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A Novel Framework for Dealing with Uncertainty Problems: A Soft Set Based Approach

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Abstract— ***When any kind of uncertainty exists in the data collected, such data is known as uncertain data. There are many real world applications such as sensor networks which produce uncertain data. Data mining methods have been around for discovering know how from uncertain data. However, soft sets are special kind of information systems that are meant for dealing with uncertain data. In our previous paper we introduced many soft set based techniques for mining uncertain data. In this paper we proposed framework that deals with uncertainty problems and extracts business intelligence which helps in making well informed decisions. The framework is based on soft sets and can be used in decision support systems of real world. We proposed an algorithm which is part of the underlying framework. Our analytical study reveals that the proposed framework is useful to solve real world uncertainty problems.***

Keywords— Data mining, soft computing, soft set theory, information systems

I. INTRODUCTION

Uncertain data is the data that exhibits a kind of uncertainty. In fact many real time applications are producing uncertain data. For instance the weather forecasting, sensor monitoring [1], location based services [2] and so on. Other reason for the existence of uncertain data is due to errors, outdated data sources, sampling discrepancy and measurement inaccuracy [3]. Data mining techniques have been around for mining data. However, mining uncertain data needs algorithms that are tailored to meet this requirement. In 1999 Molodtsov introduced soft set theory for modelling uncertainties in given data source. In fact this theory has potential to help many applications pertaining to operation research, smoothness of functions, and game theory to handle uncertain data [4]. According to Molodtsov [5] soft set theory is a mathematical approach to solve problems pertaining to uncertainty in the fields of social sciences, medical sciences, environmental science, engineering and economics. In other words the soft set theory originally introduced by Molodtsov can be seen as something used to model an uncertainty. With respect to the application of soft set theory for solving uncertainty problems, many approaches were found in the literature [6], [7], [8], [9], [10], [11], [12], [13] and [14]as provided in related works section of this paper.

In this paper our contributions include the study of the applications of soft set theory in the real world besides providing a solution to an uncertainty problem. The problem we considered is the selection of an electronic product from a universe of showrooms. The remainder of this paper is structured as follows. Section II reviews relevant literature that focuses on the applications of soft set theory in the real world. Section III provides preliminaries of soft set theory. Section IV presents the proposed methodology. Section V provides a case study based solution to an uncertainty problem while section VI concludes the paper.

II. EXISTING WORK

Soft set based data mining approach was proposed by Razak and Mohammad [15] for group decision making. Their approach used many criteria that area collection there was computed using Analytic Hierarchy Process (AHP). The actual method used to solve the problem was named as “Soft Max – Min Decision Making”. Xie and Zuhua[6] reviewed the soft setbasics and then introduced some new operations of soft sets. The new operations introduced by them include product of two soft sets, anty-product of the same, and the preimage. Lashari et al. [4] proposed soft set theory based solution for automatic classification of musical instruments of Pakistan based on sounds. They could achieve 94.26% accuracy in their experiments. Thus they proved that the soft set theory can be used for decision making applications. Soft algebras were introduced by Xueling Ma [7] based on soft set theory. They explored related properties with mathematical expressions. This can lead to further improvement in soft set theories. Herawan and Deris[8] studied soft sets and rough sets and proved that every rough set is a soft set. It does mean that their research revealed the inter connection between the two kinds of computing. Zou and Chen [9] studied relation algebra along with soft set theory for reduction of parameters. They proposed an algorithm to prove the concept of parameter reduction. Yao et al. [10] studied fuzzy soft sets extensively and came up with the comparison between the fuzzy soft set and soft fuzzy set. They compared these two with possible instances. Xiao et al. [11] studied soft information concept which is based on the soft set theory. They came up with soft information patterns that are used to solve complex problems in the real world. They brought about recognition for soft information concept. Kumar et al. [12] applied soft sets to the classification of medical data. Especially they focused on the objective soft set based classification which is a new intelligent technique many activities such as rule generation, classification, data reduction, discovery of data dependencies and so on.

Kumar and Rengasamy [13] also worked on the concept of parameters reduction based on soft set theory. They did it for improving the decision making process. Their method effectively reduced the dimension of data to support well informed decisions. Jothi and Inbarani[14] proposed a quick reduct approach based on soft set theory for unsupervised feature selection as part of pattern recognition. In terms of efficiency and speed their algorithm proved to be useful.

