On Applications of Fuzzy Soft Sets in Dimension Reduction and Medical Diagnosis

Abstract

In our daily life, we often come across various problems related to the high dimensionality of data. In such type of problems irrelevant and superfluous data along with useful data is also present. Thus, dimensionality reduction has found wide applications in data analysis and management. In recent years the issue of dimensionality reduction in a fuzzy situation has also gained importance and has invited attention of researchers. The various techniques and theories have been developed by them to solve these types of problems. Some of these techniques based on probabilistic approach and others are non-probabilistic approach.

For finding coherent and logical solution to various real life problems containing uncertainty, impreciseness and vagueness, fuzzy soft set theory is gaining significance. In this paper concept of fuzzy soft set has been defined as hybridization of fuzzy set and soft set theory. A new technique is proposed to convert the soft set table into fuzzy soft set table and has been applied in dimension reduction of big data. An application of fuzzy soft set has also studied in Medical Diagnosis following Sanchez's approach.

Keywords: Soft set, fuzzy set, fuzzy soft set, dimensionality reduction, medical diagnosis.

1. Introduction

Various real life problems in engineering, social and medical sciences, economics etc. engage imprecise and enormous data and their solution concern the use of mathematical principles based on uncertainty and imprecision. In recent years to dealing with such systems in an effective way a number of theories have been proposed. Some of these theories are probability, game theory, fuzzy sets, intuitionistic fuzzy sets, etc.

The most suitable theory for dealing with uncertainty is the theory of fuzzy sets developed by Zadeh [1] in 1965. Another one is rough set theory pioneered by Pawlak [3] in 1982, which is also a momentous tactic to modeling vagueness. This theory has been successfully applied to many fields such as machine learning, data mining, data analysis, medicine etc.

In 1999, Molodtsov [4] introduced a general mathematical tool known as soft set theory to handle the objects which have been defined using a very loose and hence very general set of characteristics, which was completely a new approach for modeling vagueness and uncertainties.

In addition to defining the fundamental outlines of soft set theory, Molodtsov [4] also illustrated how soft set theory is free from parameterization insufficiency condition of fuzzy set theory, rough set theory, probability theory and game theory. Soft set theory is a universal framework, as various traditional models emerge as unique case of soft sets theory.

Soft set theory has prospective for application in resolving realistic problems in economics, engineering, environment, social science, medical science and business management. Kalaichelvi and Malini [14] and Ozgur and Tas [16] have studied the application of fuzzy soft sets to investment decision making problems. Yukksel et al. [15] have applied soft sets in diagnosis of the prostate cancer risk. The absence of any restriction on the approximate description in soft set theory makes this theory very convenient and easily applicable. Thus in recent years, research on soft set theory has been dynamic and impressive movement has been achieved.

Later on, Maji et al [6] studied the theory of soft sets and also promote a hybrid model known as fuzzy soft set [5], which is a combination of soft set and fuzzy set. In [7] they also studied the intuitionistic fuzzy soft set. The concept of fuzzy soft set introduced by Maji et al [6] was generalized by Majumdar and Samanta [11].

Neog and Sut [12, 13] illustrated with counter examples that the axioms of contradiction and exclusion are not authenticate in case of soft sets and fuzzy soft sets if we apply the notion of complement commenced by Maji et al [6, 7]. Accordingly, they put forward new definitions of complement of soft sets and fuzzy soft sets and demonstrated that all the properties of complement of a set are possessed by soft sets and fuzzy soft sets due to the proposed definition of complement.

For extreme data dimensionality reductions becomes the centre of curiosity to a significant point of study in various fields of application (refer to Gupta and Sharma [17]). A number of techniques proposed by the researchers and authors related to dimensionality reduction. Hooda and Hooda[10] studied dimension reduction in multivariate analysis by using maximum entropy criterion.

Chen et al [9] present a new definition of parameterization reduction in soft sets and compare this definition to the associated concept of attributes reduction in rough set theory. In this paper we used fuzzy soft set based approach to reduce the dimensionality of data. The proposed novel method of dimensionality reduction involves constructions of binary information table from soft sets and fuzzy soft sets in a parametric sense for dimensionality reduction.

