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A FUZZY MATHEMATICAL MODELING TO ANALYSE THE MAJOR PROBLEMS FACED BY GYPSIES IN TAMILNADU, INDIA

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ABSTRACT

In this research paper, the authors analyse to study about the downtrodden people in India. Among the downtrodden people the most sympathetic downtrodden people is gypsies. They are moving from one place to another place towards survive of life because of not having any home at any place to live. They do not have mother tongue. Their spoken language is a combined language which doesn't have any script; they are facing lot of difficulties in all walk of their life. As the problems faced by them at large involve so much of feeling, uncertainties and unpredictability's. We felt that it deem fit to use fuzzy theory in general and Induced Fuzzy Cognitive Maps (IFCMs) in particular.

Key words: *Gypsies, Fuzzy Theory, IFCM.*

1. INTRODUCTION

In a society there are several downtrodden people are living. One of the sympathetic downtrodden people is gypsies. In this reaserch paper we interviewed particularly 250 gypsies in Tamilnadu state in India. These gypsies are affected by the factors like Living condition/health condition is very poor, due to reservation of backward community, inheritor property, no education facilities.

The modern concept of uncertainty was introduced in the publication of seminal paper by L. A. Zadeh (1965), even though some ideas presented in the paper were envisioned by the American philosopher Max Black (1937).

In that seminal paper, Zadeh introduced a theory whose objects are fuzzy sets i.e., sets with boundaries that are not precise. Bellman, Zadeh, Zimmermann and many more authors studied intensively the concept of fuzzy set theory to solve decision-making problems. Dutta and Tiwari discussed the effect of tolerance in fuzzy linear fractional programming.

Fuzzy Cognitive Maps (FCMs) are more applicable when the data in the first place, is an unsupervised one. The FCMs work on the opinion of experts. It is more suited when the data under investigation is an unsupervised one. FCMs model the world as a collection of concepts and causal relations between concepts.

This paper has four sections. Introductory part is given in section one. In section two we recall the definition of fuzzy Cognitive Maps. Induced Fuzzy Cognitive Maps and its Properties are in section three. Section four is devoted to the adaptation of the Induced Fuzzy cognitive Maps to the problem faced by gypsies for their poverty stage and we give the conclusions based on our study.

2. FUZZY COGNITIVE MAPS (FCMs)

Definition 2.1: An FCM is a directed graph with concepts like policies, events etc. as nodes and causalities as edges. It represents causal relationship between concepts.

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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 2.2: When the nodes of the FCM are fuzzy sets then they are called as fuzzy nodes.

Definition 2.3: FCMs with edge weights or causalities from the set {–1, 0, 1}, are called simple FCMs.

Definition 2.4: Consider the nodes or concepts $C_1, \ldots, C_n$ 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.

It is important to note that all matrices associated with an FCM are always square matrices with diagonal entries as zero.

Definition 2.5: 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.

$$a_i = \begin{cases} 0 & \text{if } a_i \text{ is OFF} \\ 1 & \text{if } a_i \text{ is ON, where i= 1, 2, ..., n.} \end{cases}$$

Definition 2.6: Let $C_1, C_2, \ldots, C_n$ be the nodes of an FCM. Let $\overrightarrow{C_1C_2}, \overrightarrow{C_2C_3}, \ldots, \overrightarrow{C_iC_j}$ 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 2.7: An FCM with cycles is said to have a feedback.

Definition 2.8: 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 2.9: Let $\overrightarrow{C_1C_2}, \overrightarrow{C_2C_3}, \ldots, \overrightarrow{C_iC_j}$ 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 C_i, for $i = 1, 2, \ldots, n$. The equilibrium state for this dynamical system is called the hidden pattern.

Definition 2.10: If the equilibrium state of a dynamical system is a unique state vector, then it is called a fixed point.

Example 2.1: Consider a FCM with $C_1, C_2, \ldots, C_n$ as nodes. For example, let us start the dynamical system by switching ON C_1. Let us assume that the FCM settles down with C_1 and C_n ON that is, the state vector remains as (1, 0, 0, …, 0, 1). This state vector (1, 0, 0, …, 0, 1) is called the fixed point.

Definition 2.11: If the FCM settles down with a state vector repeating in the form, $A_1 \to A_2 \to \ldots \to A_{i_{\ldots}} \to A_1$, then this equilibrium is called a limit cycle.

