SOFT SETS APPLICATION IN ANIMAL DIAGNOSIS

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Abstract
The concept of soft set is one of the recent topics developed for dealing with the uncertainties present in most of our real life situations. The parameterization tool of soft set theory enhances the flexibility of its applications. In this paper we extend Sanchez's approach for animal's diagnosis using interval-valued fuzzy soft sets and exhibit the technique with a hypothetical case study.
Keywords: Soft set, Interval-valued fuzzy soft set, Soft medical knowledge

Introduction

Most of our real life problems in medical sciences, engineering, management, environment and social sciences often involve data which are not necessarily crisp, precise and deterministic in character due to various uncertainties associated with these problems. Such uncertainties are usually being handled with the help of the topics like probability, fuzzy sets, intuitionistic fuzzy sets, interval mathematics and rough sets etc. However, Molodtsov (1999) has shown that each of the above topics don't possess enough parameterization tools and to overcome this shortcoming, we introduced a concept called 'Soft Set Theory' having parameterization tools for successfully dealing with various types of uncertainties. The absence of any restrictions on the approximate description in soft set theory makes this theory quite convenient and easily applicable in practice.

Preliminaries

Definition 2.1

Let U be a universal set, E a set of parameters and $A \subseteq E$. Then a pair *(F,A)* is called soft set over U, where F is a mapping from A to 2^U , the power set of U.

The "attractiveness of the cars" which Mr. X (say) is going to buy.

Definition 2.2

Let U be a universal set, E a set of parameters and $A \subseteq E$. Let $\mathrm{F}(U)$ denotes the set of all fuzzy subsets of U. Then a pair *(F, A)* is called fuzzy soft set over U, where F is a mapping from A to F *(U).*

Definition 2.3

An interval-valued fuzzy sets $\hat{X}$ on the universe U is a mapping such that $X^{\hat{}}: U \rightarrow Int([0,1])$ where Int([0,1]) stands for all closed subintervals of [0,1], the set of all interval-valued fuzzy sets on U is denoted by $F^U(U)$.

Definition 2.4

Let U be a universal set, E a set of parameters and $A \subset E$. Let $\hat{F}(U)$ denotes the set of all interval-valued fuzzy sets on U. Then a pair (F, A) is called interval-valued fuzzy soft set over U, where F is a mapping from A to $\hat{F}(U)$.

Soft Set Application Using Interval Valued Fuzzy Soft Set in Animals (Cows) Diagnosis

Suppose S is a set of symptoms of certain diseases, D is a set of diseases and P is a set of animal's patients. Construct an interval-valued fuzzy soft set (F, D) over S, where F is a mapping $F: D \rightarrow \widehat{F}(S)$. A relation matrix say, R_1 is constructed from the interval-valued fuzzy soft set (F, D) and called symptom-diseases matrix. Similarly its complement $(F, D)^C$ gives another relation matrix, say, R_2, called non symptom-disease matrix. Analogous to Sanchez's notion of 'Medical knowledge' we refer to each of the matrices R_1 and R_2 as 'interval-valued soft Medical Knowledge'. Again we construct another interval-valued fuzzy soft set (F_1, S) over P, where F_1 is a mapping given by $F_1: D \to \widehat{F}\,(P)$. This interval-valued fuzzy soft set gives another relation Q called patient-symptom matrix. Then we obtain two new relation matrices $T_1: QoR_1$ and $T_2: QoR_2$, called symptom-patient matrix and non symptom-patient matrix respectively, in which the membership values are given by

$$\mu_{T_1}(p_i, d_k) = \left[\inf\left\{\mu^L Q^{(p_i,\ e_j)} \wedge \mu^L R_1{}^{(e_j,\ d_k)}\right\}, sup\left\{\mu^U Q^{(p_i,\ e_j)} \wedge \mu^U R_1{}^{(e_j,\ d_k)}\right\}\right]$$

$$\mu_{T_2}(p_i, \neg d_k) = \left[\inf\left\{\mu^L Q^{(p_i,\ e_j)} \wedge \mu^L R_2{}^{(e_j,\ d_k)}\right\}, sup\left\{\mu^U Q^{(p_i,\ e_j)} \wedge \mu^U R_2{}^{(e_j,\ d_k)}\right\}\right]$$

