Global Journal of Pure and Applied Mathematics.
ISSN 0973-1768 Volume 13, Number 9 (2017), pp. 5299-5305

http://www.ripublication.com

Study On Watter Pollution Control Based On Fuzzy Cognitive Maps (FCM)

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Abstract

In this article, we study the Fuzzy cognitive map an Ecological concept. Here we take the first component is Wetlands then we relate this component into others are like fish ,Lake pollution and Law enforcement .since there are different types of relationship between the components when the wetland goes up it has a strong positive relationship an the number of fish. so there is a positive. Next when the Lake pollution increases the amount of wetland decreases, we can also think about law enforcement as it increases then Lake Pollution will decrease. So In this article we obtained some relationship between them and how one parameter influence the other through the mathematical concept of FCM.

Key words: FCMs, Hidden pattern, fixed point, aversion.

1. INTRODUCTION

Pollution is a essential evil of all development. Due to lack of development of a culture of pollution control, there has effected a heavy backlog of gaseous, liquid and solid pollution in environment. It has to be cleaned. Pollution control is a recent environmental concern. Pollution is a man-made problem, mainly of effluent countries. Pollution is an undesirable change in the physical, chemical or biological characteristics of air, water and soil that may harmfully affect the life or create potential health hazard of any living organism. Pollution is thus direct or indirect change in any component of the biosphere that is harmful to the living components and in particular undesirable for man, affecting adversely the industrial progress,

cultural and natural assets or general environment of living society. Types of pollutions are classified in different ways. On the basis of the type of environmental being polluted, we may recognize air pollution, water pollution, and land (soil) pollution, marine pollution etc.

1.1 Issues involved in enforcement of laws:

In today's time, everyone wants to fulfill his selfish desires and for this we are continuously exploiting our natural resources. This is posing a great threat to our future generation. Keeping this in view, various laws and acts have been framed like the Environment Protection Act (EPA), Wildlife Protection Act, Water Pollution Act, ect. Which are discussed above. But actual difficulty lies in implementation of these laws. Even if they are implemented,they are generally violated. Fruitful results can be obtained only by effective implementation of these laws .If a law is violated (by person, industry or institute), punishment should be given and desirable penalty must be charged through legal process.

Mass electronic media can play an instrumental role in educating public about various laws and their provisions .Every citizen must be responsible for his actions and one should act as a watchdog over other people who are violating the laws.

2. FUZZY COGNITIVE MAP (FCM):

In 1965, L.A. Zadeh has introduced a mathematical model called Fuzzy Cognitive Maps. After a decade in the year 1976, Political scientist R. Axelord used this fuzzy model to study decision making in social and political systems .Then B. Kosko enhanced the power of cognitive maps considering fuzzy values for the concepts of the cognitive map and fuzzy degrees of interrelationships between concepts. FCMs can successfully represent knowledge and human experience, introduced concepts to represent the essential elements and the cause and effect relationships among the concepts to model the behavior of any system. It is a very convenient simple and powerful tool, which is used in numerous fields such as social, economical and medical etc. illustrated by W.B.Vasantha Kandasamy in her book, "Application of Fuzzy Models in Social Sciences". In this paper we recall the notion of Fuzzy Cognitive Maps (FCMs), which was introduced by Bart Kosko in the year 1986.This work is based on expert opinion collected throughout Chennai. The data was collected and assimilated from the people using a linguistic questionnaire and this linguistic responses were transformed into fuzzy data. It is important to note that, while doing fuzzy mathematical models, the fuzzy matrix make take its entries from the interval [-1.1]. Even then, they are known as fuzzy matrices. Therefore, it is understood that Fuzzy tools alone have the capacity to analyze these concepts further substantiating the choice of this method.

In this section we recall the notion of Fuzzy Cognitive Maps (FCMs), which was introduced by Bart Kosko in the year 1986.We also give several of its interrelated

definitions. FCMs have a major role to play mainly when the data concerned is an unsupervised one. Further this method is most simple and an effective one as it can analyze the data by directed graphs and connection matrices.