III. PRELIMINARIES OF SOFT SET THEORY

Our proposed According to Molodstov [5] who introduced soft set theory for the first time, it is mathematical approach to solve a real time problem. There are many real time issues that can be solved using soft set theory. In this paper we take a case study pertaining to product selection when there are varieties and that make hard to take decision. Before going to analyse the case study, in this section, we provide some preliminaries of soft set theory.

Definition 1

Consider S to be the universal set initially. Let P be a set of parameters required pertaining to S. The parameters are nothing but objectives or characteristics. The power set of Sand $A \subseteq P$ is considered to be R(S). Over S, the pair (F, A) is said to be a soft set in which F denotes the mapping from A to R(S) which is represented as follows.

$F: A \rightarrow R(S)$.

Definition2

Considering S to be universal set and the power set of S and $A \subset$□ P to be R(S), a soft set (f, P) on the universal set represented by a set of pairs denoted as follows:

$$(f, P)= \{(p, f_A,(p)):p \in R(S)\}$$

Where f_A, $P \rightarrow R(S)$ such that $f_A(p)= \varphi$, if $p \neq A$.

Definition3

Consider (f_A,P) to be soft set over the universal set S. The definition of the subset of S×P is uniquely deduced as follows.

$$T :\{(s,e):e \in A,\ u \in f_A(e)\}$$

It is also known as the relation of (f_A,P). The features of T in this context can be represented as follows.

$$X_T: S \times P \rightarrow \{0,1\}, \qquad X_T(s, p)= \begin{cases} 1, (s,p) \epsilon T \\ 0, (s,p) \notin T \end{cases}$$

if $S =\{s_1,s_2,\ldots s_m\}$, $P=\{p_1,p_2,p_3,\ldots p_n\}$ and $A \subseteq P$ then the *T*is represented in a tabular format as shown below

R	e_1	e_2	…….e_n
s_1	$X_T(s_1, p_1)$	$X_T(s_1, p_2)$	……. $X(s_1,p_n)$
s_2	$X_T(s_2, p_1)$	$X(s_2, p_2)$	……. $X(s_2,p_n)$
	⋮	⋮	⋮
s	$X(s_m, p_1)$	$X(s_m, p_2)$	…….. $X(s_m,p_n)$

If $A_{ij}=X_T(s_i,p_j)$ then the matrix can be defined as follows.

$$[A_{ij}]_{m*n}= \begin{pmatrix} a_{11} & a_{12} & \cdots & a_{1n} \\ a_{21} & a_{22} & \cdots & a_{2n} \\ \vdots & \vdots & \ddots & \vdots \\ a_{m1} & a_{m2} & \cdots & a_{mn} \end{pmatrix}$$

This matrix is also known as m×n soft matrix of the soft set (f_A, P) over S. Before proceeding further we introduce a new operator by name product introduced by Razak and Mohammad [15].

Definition 4

Let $[u_{ij}]$, $[v_{ik}] \in SM_{m\times n}$. Between $[u_{ij}]$and $[v_{ik}]$, the AND product is deduced as follows.

$$\wedge: SM_{m\times n} \times SM_{m\times n} \rightarrow SM_{m\times n^2},\ [u_{ij}] \wedge [v_{ik}]=[w_{ip}]$$

where $[w_{ip}]=\min\{ u_{ij} , v_{ik} \}$ such that $p=(n-1)+k$.

IV. METHODOLOGY

The method proposed in this paper involves the AHP method originally introduced by Saaty [16]. The methodology has two procedures. The first one is to determine the weight of criteria while the second one focuses on solving decision making problem. In this paper we considered a decision making problem pertaining to product selection. For both procedures the details are provided below.

A. Criteria Weight Determination

For criteria weight determination we use the approach followed by Razak and Mohammad [15]. The following are the steps to be followed for criteria weight determination.

Step 1: Evaluation criteria for decision making and alternatives for the same are to be confirmed.

Step 2: Hierarchical structure has to be used in order to decompose the complex problem into fine grained decision elements. Saaty's 1-9 scale is used in order to make decisions for each element.