we calculate $S_{T_1} = \sum\left\{\left(\mu^L{}_{T_1}(p_i, d_j) - \mu^L{}_{T_1}(p_i, d_k)\right)\right\} + \sum\left\{\left(\mu^U{}_{T_1}(p_i, d_j) - \mu^U{}_{T_1}(p_i, d_k)\right)\right\}$ and $S_{T_2} = \sum\left\{\left(\mu^L{}_{T_2}(p_i, d_j) - \mu^L{}_{T_2}(p_i, d_k)\right)\right\} + \sum\left\{\left(\mu^U{}_{T_2}(p_i, d_j) - \mu^U{}_{T_2}(p_i, d_k)\right)\right\}$, which we call as diagnosis score for and against the disease respectively. Now, if $max\{S_{T_1}(p_i, d_j) - S_{T_2}(p_i, \neg\, d_j)\}$ occurs for exactly (p_i, d_k) only, then we conclude that the acceptable diagnostic hypothesis for patient p_i is the disease d_k. In case there is a tie, the process has to be repeated for patient p_i by reassessing the symptoms.

Algorithm

1. Input the interval valued fuzzy soft set (F, D) and $(F, D)^C$ over the sets S of symptoms, where D is the set of diseases. Also write the soft medical knowledge R_1 and R_2 representing the relation matrices of the IVFSS (F, D) and $(F, D)^C$ respectively.
2. Input the IVFSS $(F_{1,}S)$ over the set P of patients and write its relation matrix Q.
3. Compute the relation matrices $T_1: QoR_1$ and $T_2: QoR_2$.
4. Compute the diagnosis scores S_{T_1} and S_{T_2}.
5. Find $S_K = max\{S_{T_1}(p_i, d_j) - S_{T_2}(p_i, \neg\, d_j)\}$

   Then we conclude that the patient p_i is suffering from the disease d_k.

6. if S_k has more than one value then go to step one and repeat the process by reassessing the symptoms for the patients.

Case Study

Suppose there are three animal patients $p_1, p_2,\ and\ p_3$ admitted in Teaching and Research Farm in the department of Animal Science Federal University Dutsinma with symptoms Temperature, Blood sample , Faeces and Urine problem. Let the possible diseases relating to the above symptoms be viral diseases and bacteria diseases. We consider the set $S = \{e_1, e_2, e_3\ , e_4\}$ as universal set, where $e_1, e_2, e_3,\ and\ e_4$ represent the symptoms Temperature, Blood sample , Faeces and Urine respectively and the set $D = \{d_1, d_2\}$ where $d_1\ and\ d_2$ represent the parameters viral diseases and bacteria diseases respectively. Suppose that $(d_1) = \{\langle e_1, [0.8, 1]\rangle, \langle e_2, [0.1, 0.4]\rangle, \langle e_3, [0.5, 0\ .6]\rangle, \langle e_4, [0.2, 0.4]\rangle\}$, $F(d_2) = \{\langle e_1, [0.6, 0.9]\rangle, \langle e_2, [0.4, 0.6]\rangle, \langle e_3, [0.3, 0\ .6]\rangle, \langle e_4, [0.8, 1]\rangle\}$. The interval valued fuzzy soft set (F, D) is a parameterized family $\{F(d_1), F(d_2)\}$ of all interval valued fuzzy set over the set S and are determined from expert medical documentation. Thus the fuzzy soft set (F, D) gives an approximate description of the interval valued soft medical knowledge of the two diseases and their symptoms. This interval valued fuzzy soft set (F, D) and its complement $(F, D)^C$ are represented by two relation matrices $R_1\ and\ R_2$ call symptom-disease matrix and non-symptom-disease matrix respectively. Given by

$$R_1 = \begin{array}{c} [e_1] \\ [e_2] \\ [e_3] \\ [e_4] \end{array} \begin{bmatrix} [\quad d_1 \quad | \; [(\quad d_2 \\ [0.1,0.4][0.4,0.6] \\ [0.5,0.6][0.3,0.6] \\ [0.2,0.4][0.2,1.0] \end{bmatrix} \quad \text{and} \quad R_2 = \begin{array}{c} \\ [e_1] \\ [e_2] \\ [e_3] \\ [e_4] \end{array} \begin{array}{cc} d_1 & d_2 \\ \multicolumn{2}{c}{\begin{bmatrix} [.7,1] & [.7,1] \\ [0.1,0.4] & [0.1,0.4] \\ [0.5,0.6] & [0.5,0.6] \\ [0.2,0.4] & [0.2,0.4] \end{bmatrix}} \end{array}$$