2.1 Definition: An FCM is a directed graph with concepts like policies, events, etc. as nodes. and causalities as edges. It represents causal relationship between concepts. Let C_1, C_2, …,Cn be the nodes of an FCM. A = (a_1,a_2,…,an) where ai ∈ {0, 1}. A is called instantaneous state vector and it denotes the on-off position of the node at an instant.

2.2 Definition: Let C_1, C_2,…,C_n be the nodes of an FCM. Let C_1C_2, C_2C_3, C_3C_4,…, C_iC_j be the edges of the FCM (i □j). Then the edges form a directed cycle. An FCM is said to be cyclic if it possesses a directed cycle. An FCM is said to be acyclic if it does not possess any directed cycle.

2.3 Definition: An FCM with cycles is said to have a feedback.

2.4 Definition: Let C_1C_2, C_2C_3, C_3C_4,…, C_iC_j be a cycle. When C_i is switched on and if the causality flows through the edges of a cycle and if it again causes C_i , we say that the dynamical system goes round and round. This is true for any node Ci, for i = 1, 2, …,n. The equilibrium state for this dynamical system is called the hidden pattern.

2.5 Definition: If the equilibrium state of a dynamical system is a unique state vector, then it is called a fixes point.

2.6 Example: Consider a FCM with C_1, C_2,…,C_n as nodes. For example let us start the dynamical system by switching onC1. Let us assume that the FCM settles down with C_1 and C_n on i.e. the state vector remains as (1, 0, 0, …, 0, 1) this state vector(1, 0, 0, …, 0, 1) is called the fixed point.

In the Next section,we analyze Fuzzy cognitive map an Ecological concept.

3. ANALYSIS OF THE PROBLEM

3.1 Method of Determining Hidden Pattern

Let C_2, C_2… C_n be the nodes of an FCM, with feedback. Let E be the associated adjacency matrix. Let us find the hidden pattern when C_1 is switched on. When an input is given as the vector A_1= (1, 0, 0… 0), the data should pass through the relation matrix E. this is done by multiplying A_1 by the matrix E. Let A_1 E= (a_1… a_n)with the threshold operation that is by replacing ai by 1 if a_i > k and a_i by 0 if a_i < k (k is a suitable positive integer). We update the resulting concept. The concept C_1 is included in the updated vector by making the first coordinate as 1 in the resulting vector. Suppose A_1 E → A_2 then consider A_2 E and repeat the same procedure. This procedure is repeated till we get a limit cycle or a fixed point.

Using the linguistic questionnaire and the expert's opinion we have taken the concepts {C_1, C_2, ..., C_{10}} as nodes

$C_1 \rightarrow$ Wetlands

$C_2 \rightarrow$ Fish

$C_3 \rightarrow$ Lake pollution

$C_4 \rightarrow$ Income

$C_5 \rightarrow$ Law enforcement

The directed graph is drawn with the expert opinion where C_1, C_2, C_3, C_4, C_5, are taken as nodes and causalities as edges.

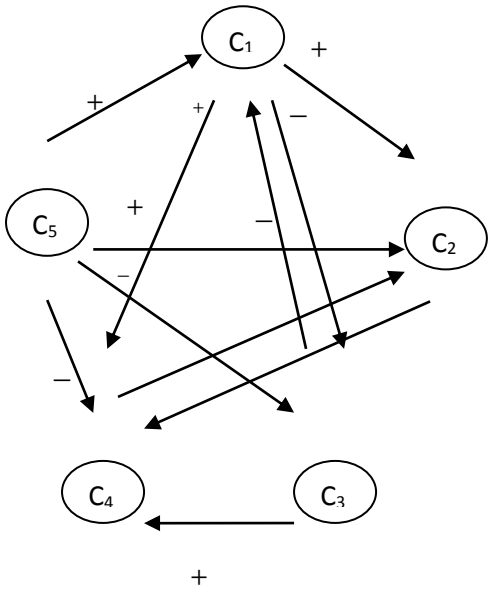

Fig. 1: Relational directed graph

$$A = \begin{array}{c} \\ c_1 \\ c_2 \\ c_3 \\ c_4 \\ c_5 \end{array} \begin{array}{c} \begin{array}{ccccc} c_1 & c_2 & c_3 & c_4 & c_5 \end{array} \\ \begin{bmatrix} 0 & 1 & 1 & 1 & 0 \\ 0 & 0 & 0 & 1 & 0 \\ 1 & 0 & 0 & 1 & 0 \\ 0 & 1 & 0 & 0 & 0 \\ 1 & 1 & 0 & 1 & 0 \end{bmatrix} \end{array}$$

