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Mathematical modelling of lifestyle disease faced by adults in Tamilnadu using Fuzzy Relational Maps (FRMs)

R. Shanmugapriya, B. KomalaDurga, T. Gunasekar

Abstract: ***The adults in Tamilnadu are commonly under the risk of many diseasessuch as diabetes, hypertension, obesity, cardiac related diseases etc., due to their modern lifestyle. The relationship between lifestyle and disease risk factor using F RM is obtained in this article. The paper consists of three sections. In section 1, we recall some preliminary definitions. In section 2, we will describe and analyze the problem. In section 3, the study-based conclusion is presented.***

Keywords:FRMs, domain space, range space, hidden pattern, limit cycle, fixed point.

I. INTRODUCTION

Professor L.A. Zadeh at the University of California at Be rkeley in 1965 suggested Fuzzy set theory to quantitatively a nd efficiently deal with the issues of this nature.Kosko B [1,2] introduces some essential concepts, terminology, notations, and arithmetic of Fuzzy logic. Vasantha et al. launched a fresh concept called Fuzzy Relati onal Maps (FRMs)[4,5&7]. An FRM, a domain space, and a range space are disconnected in the sense of concepts need to be identified. That is, the number of components in the space must not be equal to the number of components of domain space. In addition, it is suppose that there are no intermediate relationships within the domain element or node and the range space. A comparable study of the impact of the communication sector by shanmugapriya et al [3,8] has been carried out. In the same regard, the study continued to use FRMs and Fuzzy intuitionistic Fuzzy sets to analysis relationship with teacher students by Udayakumar's [6].

The beneficial and negative effect of mass media on indivi duals, kids, and young learners using the FRM model was di scussed in this article.

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* Correspondence Author
R. Shanmugapriya*, Department of Mathematics, Vel Tech Rangarajan Dr. Sagunthala R&D Institute of Science and Technology, Chennai – 600062, Tamil Nadu, India.
B. KomalaDurga, Department of Mathematics, Vel Tech Rangarajan Dr. Sagunthala R&D Institute of Science and Technology, Chennai – 600062, Tamil Nadu, India.
T. Gunasekar, Department of Mathematics, Vel Tech Rangarajan Dr. Sagunthala R&D Institute of Science and Technology, Chennai – 600062, Tamil Nadu, India.

1.1 Fuzzy relational maps:

The elements of the domain space are taken from the real ve ctor space of dimension n in Fuzzy relational maps (FRMs) and that of the range space are real vectors of the vector dim ension m (m generally does not need to be equal to n).
Denote R as the set of nodes $R_1, \dots, R_m$ of the range space, where $R = \{(x_1, \dots, x_m | x_j = 0 \text{ or } 1\}$ for

$j = 1,2, \dots, m$.If$X_i = 1$it means that the node R_i is in the ON state and if $x_i = 0$ it means that the node $R_i$is in the OFF state. Similarly D denotes the nodes $R_1, \dots, R_m$of the domain space, where $D = \{(x_1, \dots, x_n | x_i = 0 \text{ or } 1\}$for $i = 1,2, \dots, n$.if $X_i = 1$it means that the node $D_i$is in the ON state and if $X_i = 0$it means that the node D_i is in the OFF state.

Definition 1.1.1:

Let $D_iR_j(orR_jD_i)$ where $1 \le j \le m$ and $1 \le i \le n$ be the edges of an FRM. When $D_i(or\ R_j)$ is switched on and if causality flows through the edges and if it again causes$D_i(or\ R_j)$,then the equilibrium state of this dynamical system is called the hidden pattern.

Definition 1.1.2:

If the equilibrium state of a dynamical system is a unique state vector then it is called fixed point. Example: -Let us assume a dynamical system by switching onR_1 $(or\ D_1)$. FRM settles down with $R_1$and R_m (or D_1andD_n) on, i.e. state vector remains as$(1,0, \dots 0,1)$ in $R\ [or\ (1,0,..,0,1) in\ D]$this state vector is called the fixed point.

Definition 1.1.3:

If the FRM settles down with a state vector in the form

$$D_1 \to D_2 \to \dots \to D_i \to D_1\ (orR_1 \to R_2 \to \dots \to R_i \to R_1)$$

This equilibrium is called a limit cycle.

Methods of determining the hidden pattern

Let $R_1, \dots, R_n$and $D_1, D_2, \dots, D_n$ be the nodes of FRM with feedback. Let E be the relational matrix. Let us assume that $D_1$is switched on i.e. the input is given as $vectoA_1 = (1, 0, \dots, 0) in\ 1$.The data should pass through the relational matrix E. This is done by findingA_1E.Let$A_1E = (r_1, r_2, \dots, r_m)$. After thresholding and updating the resultant vector, we have$A_1E \in R$.