Again we take $P = \{p_1, p_2, p_3\}$ as the universal set where p_1, p_2 *and* p_3 represent patients respectively and $S = \{e_1, e_2, e_3, e_4\}$ as the set of parameters.

Suppose that $F_1(e_1) = \{\langle p_1, [0.6, 0.9]\rangle, \langle p_2, [0.3, 0.5]\rangle, \langle p_3, [0.6, 0.8]\rangle\}$, $F_1(e_2) = \{\langle p_1, [0.3, 0.5]\rangle, \langle p_2, [0.3, 0.7]\rangle, \langle p_3, [0.2, 0.6]\rangle\}$, $F_1(e_3) = \{\langle p_1, [0.8, 1]\rangle, \langle p_2, [0.2, 0.4]\rangle, \langle p_3, [0.5, 0.7]\rangle\}$, and $F_1(e_4) = \{\langle p_1, [0.6, 0.9]\rangle, \langle p_2, [0.3, 0.5]\rangle, \langle p_3, [0.2, 0.5]\rangle\}$.

The interval-valued fuzzy soft set (F_1, S) is another parameterized family of all interval-valued fuzzy sets and gives a collection of approximate description of the patient-symptoms in the Research Farm in the department of Animal Science Federal University Dutsinma. This interval-valued fuzzy soft set (F_1, S) represents a relation matrix Q called patient-symptom matrix given by

$$Q = \begin{array}{c} \\ [p_1] \\ [p_2] \\ [p_3] \end{array} \begin{bmatrix} e_1 & e_2 & e_3 & e_4 \\ [0.6,0.9] & [0.3,0.5] & [0.8,1.0] & [0.6,0.9] \\ [0.3,0.5] & [0.3,0.7] & [0.2,0.4] & [0.3,0.5] \\ [0.6,.8] & [0.2,0.6] & [0.5,0.7] & [0.2,0.5] \end{bmatrix}$$

Then combining the relation matrices R_1 and R_2 separately with Q we get two matrices T_1 and T_2 called patient-disease and patient-non disease matrices respectively, given by

$$T_1 = QoR_1 = \begin{array}{c} \\ [p_1] \\ [p_2] \\ [p_3] \end{array} \begin{bmatrix} d_1 & d_2 \\ [0.1,0.9] & [0.3,0.9] \\ [0.1,0.5] & [0.2,0.6] \\ [0.1,0.8] & [0.2,0.8] \end{bmatrix} \qquad T_2 = QoR_2 = \begin{array}{c} \\ [p_1] \\ [p_2] \\ [p_3] \end{array} \begin{bmatrix} d_1 & d_2 \\ [0.0,0.8] & [0.0,0.7] \\ [0.0,0.7] & [0.0,0.6] \\ [0.0,0.6] & [0.0,0.7] \end{bmatrix}$$

Now we calculate

$S_{T_1} - S_{T_2}$	d_1	d_2
P_1	0.2	0.6
P_2	-0.7	-0.4
P_3	0.5	-0.1

Now, it clear that the patient p_3 is suffering from the disease d_1 and patients p_1 and p_2 are both suffering from disease d_2.

Conclusion

We have applied the concept of interval valued fuzzy soft set in animals diagnosis, and also demonstrate with some case study.

References

Molodtsov, D. (1999) Soft set Theory-First Results, Computers and Mathematics with Application. 37, 19-31.

Sanchez, E. (1979). Inverse of fuzzy relations, Application to possibility distributions and medical diagnosis, Fuzzy Sets and Systems. 2 (1), 75-86.