Associated Matrix

Now using the matrix A of the Fuzzy Cognitive Map (FCM) the on state, we determine the hidden pattern. Suppose the concept C_1 is in the on state and another node are in the off sate.

(i) Let the initial input vector be

$X_0 = \{1\ 0\ 0\ 0\ 0\}$.

$X_0\ A = \{0\ 1\ 1\ 1\ 0\} \rightarrow \{1\ 1\ 1\ 1\ 0\} = X_1$

$X_1\ A = \{1\ 2\ 1\ 3\ 0\} \rightarrow \{1\ 1\ 1\ 1\ 0\} = X_2 = \mathbf{X_1}$

X_1 is the hidden pattern which is the fixed point.

(ii) Let the initial input vector be

$X_0 = \{0\ 1\ 0\ 0\ 0\}$.

$X_0\ A = \{0\ 0\ 0\ 1\ 0\} \rightarrow \{0\ 1\ 0\ 1\ 0\} = X_1$

$X_1\ A = \{0\ 1\ 0\ 1\ 0\ \} = X_2 = \mathbf{X_1}$

X_1 is the hidden pattern which is the fixed point.

(iii) Let the initial input vector be

$X_0 = \{0\ 0\ 1\ 0\ 0\}$.

$X_0\ A = \{1\ 0\ 0\ 1\ 0\} \rightarrow \{1\ 0\ 1\ 1\ 0\} = X_1$

$X_1\ A = \{1\ 2\ 1\ 2\ 0\} \rightarrow \{1\ 1\ 1\ 1\ 0\} = X_2$

$X_2\ A = \{1\ 2\ 1\ 3\ 0\} \rightarrow \{1\ 1\ 1\ 1\ 0\} = X_3 = \mathbf{X_2}$

X_2 is the hidden pattern which is the fixed point.

(iv) Let the initial input vector be

$X_0 = \{0\ 0\ 0\ 1\ 0\}$.

$X_0\ A = \{0\ 1\ 0\ 0\ 0\} \rightarrow \{0\ 1\ 0\ 1\ 0\} = X_1$

$X_1\ A = \{0\ 1\ 0\ 1\ 0\} = X_2 = \mathbf{X_1}$

X_1 is the hidden pattern which is the fixed point

(v) Let the initial input vector be

$X_0 = \{0\ 0\ 0\ 0\ 1\}$.

$X_0\ A = \{1\ 1\ 1\ 1\ 0\} \rightarrow \{1\ 1\ 1\ 1\ 1\} = X_1$

$X_1\ A = \{2\ 3\ 2\ 4\ 0\} \rightarrow \{1\ 1\ 1\ 1\ 1\} = X_2 = \mathbf{X_1}$

X_1 is the hidden pattern which is the fixed point

4. CONCLUSION

As the amount of wetlands increases, the number of fish increases lot .As lake pollution increases, the amount of wetlands decreases slightly. As law enforcement increases, lake pollution decreases a medium amount. So we know that because it's parameterized in an FCM wetlands can go up or down and all of these various ovals can go up or down.

We have got the relationship between these components and those are parameterized between positive one and negative one. Whether, if it's positive one it's got a high positive influence and if it's negative one it's got a high negative influence in the course of it 0.It doesn't have an influence so when thinking about these relationships. we can begin to model systems by using these different values and we can look at the different types of relationships that are represented and say well in this first one as the amount of wetlands goes up it has a strong positive relationship on the number of fish.

So that's why there's a positive one then in this example as lake pollution increases the amount of wetland decreases. We can also think about law enforcement as it increases. Lake pollution decreases about a medium amount.

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