Step 3: Comparison matrices are formed by employing pair wise comparison among the decision elements. Pair wise comparison is carried out by each decision maker (DM) as represented below.

$$A^z = [a_{ij}]^z \begin{pmatrix} a_{11} & a_{12} & \cdots & a_{1n} \\ a_{21} & a_{22} & \cdots & a_{2n} \\ \vdots & \vdots & \ddots & \vdots \\ a_{m1} & a_{m2} & \cdots & a_{mn} \end{pmatrix}$$

Where z represents the count of decision makers while the n represents the number of elements related at this level and

$[a_{ij}^{-1}]=1/a_{ij.}$

Step 4: Eigen value method is used to estimate the weights relatively of the elements considered for each and every decision maker which is represented as follows.

$W^z = (w_1,w_2,\ldots, w_i)$, where $\sum W^2_i=1$.

B. Method of Soft Matrix Theory

Soft matrices are defined by Cagman and Enginogluto solve complex real world problems. Their approach used is soft max-min which is one of the decision making strategies. More details on this can be found in [17].

C. Soft Matrices with Weight of Criteria

The method used for decision making using soft set theory proposed by Cagman and Enginoglu [17] was generalized by Razak and Mohamad [18]. However, in [15] AHP technique is used to achieve weight of criteria. We are proposing an algorithm in this paper for weight of criteria, which is influenced by Abdul Razak [18].

Step 1: Feasible subsets of parameters are found for given parameters.

$$P= \{p_1, p_2\ldots p_n\}$$

Step 2:

Matrix form is used to construct soft matrix for all parameters. The soft matrix is as given below.

$$[u_{ij}]_{m\times n} = \begin{pmatrix} u_{11} & u_{12} & \cdots & u_{1n} \\ u_{21} & u_{22} & \cdots & u_{2n} \\ \vdots & \vdots & \ddots & \vdots \\ u_{m1} & u_{m2} & \cdots & u_{mn} \end{pmatrix}$$

Step 3: Computing the weight of criteria that need for decision makers is done. It is done as per the AHP procedure.

Step 4: The criteria weight wkis given as input and the values are computed for every alternative. And then the soft matrices are constructed.

$$W_n=(w_1,w_2,\ldots\ldots w_k)$$

Criteria weight for every decision maker is computed as follows.

$[u_{ij}]\times w_k$, where $w_k$is the weight value given for parameter n.

$$K_{ij}=[u_{ij}]_{m\times n} \begin{pmatrix} u_{11}\otimes w_1 & u_{12}\otimes w_2 & \cdots & u_{1n}\otimes w_k \\ u_{21}\otimes w_1 & u_{22}\otimes w_2 & \cdots & u_{2n}\otimes w_k \\ \vdots & \vdots & \ddots & \vdots \\ u_{m1}\otimes w_1 & u_{m2}\otimes w_2 & \cdots & u_{mn}\otimes w_k \end{pmatrix}$$

Step 5: The And – product is computed for soft matrices. For instance it is done for all decision makers as follows.

$DM_{n-1}\wedge DM_n$=A)) of $[K_{ij}]$ and $[L_{ik}]$

$$[t_{ic}] = [K_{ij}]\wedge[L_{ik}] = \begin{pmatrix} K_{11} & K_{12} & \cdots & K_{1n} \\ K_{21} & K_{22} & \cdots & K_{2n} \\ \vdots & \vdots & \ddots & \vdots \\ K_{m1} & K_{m2} & \cdots & K_{mn} \end{pmatrix} \wedge \begin{pmatrix} L_{11} & L_{12} & \cdots & L_{1n} \\ L_{21} & L_{22} & \cdots & L_{2n} \\ \vdots & \vdots & \ddots & \vdots \\ L_{m1} & L_{m2} & \cdots & L_{mn} \end{pmatrix}$$

Step 6: Between the $[K_{ij}]$ and $[L_{ik}]$, the And – product is as given below.

$$t_{io} = \begin{pmatrix} t_{11} & t_{12} & \cdots & t_{1n} \\ t_{21} & t_{22} & \cdots & t_{2n} \\ \vdots & \vdots & \ddots & \vdots \\ t_{m1} & t_{m2} & \cdots & t_{mn} \end{pmatrix}$$

Where $t_{io} = \min_{o-1,2,\ldots,n}[K_{ij} \wedge L_{ik}]$.

