{H}) = \frac{0.7}{2.7} = 0.26$$

$$S_2(\widehat{F}, \widehat{H}) = \frac{0.9}{2.4} = 0.38$$

$$S_3(\widehat{F}, \widehat{H}) = \frac{0.7}{1.6} = 0.44$$

$$S_4(\widehat{F}, \widehat{H}) = \frac{0.5}{1.7} = 0.29$$

$$S_{F,H} = \max_{j}\{M_j(\widehat{F}, \widehat{H})/1, 2, \ldots, n\} = 0.44 < \frac{1}{2}$$

Consider (F, E) and (I, E):

$$S_1(\widehat{F}, \widehat{I}) = \frac{0.9}{2.7} = 0.33$$

$$S_2(\widehat{F}, \widehat{I}) = \frac{0.2}{2.4} = 0.08$$

$$S_3(\widehat{F}, \widehat{I}) = \frac{0.4}{1.6} = 0.25$$

$$S_4(\widehat{F}, \widehat{I}) = \frac{0.2}{1.7} = 0.12$$

$$S_{F,I} = \max_{j}\{M_j(\widehat{F}, \widehat{I})/1, 2, \ldots, n\} = 0.33 < \frac{1}{2}$$

Consider (F, E) and (J, E):

$$S_1(\widehat{F}, \widehat{J}) = \frac{2.3}{2.9} = 0.79$$

$$S_2(\widehat{F}, \widehat{j}) = \frac{2.2}{2.6} = 0.77$$

$$S_3(\widehat{F}, \widehat{J}) = \frac{1.9}{2.6} = 0.73$$

$$S_4(\widehat{F}, \widehat{J}) = \frac{2.2}{2.9} = 0.76$$

$$S_{F,J} = \max_{j}\{M_j(\widehat{F}, \widehat{J})/1, 2, \ldots, n\} = 0.79 > \frac{1}{2}$$

6. We now calculate the similarity measure based on matching function between these as follow:

$$M_{F,G} = \frac{\sum\limits_{j=1}^{n} F(e_i)(x_j) . G(e_i)(x_j)}{\sum\limits_{j=1}^{n} (F(e_i)(x_j))^2 \vee (G(e_i)(x_j))^2} = \frac{3.53}{8.82} = 0.40 < \frac{1}{2}$$

$$M_{F,H} = \frac{2.41}{8.82} = 0.27 < \frac{1}{2}$$

$$M_{F,I} = \frac{1.43}{8.82} = 0.16 < \frac{1}{2}$$

$$M_{F,J} = \frac{7.73}{10.16} = 0.76 > \frac{1}{2}$$

Similarity	Teacher centered method	Student centered method	Content focused method	Interactive method
Set theoretic approach	0.46	0.44	0.33	0.79
Matching Function	0.40	0.27	0.16	0.76

7. Here the Fuzzy soft set of the interactive method of teaching has more similarity to the fuzzy soft set of best method of teaching. Hence interactive method of teaching is the best method of teaching.

4.   Conclusion

We have found that the interactive method of teaching is the best method of teaching among instructor/teacher centered methods, learner centered methods, content centered method and interactive/participative method using the similarity measure based on set theoretic approach and matching function and using the parameter set as Intellectual growth, Creativity, developing Communication skills and motivation.

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