Definition 2.12: We denote the combined FCM adjacency matrix by $E=E_1+E_2+\ldots+E_p$. Finite number of FCMs can be combined together to produce the joint effect of all the FCMs. Let $E_1, E_2, \ldots, E_p$ be adjacency matrices of the FCMs with nodes $C_1, C_2, \ldots, C_n$, then the combined FCM is got by adding all the adjacency matrices $E_1, \ldots, E_p$.

3. ALGORITHMIC APPROACH IN INDUCED FCMs

Even though IFCM is an advancement of FCM it follows the foundation of FCM, it has a slight modification only in Algorithmic approaches. To derive an optimistic solution to the problem with an unsupervised data, the following steps to be followed:

Step 1: For the given model (problem), collect the Unsupervised data that is in determinant factors called nodes.

Step 2: According to the expert opinion, draw the directed graph.

Step 3: Obtain the connection matrix, M, from the directed graph (FCM). Here the number of rows in the given matrix = number of steps to be performed.

Step 4: Consider the state vector C_1 which is in ON position. Find $C_1 \times M$. the state vector is updated and threshold at each stage.

Step 5: Threshold value is calculated by assigning 1 for the values > 1 and 0 for the values < 0. The symbol '$\hookrightarrow$' represents the threshold value for the product of the result.

Step 6: Now each component in the C_1 vector is taken separately and product of the given matrix is calculated. The vector which has maximum number of one's is found. The vector with maximum number of one's which occurs first is considered as C_2.

Step 7: When the same threshold value occurs twice. The value is considered as the fixed point. The iteration gets terminated.

4. ADAPTATION OF INDUCED FCMs TO THE PROBLEMS FACED BY THE GYPSIES

In this section, we adapt Induced Fuzzy Cognitive Maps (IFCMs) to the problems faced by Gypsies.

An expert spells out the seven major concepts relating to the Gypsies as

C_1 - Inheritor Property, C_2 - Child labor is at peak, C_3 – living condition is very poor, C_4 – Due to backward community, C_5 - Unemployment , C_6 – Government indifferent about the problems faced by gypsies, C_7 – Not owners of any property/land

The related connection matrix M is given by the expert is

$$M = \begin{array}{c} \\ C_1 \\ C_2 \\ C_3 \\ C_4 \\ C_5 \\ C_6 \\ C_7 \end{array} \left(\begin{array}{ccccccc} C_1 & C_2 & C_3 & C_4 & C_5 & C_6 & C_7 \\ 0 & 0 & 1 & 1 & 0 & 1 & 0 \\ 0 & 0 & 1 & 0 & 1 & 1 & 1 \\ 0 & 0 & 0 & 1 & 1 & 1 & 1 \\ 0 & 0 & 0 & 0 & 1 & 1 & 0 \\ 0 & 1 & 1 & 1 & 0 & 1 & 0 \\ 0 & 1 & 1 & 1 & 1 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 \end{array} \right)$$

Now using the matrix M we determined the problems. Let us start living condition is very poor is taken as the ON state and all the other nodes are in the OFF state.

(i.e) C_3= (0 0 1 0 0 0 0)

Product of C_3 and M is calculated.

C_3M = (0 0 0 1 1 1 1)
$\hookrightarrow$ (0 0 1 1 1 1 1) = C_3^1

Threshold value is calculated by assigning 1 for the values >1 and 0 for the values <0. The symbol '$\hookrightarrow$' represents the threshold value for the product of the result.

Now as per Induced Fuzzy Cognitive Map methodology, each component in the C_3^1 vector is taken separately and product of the given matrix is calculated. The vector which has the maximum number of one's which occurs first is considered as C_3^2.

The symbol ~ denotes the calculation performed with the respective vector, here $C_3^{1.}$

C_3^1x M ~ (0 0 1 0 0 0 0)x M
$\rightarrow$ (0 0 0 1 1 1 1)
C_3^1x M ~ (0 0 0 1 0 0 0) x M
$\rightarrow$ (0 0 0 0 1 10)

C_3^1x M ~ (0 0 0 0 1 0 0) x M
→ (0 1 1 1 0 1 0)
C_3^1x M ~ (0 0 0 0 0 1 0) xM
→ (0 1 1 1 1 0 0)
C_3^1x M ~ (0 0 0 0 0 0 1) xM
→(0 0 0 0 0 0 0)

Therefore C_3^2 = (0 0 0 1 1 1 1)

C_3^2 x M = (0 1 1 1 1 1 0)

Product of C_3^2 and M is calculated.