Step 7: In the same fashion between $[t_{ir}]$ and $[M_{il}]$ And-product is computed.

$$[N_{ip}] = [t_{ir}] \wedge [M_{il}] = \begin{pmatrix} t_{11} & t_{12} & \cdots & t_{1n} \\ t_{21} & t_{22} & \cdots & t_{2n} \\ \vdots & \vdots & \ddots & \vdots \\ t_{m1} & t_{m2} & \cdots & t_{mn} \end{pmatrix} \wedge \begin{pmatrix} M_{11} & M_{12} & \cdots & M_{1n} \\ M_{21} & M_{22} & \cdots & M_{2n} \\ \vdots & \vdots & \ddots & \vdots \\ M_{m1} & M_{m2} & \cdots & M_{mn} \end{pmatrix}$$

$$[N_{ip}] = \begin{pmatrix} N_{11} & N_{12} & \cdots & N_{1n} \\ N_{21} & N_{22} & \cdots & N_{2n} \\ \vdots & \vdots & \ddots & \vdots \\ N_{m1} & N_{m2} & \cdots & N_{mn} \end{pmatrix}$$

Where $N_{ip} = \min_{p-1,2,\ldots,n}[t_{ir} \wedge M_{il}]$.

Step 8: Decision soft matrix for max-min is found as follows.

$$Mm\,(([K_{ij}] \wedge [L_{ik}]) \wedge [M_{il}]) = [s_1, s_2, \ldots\ldots s_n]^T.$$

Step 9: Finally compute the optimum set of S.

$$Opt_{Mm}(S) = \{s_1, s_2, \ldots\ldots, s_n\}.$$

V. CASE STUDY

The problem is modeled and described here. S is considered to be a set of showrooms where products can be chosen. P is denoted as subset of sub criteria for the purpose. We use weight of criteria approach in order to solve the problem. Imagine A, B, C are the family members who need to take decisions. It does mean that they are the decision makers (DMs). The main criteria considered include branded company product, cost, and lifetime while the sub criteria are interior, exterior for given case study. Based on the criteria and the weights, decision makers make decisions for which soft set based solution is provided here.

A. Electronic Product Selection Problem

Consider a soft set (f_A, P) that denote branded products in showrooms from which the decision makers make selections. Consider that $S=\{s_1,s_2,s_3,s_4,s_5\}$ is the universal set that contains total of five show rooms in a city. Let $P=\{p_1,p_2,p_3,p_4,p_5,p_6,p_7,p_8,p_9\}$is a set of parameters used by decision makers in order to make well informed decisions. These parameters might denote "branded name", "price", "life time", "size", "warranty", "color" and so on.

B. Comparison Matrices in AHP

For each criterion, the evaluation matrix is made for decision makers A, B, and C. The pair wise comparison approach is used which is on 1-9 scale as explored by Saaty. The matrices for decision makers are as given below.

$$A = \begin{bmatrix} 1 & 1/8 & 1/5 & 1/4 & 1/7 & 1/5 & 1/3 & 1/2 & 1/3 \\ 8 & 1 & 1/4 & 1/4 & 1/5 & 1/3 & 1/4 & 1/3 & 1/2 \\ 5 & 4 & 1 & 1/5 & 1/6 & 1/4 & 1/4 & 1/3 & 1/3 \\ 4 & 4 & 5 & 1 & 1/6 & 1/4 & 1/4 & 1/2 & 1/2 \\ 7 & 5 & 6 & 6 & 1 & 1/3 & 1/5 & 1/4 & 1/2 \\ 5 & 3 & 4 & 4 & 3 & 1 & 1/5 & 1/4 & 1/2 \\ 3 & 4 & 4 & 4 & 3 & 5 & 1 & 1/5 & 1/3 \\ 2 & 3 & 3 & 2 & 3 & 4 & 5 & 1 & 1/2 \\ 3 & 2 & 3 & 2 & 1/6 & 2 & 3 & 5 & 1 \end{bmatrix}$$