2. Preliminaries

In this section we will describe the preliminary definitions, and results which will be required later in this paper.

2.1 Fuzzy Set

The concept of a fuzzy set is an extension of the concept of a crisp set. Just as a crisp set on a universal set X is defined by its characteristic function from X to {0, 1}, where a fuzzy set on a domain X is defined by its membership function form X to [0,1].

Definition 2.1[1] Let X is a non-empty set, (called the universal set or the universe of discourse or simply domain). Then a function $\mu_A(x): X \rightarrow [0,1]$, defines fuzzy set on X as

$$A = \left\{ \left(x_i, \mu_A\left(x_i\right) \right) : \mu_A\left(x_i\right) \in \left[0,1\right]; \forall x_i \in X \right\},$$

where $\mu_A(x_i)$ is called membership function and satisfies the following properties:

$$\mu_A\left(x_i\right) = \begin{cases} 0, \text{if } x_i \notin A \text{ and there is no ambiguity} \\ 1, \text{if } x_i \in A \text{ and there is no ambiguity} \\ 0.5, \text{there is max ambiguity whether } x_i \notin A \, or \, x_i \in A \end{cases}$$

Representation of Fuzzy Set

There are following ways to represent fuzzy set.

(a) Fuzzy set A on X can be represented by, set of ordered pair as follows

$$A = \{(x, \mu_A(x)) : x \in X\}.$$

(b) In case, if the domain is finite fuzzy set $A = \sum \frac{\mu_A(x_i)}{x_i}$.

For example if $\mu_A(a) = 0, \mu_A(b) = 0.7, \mu_A(c) = 0.4, \mu_A(d) = 1$.

Then, fuzzy set A can be written as

$$A = \{(a,0),(b,0.7),(c,0.4),(d,1)\} \text{ or } A = \frac{0}{a} + \frac{0.7}{b} + \frac{0.4}{c} + \frac{1}{d}.$$

(c) In case, the domain is continuous $A = \int \frac{\mu_A(x)}{x}$.

(d) In case, the domain is finite and consisting n- elements $x_1, x_2, x_3, \ldots\ldots x_n$. Then fuzzy set

A=

x_1	x_2	……..	x_n
0.5	0.6	……..	0.9

(e) By means of a graph

(i) The fuzzy membership function for fuzzy linguistic term "COOL" relating to temperature is as below

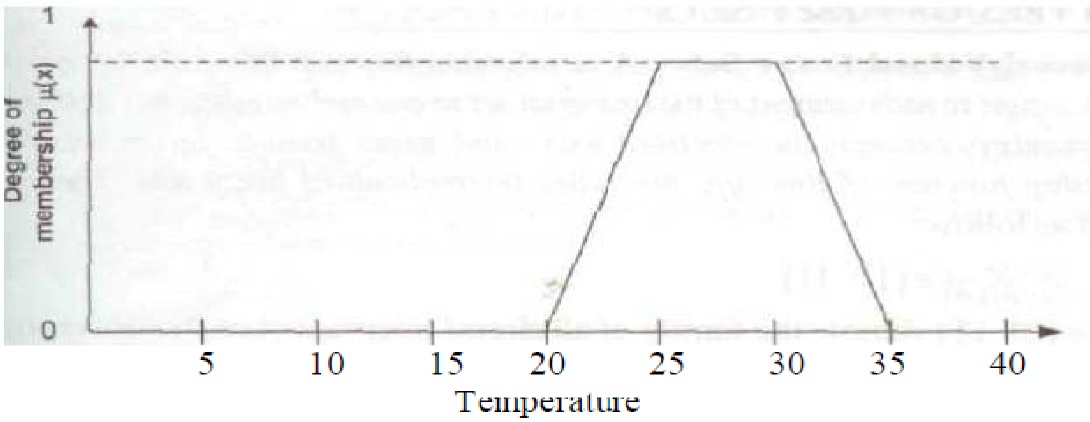

Fig1.: Continuous membership function for "COOL"

