A STUDY ON THE CAUSES FOR CHILD TRAFFICKING USING FUZZY COGNITIVE MAPS (FCMS)

A.PRAVEENPRAKASH, M.P.KANNAN, J.KIRUBAKARAN

Abstract: Child trafficking takes place all around the world, and is indeed also prevalent in India. There have been reports from many areas about the increase of trafficking taking place in India. According to the US State Department, there are approximately 600,000 to 820,000 people trafficked a year across international borders, and up to 50% of those are children. This is definitely seen as a growing issue in Asia, with the many children that are and continue to be trafficked for many reasons as well as being exploited. This paper analyses the causes of Child Trafficking using Fuzzy Cognitive Map model. This paper consists of four sections. Section one is introductory in nature that deals with the overall problem of child trafficking. Section two deals with the description of FCM. Section three gives the study and analysis of the problem using FCM model. Section four gives the conclusion and suggestion based on the study.

Keywords: FCMs, Hidden pattern, fixed point, Child Trafficking.

Introduction:

Child trafficking: According to UNICEF Child Trafficking is defined as "any person under 18 who is recruited, transported, transferred, harbored or received for the purpose of exploitation, either within or outside a country". There have been many cases where children just disappear overnight, as many as one every eight minutes, according to the National Crime Records Bureau. Children are taken from their homes to be bought and sold in the market. In India, there is a large number of children trafficked for various reasons such as labour, begging, and sexual exploitation. Because of the nature of this crime; it is hard to track; therefore making it impossible to have exact figures regarding this issue. India is a prime area for child trafficking to occur, as many of those trafficked are from, travel through or destined to go to India. Though most of the trafficking occurs within the country, there is also a significant number of children trafficked from Nepal and Bangladesh.

Factors Contributing Child Trafficking

There are many contributing factors to child trafficking, which include economic deprivation, illiteracy and ignorance, lack of employment opportunities, social status, and political uprisings. Many of the families in India are unable to afford the basic necessities of life, which forces the parents to sell their children off to gangs, and the gangs to exploit them. This paper aims at analyzing the causes for Child Trafficking using FCM model.

2. Fuzzy Cognitive Map (FCM):

2.1 Historical Perspective:

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".

2.2 Methodology : 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..

2.3 Preliminaries: 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. FCMs model the worlds as a collection of classes and causal relation between classes.

Definition 2.3.1: An FCM is a directed graph with concepts like policies, events etc as nodes and causalities as edges. It represents causal relationship between concepts.

Definition 2.3.2: When the nodes of the FCM are fuzzy sets then they are called as fuzzy nodes.

Definition 2.3.3: FCMs with edge weights or causalities from the set {-1, 0, 1} are simple FCMs.

Definition 2.3.4: The edges e_{ij} take values in the fuzzy causal interval [-1,1]. e_{ij} = 0 indicates no causality, e_{ij}> 0 indicates causal increase C_j increases as C_i increases (Or C_j Decreases as C_i Decreases). e_{ij} < 0 indicates causal decrease or negative causality. C_j decreases as C_i increases (and or C_j increases as C_i decreases). Simple FCMs have edge values in {-1, 0, 1}. Then if causality occurs, it occurs to a maximal positive or negative degree. Simple FCMs provide a quick first approximation to an expert stand or printed causal knowledge. If increase (Or decrease) in one concept leads to increase (or decrease) in another, then we give the value 1.If there exists no relation between the two concepts, the value 0 is given. If increase (or decrease) in one concept decreases (or increases) another, then we gives the value -1. Thus, FCMs are described in this way. Consider the nodes or concepts C_1, ..., 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 the e_{ij} is the weight of the directed edge C_i C_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 2.3.5: Let C_1, C_2,.... C_n be the nodes of an FCM. Let A=(a_1, a_2,...., a_n), where $a_i \in$ {0,1}. A is called the instantaneous state vector and it denoted the on off position of the node at an instant a_i =0 if a_i is off and a_i=1 if a_i is on, where i = 1, 2, ..., n.

Definition 2.3.6: Let C_1 , C_2 , ..., C_n be the nodes of an FCM. Let C_1 C_2, C_2 C_3, ..., C_i C_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 2.3.7: An FCM with cycles is said to have a feedback.

Definition 2.3.8: Where 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. $\longrightarrow$ $\longrightarrow$ $\longrightarrow$

Definition 2.3.9: Let C_1C_2, C_2 C_3,..., C_i C_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, ..., n. The equilibrium state for this dynamical system is called the hidden pattern.

Definition 2.3.10: If the equilibrium state of a dynamical system is a unique state vector, then it is called a fixed point. Consider a FCM with C_1, C_2, ..., 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, 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.