$$B = \begin{bmatrix} 1 & 1/7 & 1/6 & 5 & 1/8 & 1/4 & 1/3 & 1/2 & 1/2 \\ 7 & 1 & 8 & 1/3 & 1/5 & 7 & 1/3 & 1/2 & 6 \\ 6 & 1/8 & 1 & 1/5 & 1/7 & 1/4 & 5 & 1/3 & 1/3 \\ 1/5 & 3 & 7 & 7 & 1 & 7 & 1/4 & 1/3 & 1/2 \\ 4 & 1/7 & 4 & 1/6 & 1/7 & 1 & 1/5 & 1/3 & 1/2 \\ 3 & 3 & 1/5 & 4 & 4 & 5 & 1 & 1/4 & 1/3 \\ 3 & 3 & 1/5 & 4 & 4 & 5 & 1 & 1/4 & 1/3 \\ 2 & 3 & 3 & 1/6 & 3 & 3 & 4 & 1 & 1/5 \\ 2 & 1/6 & 3 & 2 & 2 & 2 & 3 & 5 & 1 \end{bmatrix}$$

$$C=\begin{bmatrix} 1 & 1/8 & 5 & 1/5 & 1/7 & 6 & 4 & 1/3 & 3 \\ 8 & 1 & 8 & 7 & 1 & 1/3 & 6 & 1/3 & 6 \\ 1/5 & 1/8 & 1 & 1 & 1/8 & 6 & 1/4 & 6 & 4 \\ 5 & 1/7 & 1 & 1 & 1/6 & 1/4 & 1/3 & 6 & 1/3 \\ 7 & 1 & 8 & 6 & 1 & 7 & 1/4 & 7 & 1/3 \\ 1/6 & 3 & 1/6 & 4 & 1/7 & 1 & 1 & 1/4 & 6 \\ 1/4 & 1/6 & 4 & 3 & 4 & 1 & 1 & 1/3 & 1 \\ 3 & 3 & 1/6 & 1/6 & 1/7 & 4 & 3 & 1 & 1 \\ 1/3 & 1/6 & 1/4 & 3 & 3 & 1/6 & 1 & 1 & 1 \end{bmatrix}$$

C. Computation of Soft Max-Min Decision Making

According to this kind of decision making there are certain steps which are presented below.

Step 1: Parameters are chosen by decision makers which are presented below.

$A= \{p_1, p_2, p_3, p_4, p_5, p_6, p_7, p_8, p_9\}$,

$B= \{p_1, p_2, p_3, p_4, p_5, p_6, p_7, p_8, p_9\}$,

$C= \{p_1, p_2, p_4, p_5, p_6, p_7, p_8\}$.

Step 2: Soft matrices are built based on the inputs given by decision makers. The matrices are as presented below.

$$[A_{ij}]=\begin{bmatrix} 1 & 1 & 1 & 1 & 1 & 1 & 1 & 1 & 0 \\ 0 & 1 & 1 & 0 & 1 & 0 & 0 & 1 & 0 \\ 0 & 1 & 1 & 0 & 1 & 1 & 1 & 0 & 0 \\ 1 & 1 & 0 & 1 & 1 & 0 & 0 & 1 & 0 \\ 1 & 1 & 1 & 0 & 1 & 1 & 1 & 0 & 0 \\ 1 & 1 & 1 & 1 & 1 & 1 & 1 & 0 & 0 \end{bmatrix}$$

$$[B_{ik}]=\begin{bmatrix} 1 & 1 & 1 & 1 & 1 & 1 & 1 & 1 & 0 \\ 0 & 1 & 1 & 1 & 1 & 1 & 1 & 0 & 0 \\ 1 & 1 & 0 & 0 & 1 & 1 & 1 & 0 & 0 \\ 0 & 1 & 1 & 1 & 0 & 1 & 1 & 1 & 0 \\ 1 & 1 & 1 & 1 & 1 & 0 & 0 & 1 & 0 \\ 1 & 1 & 1 & 1 & 0 & 1 & 0 & 0 & 0 \end{bmatrix}$$

$$[C_{ik}]=\begin{bmatrix} 1 & 1 & 0 & 1 & 1 & 1 & 1 & 1 & 0 \\ 0 & 1 & 0 & 1 & 0 & 1 & 0 & 1 & 0 \\ 1 & 1 & 0 & 1 & 1 & 1 & 1 & 1 & 0 \\ 0 & 1 & 0 & 0 & 0 & 1 & 0 & 0 & 0 \\ 1 & 1 & 0 & 0 & 1 & 1 & 1 & 0 & 0 \\ 1 & 1 & 0 & 1 & 1 & 1 & 1 & 1 & 0 \end{bmatrix}$$

Step 3: Using the AHP approach the weight of each criterion is computed as follows.