(ii) A membership function can also be given mathematically as

$$\mu_A(x) = \frac{1}{(1+x)^2}$$

The graph of the above function is shown below:

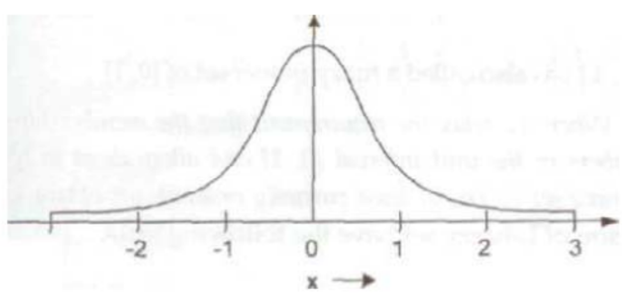

Fig.2: Continuous membership function dictated by mathematical function

Definition 2.2[18] In the definition of fuzzy set S the membership function $m_S(z)$ illustrates the membership of the element z of the base set$Z$, whereby for $m_S(z)$ a large class of function can be taken. For the fuzzy set S, the grade of membership $m_S(z_0)$ of a membership function $m_S(z)$ express for the special element $z = z_0$. This value is in the unit interval $[0, 1]$.

2.2 Soft Set

Soft set theory that was insinuated by Molodtsov in 1999 to deal with uncertainty in a non-parametric approach is a generalization of fuzzy set theory. Soft set theory has a productive prospective for application in various areas, some of which had been discussed by Molodtsov [4]. To deal with a collection of approximate portrayal of objects, a generalized parametric gizmo is used known as Soft set.

Each approximate portrayal has two parts a predicate and an approximate value sets. Since the initial portrayal of the object has an approximate nature, therefore, there is no need to introduce the notion of exact solution. The soft set theory is very handy and simply valid in performance

Çdue to the nonexistence of any restrictions on the approximate descriptions. With the aid of words and sentences, real number, function, mapping and so on; any parameter can be operate that we desire.

Definitions 2.3 Let X be an initial universe set and E be the set of parameters and A *is subset of* E . Then the pair (F, A) is called a soft set (over$X$) if F is a mapping of A into the power set of X, i.e., $F\colon A \rightarrow P(X)$.

Obviously, for a given universe X a soft set is a parameterized family of subsets over X

Example2.1. Let X= {c_1,c_2,c_3} be the set of three cars and E={e_1=costly, e_2=metallic color, e_3=cheap}be set of parameters. Let A = { e_1,e_2} , then(F,A)= { F(e_1)= {**c_1**,c_2,c_3}, F(e_2)={c_1,c_2}} is the crisp soft set over X which describes the " attractiveness of cars" which Mr. S is going to buy.

Table 2.1

Y/A	**e_1**	**e_2**
c_1	1	1
c_2	1	1
c_3	1	0

Example 2.2 Let $X = \{m_1, m_2, \ldots, m_5\}$ be the sets of mobiles under consideration and E be the set of parameters, A= $E = \{e_1 = expensive, e_2 = good\ quality, e_3 = cheap, e_4 = stylish, e_5 = latest\}$. Then the soft set (F, E) describes the attractiveness of the mobiles as

$(F, E) = \{\{expensive = m_1, m_2, m_5\}, \{good\ quality = m_3, m_5\}, \{cheap = m_3, m_4, m_5\}, \{stylish = m_1, m_2, \ldots, m_5\}, \{latest = m_1, m_3, m_4, m_5\}\}$. This soft set representation is shown in the table 2.1 form as below:

Table 2.2

X/E	e_1	e_2	e_3	e_4	e_5
m_1	1	0	0	1	1
m_2	1	0	0	1	0
m_3	0	1	1	1	1
m_4	0	0	1	1	1
m_5	1	1	1	1	1

2.3 Fuzzy Soft Set

By hybridization of fuzzy sets and soft sets, Maji et al [6] defined fuzzy soft sets. Actually, the concept of fuzzy soft set is an extension of crisp soft set. The fuzziness or vagueness deals with uncertainty inherent in the dimensionality reduction and decision making problems like medical diagnosis. The definition of fuzzy soft set is given and illustrated by examples.