Definition 2.3.11: If the FCM settles down with a state vector repeating in the form $A_1 \rightarrow A_2 \rightarrow ... A_l \rightarrow A_1$. Then this equilibrium is called limit cycle.

2.3.12: Method Of Determining Hidden Pattern: Let C_1, 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 a_i 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 $\rightarrow A_2$ then consider A_2 E and repeat the same procedure. This procedure is repeated till we get a limit cycle or a fixed point.

3. A Study on the causes for Child trafficking using Fuzzy Cognitive Maps (FCMs): By administering linguistic questionnaire to the rescued children living in home and the NGO's involved in their rescue cum care operation, we have taken the following ten concepts {C_1, C_2, ..., C_{10}}

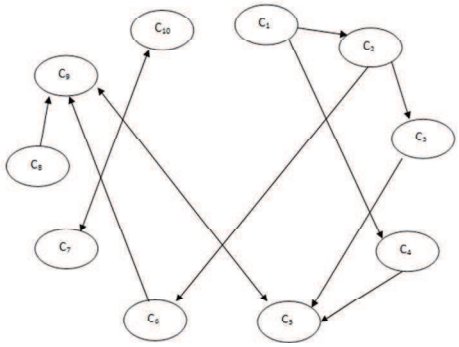
3.1 The results of causes for Child Trafficking:

The results of causes for Child Trafficking are taken as the concepts and as the main nodes for our analysis. They are listed as follows:

C_1- Poverty
C_2- Illiteracy and lack of vocational oppurtunities
C_3- Unemployement
C_4-Bonded Labour
C_5-Sexual exploitation
C_6- Illegal activities
C_7- Political uprising
C_8- Entertainment
C_9- Social factors
C_{10}- High profit, low risk

3.2 Analysis Of The Problem: Now we proceed on to analyze the problems using FCM. Let us consider the ten concepts {C_1, C_2, ..., C_{10}}

The results listed above were collected from the expert's opinion and the following diagram summaries their inter-relationship.



A =

	C_1	C_2	C_3	C_4	C_5	C_6	C_7	C_8	C_9	C_{10}
C_1	0	1	0	1	0	0	0	0	0	0
C_2	0	0	1	0	0	1	0	0	0	0
C_3	0	0	0	0	1	0	0	0	0	0
C_4	0	0	0	0	1	0	0	0	0	0
C_5	0	0	0	0	0	0	0	0	1	0
C_6	0	0	0	0	0	0	0	0	1	0
C_7	0	0	0	0	0	0	0	0	0	1
C_8	0	0	0	0	0	0	0	0	1	0
C_9	0	0	0	0	1	0	0	0	0	0
C_{10}	0	0	0	0	0	0	1	0	0	0

The matrix associated with the above graph is 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 other nodes are in the off sate.

(i) Let the initial input vector be

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

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

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

$X_2 A \rightarrow \{1\,1\,1\,1\,1\,1\,0\,0\,1\,0\} = X_3$

$X_3 A \rightarrow \{1\,1\,1\,1\,1\,1\,0\,0\,1\,0\} = X_4 = X_3$

X_3 is the hidden pattern which is the fixed point.

(ii) Let the initial input vector be

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

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

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

X_1 is the hidden pattern which is the fixed point.

(iii) Let the initial input vector be

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

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

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

$X_2 A \rightarrow \{0\,1\,1\,0\,1\,1\,0\,0\,1\,0\} = X_3 = X_2$

X_2 is the hidden pattern which is the fixed point.

Where $\rightarrow$ Denotes the resultant vector after thresholding and updating. X_3 is the hidden pattern which is the fixed point.[8]

3.3 Future Work: Analyzing causes for Child Trafficking using different Fuzzy Models and to construct new models to do the same.

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4. Conclusion And Suggestions: While analyzing FCM, when the attribute C_1 , "Poverty" is in the on state and other states are in the off state we get the attributes C_2, C_3, C_4, C_5, C_6, C_9 to be in the on state. i.e - Illiteracy and lack of vocational oppurtunities , Unemployment ,Bonded Labour ,Sexual exploitation, illegal activities and Social factors. when the attribute C_5 , "Sexual exploitation" is in the on state and other states are in the off state we get the attributes C_9 to be in the on state. i.e Social factors. When the attribute C_2 , "Illiteracy and lack of vocational oppurtunities" is in the on state and other states are in the off state we get the attributes C_3, C_5, C_6, C_9 to be in the on state. i.e - Unemployment , Sexual exploitation, illegal activities and Social factors.

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Department of Mathematics, Design Engineer
Hindustan University, Velammal, Mat, School, GEM3s Software Solution
Padur, Chennai-603 103, Mugapeir west, Chennai-603 103, Royapet, Chennai - 600014
apraveenprakash@gmail.com , mpkannan11@gmail.com