$[w_A]= (p_1=0.14,p_2=0.05,p_3=0.02,p_4=0.13,p_5=0.04, p_6=0.17,p_7=0.08,p_8=0.15,p_9=0.18)$

$[w_B]= (p_1=0.05,p_2=0.18,p_3=0.13,p_4=0.02,p_5=0.15, p_6=0.04,p_7=0.19,p_8=0.03,p_9=0.17)$

$[w_c]= (p_1=0.07,p_2=0.13,p_3=0.23,p_4=0.16,p_5=0.05, p_6=0.07,p_7=0.18,p_8=0.09,p_9=0.03)$

Step 4: For each decision maker, each and every parameter is multiplied with weight of criteria. The results are as given below.

$$[A_{ij}\times w_A]=[p_{ij}]=\begin{bmatrix} 0.14 & 0.05 & 0.02 & 0.13 & 0.04 & 0.17 & 0.08 & 0.15 & 0 \\ 0 & 0.05 & 0.02 & 0 & 0.04 & 0 & 0 & 0.15 & 0 \\ 0 & 0.05 & 0.02 & 0 & 0.04 & 0.17 & 0.08 & 0 & 0 \\ 0.14 & 0.05 & 0 & 0.13 & 0.04 & 0 & 0 & 0.15 & 0 \\ 0.14 & 0.05 & 0.02 & 0 & 0.04 & 0.17 & 0.08 & 0 & 0 \\ 0.14 & 0.05 & 0.02 & 0.13 & 0.04 & 0.17 & 0.08 & 0 & 0 \end{bmatrix}$$

$$[B_{ik}\times W_B]=[Q_{ik}]=\begin{bmatrix} 0.05 & 0.18 & 0.13 & 0.02 & 0.15 & 0.04 & 0.19 & 0.03 & 0 \\ 0 & 0.18 & 0.13 & 0.02 & 0.15 & 0.04 & 0.19 & 0 & 0 \\ 0.05 & 0.18 & 0 & 0 & 015 & 0.04 & 0.19 & 0 & 0 \\ 0 & 0.18 & 0.13 & 0.02 & 0 & 0.04 & 0.19 & 0.03 & 0 \\ 0.05 & 0.18 & 0.13 & 0.02 & 0.15 & 0 & 0 & 0.03 & 0 \\ 0.05 & 0.18 & 0.13 & 0.02 & 0 & 0.04 & 0 & 0 & 0 \end{bmatrix}$$

$$[C_{ij} \times w_C] = [R_{ij}] = \begin{bmatrix} 0.07 & 0.13 & 0 & 0.16 & 0.05 & 0.07 & 0.18 & 0.09 & 0 \\ 0 & 0.13 & 0 & 0.16 & 0 & 0.07 & 0 & 0.09 & 0 \\ 0.07 & 0.13 & 0 & 0.16 & 0.15 & 0.07 & 0.18 & 0.09 & 0 \\ 0 & 0.13 & 0 & 0 & 0 & 0.07 & 0 & 0 & 0 \\ 0.07 & 0.13 & 0 & 0 & 0.15 & 0.07 & 0.18 & 0 & 0 \\ 0.07 & 0.13 & 0 & 0.16 & 0.15 & 0.07 & 0.18 & 0.09 & 0 \end{bmatrix}$$

Step 5: And – product operator of soft set introduced by Razak and Mohamad is used to have multiplication matrices between $[P_{ij}]$ and $[Q_{ik}]$. The result is a 6x81 matrix which is as presented below.