Definition 2.4[4] Let X be a universal set and F(X) be the set of all fuzzy subsets of X. Let E a set of parameters and A is a subset of E, a pair (F, A) is called fuzzy soft set, where F is a mapping from A to F(X). Thus, a fuzzy soft set (F, A) over X can be represented by the set of ordered pairs

$$(F,A) = \{(p,\ F_A(p)) : p \in P,\ F_A(p) \in F(X)\}$$

Example 2.3 Let $X = \{b_1, b_2, b_3\}$ be the set of three bikes represented as set of object and $P = \{\text{costly}(p_1), \text{colour}(p_2), \text{getup}(p_3)\}$ be the set of parameters, where $A = \{p_1, p_2\} \subset P$. Then $\mathrm{F}_A = \{\mathrm{F}_A(p_1) = \{b_1/0.5, b_2/0.7, b_3/0.4\}, \mathrm{F}_A(p_2) = \{b_1/0.6, b_2/0.3, b_3/0.8\}\}$ is the fuzzy soft set over X which describes the "attractiveness of the bikes".

Example 2.4 In Example 2.2 of soft set considered above if m_2 has stylish then it will not be possible to express it with only the two numbers 0 and 1. In that case we can characterize it by a membership function instead of the crisp number 0 and 1 that associated with each element a real number in the interval [0, 1]. The fuzzy soft set can then be described as

$$\mathrm{F}_E = \left\{\mathrm{F}_E(e_1) = \left\{\frac{m_1}{0.36}, \frac{m_2}{0.24}, \frac{m_3}{0}, \frac{m_4}{0}, \frac{m_5}{0.6}\right\}, \mathrm{F}_E(e_2) = \left\{\frac{m_1}{0}, \frac{m_2}{0}, \frac{m_3}{0.32}, \frac{m_4}{0}, \frac{m_5}{0.40}\right\}, \mathrm{F}_E(e_3) = \left\{\frac{m_1}{0}, \frac{m_2}{0}, \frac{m_3}{0.48}, \frac{m_4}{0.36}, \frac{m_5}{0.6}\right\}, \mathrm{F}_E(e_4) = \left\{\frac{m_1}{0.6}, \frac{m_2}{0.4}, \frac{m_3}{0.8}, \frac{m_4}{0.6}, \frac{m_5}{1}\right\}, \mathrm{F}_E(e_5) = \left\{\frac{m_1}{0.48}, \frac{m_2}{0}, \frac{m_3}{0.64}, \frac{m_4}{0.48}, \frac{m_5}{0.8}\right\}\right\}.$$

The tabular representation of this fuzzy soft set F_E is as shown below:

Table 2.3

X/E	e_1	e_2	e_3	e_4	e_5
m_1	0.36	0.00	0.00	0.60	0.48
m_2	0.24	0.00	0.00	0.40	0.00
m_3	0.00	0.32	0.48	0.80	0.64
m_4	0.00	0.00	0.36	0.60	0.48
m_5	0.60	0.40	0.60	1.00	0.80

3. A New Technique for Finding Thresh Hold Value

In this section we introduce a new concept of dimensionality reduction by using the fuzzy soft sets approach via soft sets. Here we also propose a process by which we convert binary valued information table of soft sets into the object oriented membership valued information table of fuzzy soft sets. By this process we assign the membership value of objects with respect to parameters in fuzzy soft sets by using soft set information. Before discussing our proposed method we first define some terms.

Given a soft set (Ω, E), with tabular presentation, $X = \{m_1, m_2, .., m_n\}$ is the object set, $E = \{e_1, e_2, .., e_m\}$is the parameter set, and m_{ij} are the entries in the table of (Ω, E).

Definition 3.1 For soft set $(\Omega, E), X = \{m_1, m_2, .., m_n\}$, $E = \{e_1, e_2, .., e_m\}$ we denote $T_E(m_i) = \sum_j m_{ij}$ as an oriented- object sum and $R_i = (T_E(m_i)/|E|)$is oriented-object grade with respect to parameters.