Now let$B = A_1E$. Passing B into E^T by obtainingBE^T. After thresholding and updating the vector, we have$BE^T \in D$. The procedure is repeated till we get a fixed point or limit cycle.

1.2 Risk factors of the Lifestyle disease:

II. MODEL

Domain Space:

Attributes related to the Lifestyle

D_1: Diabetes
D_2: Nephrosis
D_3: Hyper tension
D_4: Obesity
D_5: Cardiac disease

Range Space:

Attributes related to habitude

R_1: High carb diet
R_2: Lack of exercise
R_3: Medications like anti-depressants
R_4: Psychological factors
R_5: Social issues
R_6: Legal recreational drugs like smoking and alcohol consumption
R_7: Stress
R_8: Sleep deprivation
R_9: Engineered junk food and food addiction.

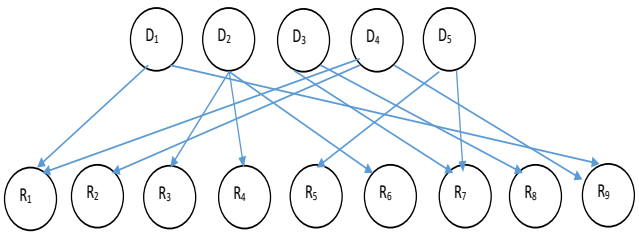
Now from the Expert's opinion, the Directed Graph is drawn and the relational matrix is framed from it by taking the attributes related to Lifestyleie,D_1 , $D_2, \dots, D_5$as the rows and attributes related to the dengue virus i.e D_1 , $D_2, \dots, D_n$ as the columns.

III. FUZZY ANALYSIS OF THE PROBLEM BY FRM:

In this section we use the two experts to form the FRM model to analyse the problem.

First Expert's opinion: (Doctor)

The relational map is given by the First Expert opinion



The Fuzzy matrix $E_1$is obtained from the above relational maps is as follows.

$$E_1 = \begin{bmatrix} 1 & 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 1 & 0 \\ 0 & 1 & 0 & 0 & 0 \\ 0 & 1 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 1 \\ 0 & 1 & 0 & 0 & 0 \\ 0 & 0 & 1 & 0 & 1 \\ 0 & 0 & 1 & 0 & 0 \\ 1 & 0 & 0 & 1 & 0 \end{bmatrix}$$

Now, we make the state D_1 as on state ('Adults suffering from Diabetes') and remaining all nodes are off state in the domain space.

We have to use hidden pattern of the state vector $X_1 = (1\,0\,0\,0\,0)$ is derived by the following process.

$$X_1 = (1\,0\,0\,0\,0)$$

$$E_1X_1 = (1\,0\,0\,0\,0\,0\,0\,0\,1) = Y_1$$

$$E_1{}^TY_1 = (1\,0\,0\,1\,0) = X_2$$

$$E_1X_2 = (1\,1\,0\,0\,0\,0\,0\,0\,1) = Y_2$$

$$E_1{}^TY_2 = (1\,0\,0\,1\,0) = X_3$$

$$E_1X_3 = (1\,1\,0\,0\,0\,0\,0\,0\,1) = Y_2 \in R$$

$$E_1{}^TY_3 = (1\,0\,0\,1\,0) = X_3 \in D$$

Weget the outcome vector, after thresh holding and updating process of the following chain.

$$\boldsymbol{X_1 \to Y_1 \to X_2 \to Y_2 \to X_3 = Y_2 \to X_3}$$

i.e.X_3 is a fixed point

Now, we make the state D_4 as on state ('Obesity people') and remaining all other nodes are off state in domain space.

The below method is used to derive the hidden pattern of the state vector $A_1 = (0\,0\,0\,1\,0)$.