↪ (0 1 1 1 1 1 1)
C_3^2 = (0 1 1 1 1 1 1)
C_3^2 x M = (0 1 0 0 0 0 0) x M
→ (0 0 1 0 1 1 1)
C_3^2 x M = (0 0 1 0 0 0 0) x M
→ (0 0 0 1 1 1 1)
C_3^2 x M= (0 0 0 1 0 0 0) x M,
→ (0 0 0 0 1 1 0)
C_3^2 x M = (0 0 0 0 1 0 0) x M
→ (0 1 1 1 0 1 0)
C_3^2 x M = (0 0 0 0 0 1 0) x M
→ (0 1 1 1 1 0 0)
C_3^2 x M = (0 0 0 0 0 0 1) x M
→ (0 0 0 0 0 0 0)

Therefore C_3^3 = (0 0 0 1 1 1 1) = C_3^2

The fixed point is C_3^3 = (0 0 0 1 1 1 1) .

Let us start Due to backward community is taken as the ON state and all the other nodes are in the OFF state.

(i.e) C_4= (0 0 0 1 0 0 0)

Product of C_4 and M is calculated.

C_4M = (0 0 0 0 1 1 0)
↪ (0 0 0 1 1 1 0) = C_4^1

Threshold value is calculated by assigning 1 for the values >1 and 0 for the values <0 . The symbol '↪' represents the threshold value for the product of the result.

Now as per Induced Fuzzy Cognitive Map methodology, each component in the C_4^1 vector is taken separately and product of the given matrix is calculated. The vector which has the maximum number of one's which occurs first is considered as C_4^2.

The symbol ~ denotes the calculation performed with the respective vector, here C_4^1.

C_4^1x M ~ (0 0 0 1 0 0 0) x M
→ (0 0 0 0 1 10)
C_4^1x M ~ (0 0 0 0 1 0 0) x M
→ (0 1 1 1 0 1 0)
C_4^1x M ~ (0 0 0 0 0 1 0) xM
→ (0 1 1 1 1 0 0)

Therefore C_4^2 = (0 1 1 1 0 1 0)
C_4^2 x M = (0 1 1 1 1 1 1)

Product of C_4^2 and M is calculated.
↪ (0 1 1 1 1 1 1)

$C_4^{\ 2}$ = (0 1 1 1 1 1 1)
$C_4^{\ 2}$ x M =(0 1 0 0 0 0 0) x M
→(0 0 1 0 1 1 1)
$C_4^{\ 2}$ x M =(0 0 1 0 0 0 0) x M
→(0 0 0 1 1 1 1)
$C_4^{\ 2}$ x M= (0 0 0 1 0 0 0) x M,
→ (0 0 0 0 1 1 0)
$C_4^{\ 2}$ x M =(0 0 0 0 1 0 0) x M
→(0 1 1 1 0 1 0)
$C_4^{\ 2}$ x M = (0 0 0 0 0 1 0) x M
→ (0 1 1 1 1 0 0)
$C_4^{\ 2}$ x M = (0 0 0 0 0 0 1) x M
→(0 0 0 0 0 0 0)

Therefore $C_4^{\ 3}$ = (0 1 1 1 0 1 0) = $C_4^{\ 2}$

The fixed point is $C_4^{\ 3}$ = (0 1 1 1 0 1 0)

When the same threshold value occurs twice, the value is considered as the fixed point. The iteration gets terminated and the calculation gets terminated.

CONCLUSIONS & SUGGESTIONS

- While analyzing with IFCMs, we observe that when living condition is very poor is taken as the ON state, the resultant vector is (0 0 0 1 1 1 1).
- While analyzing with IFCMs, we observe that when Due to backward community is taken as the ON state , the resultant vector is(0 1 1 1 0 1 0)
- From the IFCMs it is noted that the Due to backward community is the major problem of Gypsies.
- Most of them were uneducated, living below poverty line.
- A school must be build separately so that the children of these gypsies are sent to school regularly.
- From our study the whole family works for over ten hours a day and live below poverty line. They don't even have a square meal a day.
- No one can prevent these gypsies from starvation and death, unless the government takes steps to provide them an alternative means of living.

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