A MATHEMATICAL APPROACH TO ANALYZE
THE PROBLEMS FACED BY TRIBALS IN SIRUVANI HILLS,
COIMBATORE DISTRICT IN TAMILNADU

S. Narayanamoorthy¹, K. Thangapandi²
¹,²Department of Mathematics
Bharathiar University
Coimbatore, 641 046, INDIA

Abstract: In this research work, the authors investigate (analyze) the problems faced by tribals in Siruvani Hills, Coimbatore District in TamilNadu, India, using Fuzzy Cognitive Maps (FCMs). We have interviewed 76 households in the study area using a linguistic questionnaire. As the problems faced by them at large, involved so much of feelings and uncertainties. We felt it to fit to use fuzzy theory in general and fuzzy cognitive maps in particular. The result of the study would help us to understand the problem faced by tribals

Key Words: Fuzzy Theory, Fuzzy Cognitive Maps, Tribals

1. Introduction

The siruvani forest forms a South West part of Tamil Nadu, India included in the Coimbatore district and which is one of the famous historical place in TamilNadu. The Irulas are one of the primitive hill tribals of Tamil Nadu. They are mainly located in the Siruvani village. There are lived in totaly 76 households of tribals. The information on problems faced by them were gathered through interviews using a linguistic questionnaire this linguistic questionnaire was transformed into a fuzzy data. It is important to note while doing fuzzy mathematical models the fuzzy matrix may take its entries from the interval [-1, 1]. Irula tribes sought work as agricultural laborers in the nearby towns and farm land owned by rich landlords. Honey or Bamboo collection and Fishing
are also a major occupation. As the problems faced by them at large, involved so much of feelings and uncertainties.

2. Fuzzy Cognitive Maps

Fuzzy Cognitive Maps are techniques that attempt to depict and analyze the cognitive process of human thinking and human behavior on specific domains by creating models. These models are represented as signed directed graphs of concepts and by the various casual relationships that exists between the concepts. In 1976 Axelord[1] proposed cognitive maps as a formal tool for decision-making. He used the matrix representation of the directed graph to represent and study the social scientific knowledge. In 1986 Kosko[2] proposed FCMs based on the cognitive maps structure.

In this section we recall the notion of Fuzzy Cognitive Maps (FCMs), which was introduced by Bart Kosko[2] in the year 1986.

Definition 1. An FCM is a directed graph with concepts like policies, events etc. as nodes and causalities as edges. It represents causal relationship between concepts. If increase (or decrease) in one concept, leads to increase (or decrease) in another, then give the value 1. If there exists no relation between two concepts, then the value 0 is given. If increase (or decrease) in one causalities decreases (or increases) another, then give the value $-1$. Thus FCMs are described in this way.

Definition 2. When the nodes of the FCM are fuzzy sets then they are called as fuzzy nodes.

Definition 3. FCMs with edge weights or causalities from the set $\{-1, 0, 1\}$, are called simple FCMs.

Definition 4. Consider the nodes or concepts $C_1, C_2, \ldots, C_n$ of the FCM. Suppose the directed graph is drawn using edge weight $e_{ij} \in \{0, 1, -1\}$. The matrix $E$ be defined by $E = (e_{ij})$, where $e_{ij}$ is the weight of the directed edge $C_iC_j$. $E$ is called the adjacency matrix of the FCM, also known as the connection matrix of the FCM.

Definition 5. Let $C_1, C_2, \ldots, C_n$ be the nodes of an FCM. $A = (a_1, a_2, \ldots, a_n)$, where $a_i \in 0, 1$. $A$ is called the instantaneous state vector and it denotes the on-off position of the node at an instant.

$$a_i = \begin{cases} 0 & \text{if } a_i \text{ is OFF} \\ 1 & \text{if } a_i \text{ is ON,} \end{cases} \text{ Where } i = 1, 2, \ldots, n.$$
Definition 6. Let $C_1, C_2, \ldots, C_n$ be the nodes of an FCM. Let $\rightarrow C_1C_2, \rightarrow C_2C_3, \ldots, \rightarrow C_iC_j$ be the edges of the FCM ($i \neq j$). 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.

Definition 7. An FCM with cycles is said to have a feedback.

Definition 8. When there is a feedback in an FCM, i.e., when the causal relations flow through a cycle in a revolutionary way, the FCM is called a dynamical system.

Definition 9. Let $\rightarrow C_1C_2, \rightarrow C_2C_3, \ldots, \rightarrow C_1C_2$ 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 $C_i$, for $i = 1, 2, \ldots, n$. The equilibrium state for this dynamical system is called the hidden pattern.

Definition 10. If the equilibrium state of a dynamical system is a unique state vector, then it is called a fixed point.