Definition3.2. For soft set (Ω, E), $X = \{m_1, m_2, .., m_n\}$, $E = \{e_1, e_2, .., e_m\}$ we denote $S_X(e_j) = \sum_i m_{ij}$ as an oriented- parameter sum and $C_j = \left(S_X(e_j)/|X|\right)$ is oriented-parameter grade with respect to objects.

Definition 3.3 For soft set$(\Omega, E), X = \{m_1, m_2, .., m_n\}$, $E = \{e_1, e_2, .., e_m\}$we construct a fuzzy soft set F_E over X by assigning membership value of objects with respect to parameter by using definition 3.1 and Definition 3.2. Let v_{ij} be the membership value of objects in fuzzy soft set F_E then $v_{ij} = \left(m_{ij} \times R_i \times C_j\right)$ such that $v_{ij} \in [0, 1]$

We construct a fuzzy soft set and corresponding table via soft set defined in Example2.1 by using the Definition 3.3.

Definition 3.4 For fuzzy soft set F_E, $X = \{m_1, m_2, .., m_n\}$, $E = \{e_1, e_2, .., e_m\}$ we denote $O_i = \left(\sum_j v_{ij}\right)/|E|$ oriented- object grade with respect to parameters.

Definition 3.5 For fuzzy soft set F_E, $X = \{m_1, m_2, .., m_n\}$, $E = \{e_1, e_2, .., e_m\}$ we denote $E_j = \left(\sum_i v_{ij}\right)/|X|$ oriented- parameter grade with respect to objects.

For fuzzy soft set represent in example 3 the values of $O_i = 0.29, 0.13, 0.45, 0.29, 0.68$ for $i = 1\ to\ 5$ respectively and the value of $E_j = 0.24, 0.14, 0.29, 0.68, 0.48$ for $j = 1\ to\ 5$ respectively. In proposed technique we define a term known as threshold value.

Definition 3.6 For fuzzy soft set F_E we denote $T = \left(\sum_i \sum_j v_{ij}\right)/(|X| \times |E|)$ as threshold value of fuzzy soft sets. For fuzzy soft set represent in Example 2.4, the threshold value defined in Definition 3.6 is 0.37.

3.1 Proposed Algorithm:

The step wise process of proposed technique is as follows:

- Input the soft set (Ω, E).
- Construct the binary valued information table of soft set (Ω, E).
- Convert soft set (Ω, E)into fuzzy soft set F_E and construct fuzzy soft set table by using soft set table by proposed technique.
- Find the value of Grade membership O_i of i^{th} object and E_j of j^{th} parameter in fuzzy soft set.
- Find the threshold value'T' of fuzzy soft sets

- Remove those rows for which $O_i < T$ and column for which $E_j > T$ in fuzzy soft set table.
- The new table is our desired dimensionality reduced table.

4. Application of New Technique in dimensionality reduction

Here we analyze again the example presented by Maji et al in [7] and is discussed by Chen et al [9]. Let $U = \{h_1, h_2, h_3, h_4, h_5, h_6\}$ be a set of six houses, E = {expensive, beautiful, wooden, cheap, in green surroundings, modern, in good repair, in bad repair} be the set of parameters. Let Mr. X is interested to buy a house on the following parameters subset P = {beautiful, wooden, cheap, in green surroundings, in good repair}. Let $\{p_1, p_2, p_3, p_4, p_5\}$ be symbolic representation of the set P. Boolean-valued information system table gives the soft set as in Table 4.1.