$$\left[\begin{matrix} 0.14 & 0.14 & 0.14 & 0.14 & 0.14 & 0.14 & 0.14 & 0.14 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0.14 & 0.14 & 0 & 0.14 & 0.14 & 0.14 & 0.14 & 0 \\ 0.14 & 0.14 & 0.14 & 0.14 & 0 & 0.14 & 0 & 0.14 & 0 \\ 0.14 & 0.14 & 0.14 & 0 & 0.14 & 0.07 & 0 & 0 & 0 \end{matrix}\right.$$

$$\begin{matrix} 0.05 & 0.05 & 0.05 & 0.05 & 0.05 & 0.05 & 0.05 & 0.05 & 0 \\ 0 & 0.05 & 0.05 & 0.05 & 0.05 & 0.05 & 0.05 & 0 & 0 \\ 0.05 & 0.05 & 0.05 & 0.05 & 0.05 & 0 & 0.05 & 0 & 0 \\ 0 & 0.05 & 0.05 & 0 & 0.05 & 0.05 & 0.05 & 0.05 & 0 \\ 0.05 & 0.05 & 0.05 & 0.05 & 0 & 0.05 & 0 & 0.05 & 0 \\ 0.05 & 0.05 & 0.05 & 0 & 0.05 & 0 & 0 & 0 & 0 \end{matrix}$$

$$\begin{matrix} 0.05 & 0.02 & 0.02 & 0.02 & 0.02 & 0.02 & 0.02 & 0.02 & 0 \\ 0 & 0.02 & 0.02 & 0.02 & 0.02 & 0.02 & 0.02 & 0 & 0 \\ 0.05 & 0.02 & 0.02 & 0.02 & 0.02 & 0 & 0.02 & 0 & 0 \\ 0 & 0.02 & 0.02 & 0 & 0.02 & 0.02 & 0.02 & 0.02 & 0 \\ 0.05 & 0.02 & 0.02 & 0.02 & 0 & 0.02 & 0 & 0.02 & 0 \\ 0.05 & 0.02 & 0.02 & 0 & 0.02 & 0 & 0 & 0 & 0 \end{matrix}$$

$$\begin{matrix} 0.05 & 0.13 & 0.02 & 0.13 & 0.13 & 0.02 & 0.13 & 0.13 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0.13 & 0.02 & 0 & 0.13 & 0.02 & 0.13 & 0.13 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0.05 & 0.13 & 0.02 & 0 & 0.13 & 0 & 0 & 0 & 0 \end{matrix}$$

$$\begin{matrix} 0.05 & 0.18 & 0.02 & 0.02 & 0.04 & 0.02 & 0.17 & 0.17 & 0 \\ 0 & 0.18 & 0.02 & 0.02 & 0.04 & 0.02 & 0.17 & 0 & 0 \\ 0.05 & 0.18 & 0.02 & 0.02 & 0.04 & 0 & 0.17 & 0 & 0 \\ 0 & 0.18 & 0.02 & 0 & 0.04 & 0.02 & 0.17 & 0.17 & 0 \\ 0.05 & 0.18 & 0.02 & 0.02 & 0 & 0.02 & 0 & 0.17 & 0 \\ 0.05 & 0.18 & 0.02 & 0 & 0.04 & 0 & 0 & 0 & 0 \end{matrix}$$

$$\begin{matrix} 0.05 & 0.17 & 0.02 & 0.02 & 0.17 & 0.02 & 0.17 & 0.17 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0.05 & 0.17 & 0.02 & 0.02 & 0.17 & 0 & 0.17 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0.05 & 0.17 & 0.02 & 0.02 & 0 & 0.02 & 0 & 0.17 & 0 \\ 0.05 & 0.17 & 0.02 & 0 & 0.17 & 0 & 0 & 0 & 0 \end{matrix}$$

$$\begin{matrix} 0.05 & 0.18 & 0.02 & 0.02 & 0.04 & 0.02 & 0.17 & 0.17 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0.05 & 0.18 & 0.02 & 0.02 & 0.04 & 0 & 0.17 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0.05 & 0.18 & 0.02 & 0.02 & 0 & 0.02 & 0 & 0.17 & 0 \\ 0.05 & 0.18 & 0.02 & 0 & 0.04 & 0 & 0 & 0 & 0 \end{matrix}$$

$$\begin{matrix} 0.05 & 0.18 & 0.02 & 0.02 & 0.15 & 0.02 & 0.17 & 0.17 & 0 \\ 0 & 0.18 & 0.02 & 0.02 & 0.15 & 0.02 & 0.17 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0.18 & 0.02 & 0 & 0.15 & 0.02 & 0.17 & 0.17 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \end{matrix}$$

$$\begin{array}{ccccccccc} 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \end{array}\Bigg]$$