3. Adaptation of FCMs to the Problem

Now we illustrate the dynamical system by a very simple model from the problem faced by tribals. At the first stage we have the following five arbitrary attributes ($P_1, P_2, \ldots, P_5$) are taken as the main nodes for study

$P_1$- No Education  
$P_2$- No Transport Facilities  
$P_3$- Living Condition is Poor  
$P_4$- Wandering of Wild Animals (Unable to cultivate their lands)  
$P_5$- Government Policies on Forest

Based on the first experts opinion, the corresponding directed graph and connection matrix $M$ is given as

\[
M = \begin{pmatrix}
P_1 & P_2 & P_3 & P_4 & P_5 \\
0 & 0 & 1 & 0 & 0 \\
1 & 0 & 1 & 0 & 0 \\
1 & 0 & 0 & 1 & 1 \\
1 & 1 & 1 & 0 & 0 \\
0 & 0 & 1 & 1 & 0
\end{pmatrix}
\]
Now using the matrix $M$ we determined the problems. Let us start No Education is taken as the ON state and all the other nodes are in the OFF state.

$$C = (1 \ 0 \ 0 \ 0 \ 0)$$

The product of $CM$ is calculated.

$$CM = (0 \ 0 \ 1 \ 0 \ 0)$$
$$\leftrightarrow (1 \ 0 \ 1 \ 0 \ 0) = C_1$$

$$C_1M = (1 \ 0 \ 1 \ 1 \ 1)$$
$$\leftrightarrow (1 \ 0 \ 1 \ 1 \ 1) = C_2$$

$$C_2M = (2 \ 1 \ 3 \ 2 \ 1)$$
$$\leftrightarrow (1 \ 1 \ 1 \ 1 \ 1) = C_3$$

$$C_3M = (3 \ 1 \ 4 \ 2 \ 1)$$
$$\leftrightarrow (1 \ 1 \ 1 \ 1 \ 1) = C_4$$

The fixed point is $C_4 = (1 \ 1 \ 1 \ 1 \ 1)$

Let us start Wandering of Wild Animals is taken as the ON state and all the other nodes are in the OFF state.

$$D = (0 \ 0 \ 0 \ 1 \ 0)$$

The product of $DM$ is calculated.

$$DM = (1 \ 1 \ 1 \ 0 \ 0)$$
The fixed point is $D_3 = (1 \ 1 \ 1 \ 1 \ 1)$

Based on the second experts opinion, the corresponding directed graph and connection matrix $N$ is given as

![Directed Graph](image)

Now using the matrix $N$ we determined the problems. Let us start No Transport Facilities is taken as the ON state and all the other nodes are in the OFF state.

$$X = \begin{pmatrix} 0 & 1 & 0 & 0 & 0 \end{pmatrix}$$

The product of $XN$ is calculated.

$$XN = \begin{pmatrix} 1 & 0 & 1 & 0 & 0 \end{pmatrix}$$
The fixed point is $X_3 = (1\ 1\ 1\ 1\ 1)$

Let us start Government Policies on Forest is taken as the ON state and all the other nodes are in the OFF state.

$Y = (0\ 0\ 0\ 0\ 1)$

The product of $YN$ is calculated.

$YN = (0\ 1\ 0\ 1\ 0)$

$\leftrightarrow (0\ 1\ 0\ 1\ 1) = Y_1$

$Y_1N = (2\ 1\ 2\ 1\ 1)$

$\leftrightarrow (1\ 1\ 1\ 1\ 1) = Y_2$

$Y_2N = (3\ 2\ 2\ 2\ 2)$

$\leftrightarrow (1\ 1\ 1\ 1\ 1) = Y_3$

The fixed point is $Y_3 = (1\ 1\ 1\ 1\ 1)$

When the same threshold value occurs twice, the value is considered as the fixed point. The iteration gets terminated and the calculation gets terminated. Likewise any state vector can be taken and its effect can be analyzed.

4. Conclusion and Suggestion

In this section we have discussed the major problem of the tribals which are evolved through FCMs and based on two experts opinion. We observe that from the algorithm of the given problem the fixed point is $(1\ 1\ 1\ 1\ 1)$ and wandering of wild animals and no education is the major problems of the tribals in Siruvani hills. To reduce their problems, we suggests to the government as follows

- To give the protection from wild animals.
• Education for the children of these tribals should be made compulsory.
• Laying of better roads in forest area will be helpful.
• It is high time government takes steps to revive the life of tribals.

Fuzzy Cognitive Maps have several advantages. The main advantage of this method is simple. It functions on experts opinion. When the data happens to be an unsupervised one the FCM comes handy. This is the only known fuzzy technique that gives the hidden pattern of the situation.

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References