$$E_1A_1 = (1\,1\,0\,0\,0\,0\,0\,0\,1) = B_1$$

$$E_1{}^TB_1 = (1\,0\,0\,1\,0) = A_2$$

$$E_1A_2 = (1\,1\,0\,0\,0\,0\,0\,0\,1) = B_1 \in R$$

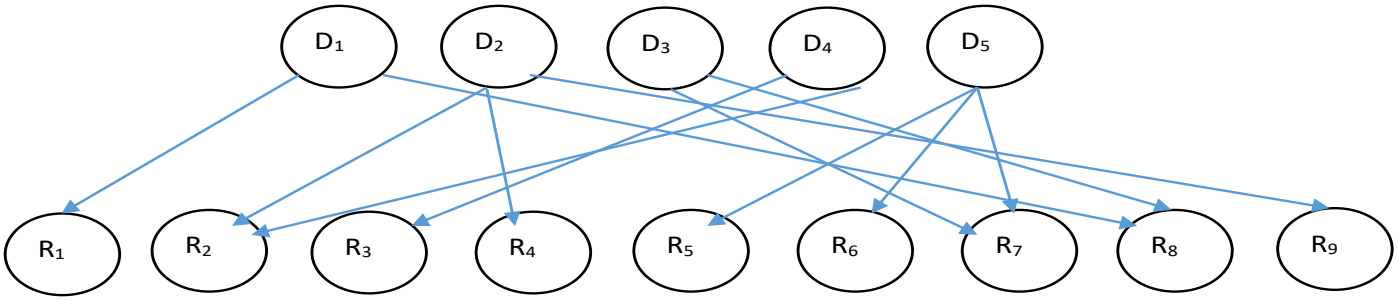
$$E_1{}^TB_1 = (1\,0\,0\,1\,0) = A_2 \in D$$

We get the outcome vector, after thresh holding and updating process of the following chain.

$$A_1 \to B_1 \to A_2 = B_1 \to A_2$$

i.e.$A_2$is a fixed point

The view of first expert (Doctor), if the first and fourth nodes are diabetes and obesity are on state, we discover the resultant vector as the adults consume high carb diet and lack of exercise, addition to the engineered junk food etc. so they must ensure the minimal consumption of high carb diets and avoid the junk food, also regular exercise should be followed.



The Fuzzy matrix E_2 is obtained from the above relational maps is as follows.

$$E_2=\begin{bmatrix}1&0&0&1&0\\0&1&0&1&0\\0&0&0&0&0\\0&1&0&0&0\\0&0&0&0&1\\0&0&0&0&1\\0&0&1&0&1\\1&0&1&0&0\\0&1&0&0&0\end{bmatrix}$$

Now, we make the state D_3 as on state ('Hyper tensed people') and remaining all nodes off state in the domain space.

We have to use hidden pattern of the state vector $L_1 = (0\,0\,1\,0\,0)$ is derived by the following process.

$$L_1 = (0\,0\,1\,0\,0)$$

$$E_2L_1 = (0\,0\,0\,0\,0\,0\,1\,1\,0) = M_1$$

$$E_2{}^T M_2 = (1\,0\,1\,0\,1) = L_2 \in D$$

$$E_2L_2 = (1\,0\,0\,0\,1\,1\,1\,1\,0) = M_2 \in R$$

We get the limit cycle, after thresh holding and updating of the outcome vector.

$$\boldsymbol{L_1 \to M_1 \to L_2 \to M_2 = L_2 \to M_2}$$

i.e.L_2 is a fixed point

Now the state vector $R_7$is on state ('public experiencing fromsevere stresses') and remaining nodes are off state in the range space.

We have to use hidden pattern of the state vector $P_1 = (0\,0\,0\,0\,0\,0\,1\,0\,0)$ is derived by the following process.

$$E_2P_1 = (0\,0\,1\,0\,0) = Q_1$$

Second Expert's opinion: (Adult medicine specialist)

The relational map is given by the Second Expert opinion

$$E_2{}^T Q_1 = (0\,0\,0\,0\,0\,0\,1\,1\,0) = P_2$$

$$E_2P_2 = (0\,0\,1\,0\,1) = Q_2 \in D$$

$$E_2{}^T Q_2 = (0\,0\,0\,0\,1\,0\,1\,0) = P_3 \in R$$

$$E_2P_3 = (0\,0\,1\,0\,1) = Q_2 \in D$$

$$E_2{}^T Q_3 = (0\,0\,0\,0\,1\,0\,1\,1\,0) = P_4 = P_3 \in R$$

The resultant vector after thresh holding and updating the following chain.

$$\boldsymbol{P_1 \to Q_1 \to P_2 \to Q_2 \to P_3 = P_3 \to Q_2}$$

i.e. Q_2 is a fixed point

According to the second expert (Adult medicine specialist), if the third node is on state, we attain the resultant vector is P3, i.e. the hyper tensed people face the problem due to social issues like addiction to alcohol and smoking and over stress and sleep deprivation. If the seventh node (stress) is on state in the range space, we find the resultant vector is hyper tension and heart disease. These kind of people were advised to be stress free and to have sound sleep. Also they should have control over their drinking habits.

IV. CONCLUSION

In this paper using this FRMs model, we discover that due to the modern lifestyle of the people,like consuming high carb diet and lack of exercise, addition to the engineered junk food etc. are suffering serious diabetes and obesity. They must ensure the minimal consumption of high carb diets and avoid the junk food, also regular exercise should be followed. Also the hyper tensed people face the problem due to social issues like addiction to alcohol and smoking and over stress and sleep deprivation. These kind of people were advised to be stress free and to have sound sleep. Also they should have control over their drinking habits.

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