Step 6 :When the nine blocks of 6x9 elements are observed, for each block minimum value is chosen. The resultant matrixis as presented below.

$$[d_{ir}] = \begin{bmatrix} 0.02 & 0.05 & 0.05 & 0.05 & 0.05 & 0.05 & 0.05 & 0.05 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \end{bmatrix}$$

Step 7:$[d_{ir} \wedge R_{il}]$ is computed using And-product operator as follows.

$[d_{ir} \wedge R_{il}]$ =

$$R_i = [0.02\ \ 0.02\ \ 0\ \ 0.02\ \ 0.02\ \ 0.02\ \ 0.02\ \ 0.02\ \ 0$$
$$0.05\ \ 0.05\ \ 0\ \ 0.05\ \ 0.05\ \ 0.05\ \ 0.05\ \ 0.05\ \ 0$$
$$0.05\ \ 0.05\ \ 0\ \ 0.05\ \ 0.05\ \ 0.05\ \ 0.05\ \ 0.05\ \ 0$$

$$0.05\ \ 0.05\ \ 0\ \ 0.05\ \ 0.05\ \ 0.05\ \ 0.05\ \ 0.05\ \ 0$$
$$0.05\ \ 0.05\ \ 0\ \ 0.05\ \ 0.05\ \ 0.05\ \ 0.05\ \ 0.05\ \ 0$$
$$0.05\ \ 0.05\ \ 0\ \ 0.05\ \ 0.05\ \ 0.05\ \ 0.05\ \ 0.05\ \ 0$$

$$0.05\ \ 0.05\ \ 0\ \ 0.05\ \ 0.05\ \ 0.05\ \ 0.05\ \ 0.05\ \ 0$$
$$0.05\ \ 0.05\ \ 0\ \ 0.05\ \ 0.05\ \ 0.05\ \ 0.05\ \ 0.05\ \ 0$$
$$0.05\ \ 0.05\ \ 0\ \ 0.05\ \ 0.05\ \ 0.05\ \ 0.05\ \ 0.05\ \ 0]$$

$R_2=R_3=R_4=R_5=R_6=\{0,0,0\ldots..0\}$(81 zeros) where R_i indicates the elements in row i.

Hence, the min for the *And-product*

$[d_{ir}] \wedge [R_{il}] = [t_{ip}]$ is:

$$[t_{ip}] = \begin{bmatrix} 0.02 & 0.05 & 0.05 & 0.05 & 0.05 & 0.05 & 0.05 & 0.05 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \end{bmatrix}$$

Step 8: From the previous step the max value can be obtained for each row as follows.

$$Mm(([P_{ij}] \wedge [Q_{ik}]) \wedge [R_{il}]) = Mm[t_{ip}] = \begin{bmatrix} 0.04 \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \end{bmatrix}$$

Step 9: This is the final step in which optimal decisions are made. The optimum set U is obtained as follows.

$(([p_{ij}] \wedge [Q_{ik}]) \wedge [R_{il}])$ is calculated $Opt_{Mm}(([p_{ij}] \wedge [Q_{ik}]) \wedge [R_{il}])^{(S)} = \{s_1\}$,

From this it is crystal clear that from the given universal set (S) the optimal set is "s1". Therefore the optimal product selection thus is made by the decision makers.

VI. CONCLUSIONS

In this paper we studied the application of soft set theory to a real world problem. We provided preliminaries pertaining to soft sets. Product selection from universal set of showrooms is taken as case study. This uncertainty problem is solved mathematically using soft set matrices. We employed the criteria weight method proposed by Razak and Mohammad to solve the problem pertaining to product selection from multiple showrooms. The showrooms are taken as part of universal set and many parameters are considers that denote the features. Decision makers are considered while developing the analytical model with mathematical soft set matrices. We also employed the new operators such as product to solve the problem. Our analytical results reveal that the proposed framework is capable of solving uncertainty problems. Solving other uncertain problems such as career selection, weapon selection in military, policy selection in insurance and so on will be explored as future work.

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