Table 4.1

U/P	p_1	p_2	p_3	p_4	p_5
h_1	1	1	1	1	1
h_2	1	1	1	1	0
h_3	1	0	1	1	1
h_4	1	0	1	1	0
h_5	1	0	1	0	0
h_6	1	1	1	1	1

Next we determine oriented-object gradeR_i and oriented-parameter grade C_j of given soft sets by using Table 2.3 and applying proposed technique, then table 4.1 transformed into the following Table 4.2:

Table 4.2

$/P$	p_1	p_2	p_3	p_4	p_5	R_i
h_1	1	1	1	1	1	1
h_2	1	1	1	1	0	$4/5$
h_3	1	0	1	1	1	$4/5$
h_4	1	0	1	1	0	$3/5$
h_5	1	0	1	0	0	$2/5$
h_6	1	1	1	1	1	1
C_j	1	½	1	$5/6$	½	

Transform Table 4.2 into the fuzzy soft set table by assigning membership valuev_{ij} of object using the proposed method where $v_{ij} = \left(m_{ij} \times R_i \times C_j\right)$ such that $v_{ij} \in [0, 1]$, thus the transformed table is as:

Table 4.3

U/P	p_1	p_2	p_3	p_4	p_5
h_1	1.00	0.50	1.00	0.83	0.50
h_2	0.80	0.40	0.80	0.66	0
h_3	0.80	0	0.80	0.66	0.40
h_4	0.60	0	0.60	0.50	0
h_5	0.40	0	0.40	0	0
h_6	1.00	0.50	1.00	0.83	0.50

Now determine oriented-object grade $H_i = \left(\sum_j v_{ij}\right)/|P|$ and oriented-parameter grade $P_j = \left(\sum_i v_{ij}\right)/|U|$of fuzzy soft set tablewhere $i = 1\ to\ |U|$ and $j = 1\ to\ |P|$. Then by applying this process table 4.3 transformed into new table as given below:

Table 4.4

U/P	p_1	p_2	p_3	p_4	p_5	H_i
h_1	1.00	0.50	1.00	0.83	0.50	0.77
h_2	0.80	0.40	0.80	0.66	0	0.53
h_3	0.80	0	0.80	0.66	0.40	0.53
h_4	0.60	0	0.60	0.50	0	0.34
h_5	0.40	0	0.40	0	0	0.16
h_6	1.00	0.50	1.00	0.83	0.50	0.77
P_j	0.75	0.23	0.75	0.58	0.23	

Now determine $T = \left(\sum_i \sum_j v_{ij}\right)/(|U| \times |P|)$ threshold value of fuzzy soft sets, thus by calculation we get value of T = 0.52. Now remove those rows for which $H_i < T$ and those columns for which $P_j > T$. Now after removing the corresponding rows and columns Table 4.4 transform into new Table 4.5 and that is desired reduced table:

Table 4.5

U/P	p_2	p_5	H_i
h_1	0.50	0.50	0.77
h_2	0.40	0	0.53
h_3	0	0.40	0.53
h_6	0.50	0.50	0.77
P_j	0.23	0.23	

As can be seen above, data size has been reduced to approximately 75%. Yet after the process of reduction the reduced dataset maintain the same decision partition stated by Maji et al [7], that Mr. X prefers the house h_1 and h_6.

5. **Application in Medical Diagnosis**

Here we study an application of fuzzy soft sets in medical diagnosis following Sanchez's approach [2].

5.1 Methodology

Suppose S is a system of symptoms, D is a set of diseases and P is a set of patients. Then A fuzzy soft set (F, D) is constructed over S, where F is a mapping from D to I^S. This fuzzy soft set gives a relation matrix R_1 (say) and is called symptom-disease matrix. Its complement $(F,D)^c$ gives another relation matrix R_2(say) and is called non symptom - disease matrix. These matrices are referred to 'Soft Medical Knowledge'.

Again we construct another Fuzzy Soft Set (F_1, S) over P, where F_1 is a mapping from S to I^p. This fuzzy set gives a relation matrix Q called patient-system matrix. Then we obtain two new relation matrices are given by T_1= QoR_1 and T_2= QoR_2 and are called symptom-patient matrix and non symptom-patient matrix respectively. These matrices are obtained by combining the relation matrices R_1 and R_2 with Q and following max.[min.] rule and their membership values are given by

$$\mu_{R1}(p_i, d_j) = \cup [\mu_q, p_i, e_{k)} \cap \mu_{R1}(e_k, d_j) \text{ and}$$

$$\mu_{R2}(p_i, d_j) = \cup [\mu_q, p_i, e_{k)} \cap \mu_{R2}(e_k, d_j), \text{ where } \cup = \max\, and\ \cap = mini$$

In case max $\{\mu_{R1}(p_i, d_j)-\mu_{R2}(p_i, d_j)\}$ 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, however, if there is a tie, the process is to be repeated for patient p_i by reassessing the symptoms.

5.2 **A Case Study**

Suppose there are three patients' p_1, p_2 and p_3 in a hospital with symptoms temperature, headache, cough and stomach problem. Let the possible diseases relating to these symptoms be viral fever and malaria. We consider the set S= {e_1, e_2, e_3, e_4}, where e_1, e_2, e_3, e_4 represent symptoms temperature, headache, cough and stomach problem respectively and D= {d_1, d_2), where d_1 and d_2 represent the parameters viral fever and malaria respectively.

Next, we suppose that F(d_1)= {e_1/.8, e_2/.5, e_3/.4, e_4/.3}, F(d_2) ={ e_1/.6, e_2/.4, e_3/.3, e_4/.9}. Hence the fuzzy soft set (F,D) is a parameterized family of all fuzzy sets over the set S given by { F(d_1), F(d_2) }and determined from expert medical documentation. Thus the fuzzy soft set (F,D) gives an approximate description of the soft medical knowledge of the two diseases and symptoms and are represented by the following two relation matrices R_1 and R_2:

$$R_1 = \begin{array}{c} \\ e1 \\ e2 \\ e3 \\ e4 \end{array} \begin{array}{c} \begin{array}{cc} \mathbf{d1} & \mathbf{d2} \end{array} \\ \begin{bmatrix} .8 & .6 \\ .5 & .4 \\ .4 & .3 \\ .3 & .9 \end{bmatrix} \end{array} \qquad R_2 = \begin{array}{c} \\ e1 \\ e2 \\ e3 \\ e4 \end{array} \begin{array}{c} \begin{array}{cc} d_1 & d_2 \end{array} \\ \begin{bmatrix} .2 & .4 \\ .5 & .6 \\ .6 & .7 \\ .7 & .1 \end{bmatrix} \end{array}$$

Let P = $\{p_1, p_2, p_3\}$ be the universal set where p_1, p_2 andp_3 represent the patients under consideration and S= $\{e_1, e_2, e_3, e_4\}$, where e_1, e_2, e_3, e_4 represent symptoms temperature, headache, cough and stomach problem respectively be the parameters. Further suppose that $F(e_1) = \{ p_1/.7, p_2/.8, p_3/.3\}$, $F(e_2) = \{p_1/.5, p_2/.4, p_3/.5\}$, $F(e_3) = \{p_1/.6, p_2/.5, p_3/.4\}$ and $F(e_4) = \{p_1/.4, p_2/.7, p_3/.5\}$. Then fuzzy soft set (F, S) represents a relation matrix Q called patient- symptoms matrix and is given by

$$Q = \begin{array}{c} \\ p_1 \\ p_2 \\ p_3 \end{array} \begin{array}{c} \begin{array}{cccc} e_1 & e_2 & e_3 & e_4 \end{array} \\ \begin{bmatrix} .7 & .5 & .6 & .4 \\ .8 & .4 & .5 & .7 \\ .3 & .5 & .4 & .5 \end{bmatrix} \end{array}$$

On combining the relation matrices R_1 and R_2 with Q and following max.[min.] rule, we get two matrices T_1 and T_2 called patient-disease and patient-non disease matrices respectively and given by

$$T_1 = Q_0 R_1 = \begin{array}{c} \\ p_1 \\ p_2 \\ p_3 \end{array} \begin{array}{c} \begin{array}{cc} d_1 & d_2 \end{array} \\ \begin{bmatrix} .7 & .6 \\ .8 & .7 \\ .5 & .3 \end{bmatrix} \end{array}, \quad T_2 = Q_0 R_1 = \begin{array}{c} \\ p_1 \\ p_2 \\ p_3 \end{array} \begin{array}{c} \begin{array}{cc} d_1 & d_2 \end{array} \\ \begin{bmatrix} .6 & .6 \\ .7 & .5 \\ .5 & .5 \end{bmatrix} \end{array} \text{ and } T_1 - T_2 = \begin{array}{c} \\ p_1 \\ p_2 \\ p_3 \end{array} \begin{array}{c} \begin{array}{cc} d_1 & d_2 \end{array} \\ \begin{bmatrix} .1 & .0 \\ .1 & .2 \\ .0 & -.1 \end{bmatrix} \end{array}$$

Thus from matrix T_1-T_2 we can infer that $p_1$and p_3 are suffering from d_1 and p_2 is suffering from d_2.

5. Conclusion

In this paper a new technique of dimensionality reduction are discussed by using fuzzy soft set theory via soft set theory. By using proposed technique in considered example taken by Maji et al [6] we see that data size has been reduced to approx 75% and reduced data still maintain the same decision partition stated by Maji et al [7]. The example illustrates our contribution and shows that the proposed algorithm efficiently captures the reduction. We have also studied an application of fuzzy soft set in medical diagnosis and illustrated by a case study.

References

1. L.A. Zadeh; Fuzzy Sets,Information and Control, 8, 338-353 (1965).
2. E. Sanchez: Inverses of fuzzy relation and applications to possibility distributions and medical diagnosis, Fuzzy Sets and Systems 2(1), 75-86 (1979).

3. Z. Pawlak; Rough Sets: International Journal of Information and Computer Sciences, 11, 341–356 (1982).
4. D.A. Molodstov; Soft Set Theory–First Result, Computers and Mathematics with Applications, 37, 19–31(1999).
5. P.K. Maji,R. Biswas andA.R. Roy: Fuzzy Soft Sets, The Journal of Fuzzy Mathematics, 9(3), 589–602 (2001).
6. P.K. Maji, R. Biswas andA.R. Roy: Intuitionistic Fuzzy Soft Sets, The Journal of Fuzzy Mahtematics, 9(3), 677–692 (2001).
7. P.K. Maji, R. Biswas and A.R. Roy: An application of soft sets in a decision making Problem, Computer and Mathematics with application, 44, 1077-1083 (2002).
8. P.K. Maji and A.R. Roy; Soft Set Theory, Computers and Mathematics with Applications, 45, 555 – 562 (2003).
9. D. Chen, E.C.C. Tsang, D.S. Yeungand , X. Wang;The Parameterization Reduction of Soft Sets and its Application, Computer and Mathematics with Applied, 49, 757–763 (2005).
10. D.S.Hooda and B.K.Hooda: Dimension reduction in multivariate analysis using maximum entropy criterion, Journal of Statistics and Management, Vol. 9, no1, 175-183(2006)
11. P. Majumder andS.K. Samanta; Generalised Fuzzy Soft Sets, Comput. Math. Appl., 59(4), 1425–1432 (2010).
12. T.J. Neogand and D.K. Sut; Theory of Fuzzy Soft Sets from a New Perspective, International Journal of Latest Trends in Computing, 2(3), 439 – 450 (2011).
13. T.J. Neogand and D.K. Sut; A New Approach to the Theory of Soft Sets, International Journal of Computer Applications, 32(2), 1- 6 (2011).
14. A. Kalaichelvi and P.H. Malini: Applications of FuzzySoft Sets to investment Decision Making Problem, International Journal of Mathematical Sciences and Applications 1(3), 1583-1586(2011).
15. S., Yuksel, T. Dizman, G. Yildizdan and U. Sert: Application of soft sets to diagnose the prostate cancer risk, J. Inequal. Appl., doi: 10.1186/1029--241X-(2013)-229.
16. N.Y. Ozgur and N. Tas: A Note on " Application of Fuzzy Soft Sets to Investment Decision Making Problem", Journal of New Theory 7, 1-10 (2015)
17. P. Gupta and and O.D. Sharma: Feature Selection: an Overview, International Journal of Information Engineering and Technology, 1, 1- 12 (2015).
18. D.S.Hooda and Vivek Raich: Fuzzy Set Theory and Fuzzy Control, Narosh Publishers, New Delhi (2016)