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A Study on Child marriage using New Neutrosophic Associative Fuzzy Cognitive Dynamical System

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Abstract

The practices of child marriage is a violation of human rights and denies a child from basic right such as health, education and nutrition. It not only affects the girl's lives but also the society. The aim of this paper is to introduce new Fuzzy bimodel called Neutrosophic Associative Fuzzy Cognitive Map(NAFCM) to study the problems of girls in child marriages Section one describes introduction. Section two deals with the definitions. Section three give description of the problems. Section four deals with the adaptation of the problem. Ultimately section five reveals the conclusion.

Keywords: Neutrosophic Associative Memories, Fuzzy Cognitive Map, Child Marriage, Bihidden patterns, Limit cycle.

1. INTRODUCTION

Fuzzy set theory was introduced by L.A.Zadeh [1] in 1965 to deal vagueness and imprecise. Political scientist Robert Axelrod (1976) introduced cognitive map for representing social scientific knowledge [2]. Bart Kosko proposed Fuzzy Cognitive Maps (FCM) in 1986 [3]. FCMs is a collection of classes and represents causal relations between classes. The Neutrosophic models are fuzzy models which allows the factor of indeterminacy. Neutrosophic Associative Memories (NAM) was pioneered by Vasantha Kandasamy and Floretin Smarandache in 2005[4]. Fuzzy Cognitive

Relational map was introduced by Praveen Prakash (2010) to study the psychological problem faced by the people with disabilities[5]. Thirusangu et all (2012) introduced bimodal called Bidirectional Associative Fuzzy Cognitive Map [6].Victor Devadoss and Felix introduced Bidirectional Associative Neutrosophic Cognitive map to study the youth violence by combining BAM and NCM due to occurrence of indeterminate in NCM [7]. In this paper a new model Neutrosophic Associative Fuzzy Cognitive Map (NAFCM) was proposed to study the problems of girls in child marriage by combining Neutrosophic Associative Memories and Fuzzy Cognitive Map due to presence of indeterminate in NAM. Two set of attributes for the problems of child marriages are collected from two different experts in an unsupervised method. The one set of attributes deals with Neutrosophic Associative memories dynamical system which consists of pair of attributes where an indeterminacy occurs in the relationship between concepts\nodes and other relates with Fuzzy Cognitive Map Dynamical system. Hence the role of dynamical bisystem is to captures the bihidden pattern to study the problem of child marriage.

2. DEFINITIONS

2.1 Neutrosophic Associative Memories

Neutrosophic Associative Memories can be seen as an extension of the Fuzzy Associative Memories which is different from the FAM in such a way that it deals with the indeterminate state.

Definition 2.1.1*:* Every logical variable x in the Neutrosophic Associative Memories is described by an ordered triplet (T, I, F) where T is the degree of truth, I is the level of indeterminacy and F is the degree of falsehood [4].

Definition 2.1.2*:* The simplest NAM encodes the NAM rule which associates a neutrosophic set B_i of dimension p with a neutrosophic set A_j of dimension n (here by an n- dimensional neutrosophic set, it means the unit neutrosophic hyper cube $[0, 1]^n$ U $[0,I]^n$). The NAM essentially map one ball in $[0,1]^n$ U $[0,I]^n$ [4] .

Definition 2.1.3*:* The Neutrosophic Associative Memories (NAM) is defined as follows. It can be noted that <Z U I>, <Q U I> and <R U I> denote the ring generated by Z and I or Q and I or R and I where the property is used. I.I = I but I+I = 2I. And thus the sum of I taken n times gives nI [4].

Definition 2.1.4: Let A be a matrix whose entries are from [0, 1] U [0, I]. Then A is called as a fuzzy Neutrosophic matrix. The combined interval is denoted by N= [0, 1] U [0, I] and N denotes the special fuzzy Neutrosophic interval [4].

Definition 2.1..5: The fit vector is defined as $B_N = (a_1, a_2, \ldots, a_n)$ where

$$a_i = \begin{cases} 0 \text{ if the node is in the off state} \\ 1 \text{ if the node is in the on state} \\ I \text{ if it is an indeterminate state} \end{cases}$$

Definition 2.1.6: The minimum function is defined as $\min\{x, I\} = x$ where x is real but $\min\{mI, nI\} = mI$ if $m < n$ [4].

Definition 2.1.7*:* The maximum function is defined as $\max\{x, I\} = I$ where x is real and $\max\{mI, nI\} = nI$ if $m < n$ [4].

2.2 Fuzzy Cognitive Map

Definition 2.2.1

Nodes of the FCM are called Fuzzy nodes if nodes are fuzzy sets.[3]

Definition 2.2.2

Simple FCM contains edges weight from the set {-1, 0, 1}.[3]

Definition 2.2.3

An FCM is a directed graph with concepts as nodes and causalities as edges. It gives causal relationship between concepts.[3]

Definition 2.2.4

Consider the nodes $C_1, C_2, C_3 \ldots C_n$ of the FCM. The matrix M is a called connection matrix with $M = (e_{ij})$ where e_{ij} is the weight of the directed edge C_iC_j .FCM is a square matrices where always an diagonal entries are zero.[3]

Definition 2.2.5

A is called Instantaneous state vector where it denotes only ON-OFF position with $A = (a_1, a_2, a_3 \ldots a_n)$. If $a_i = 1 (i = 1 \ldots .n)$ represents ON otherwise it is OFF position.[3]

Definition 2.2.6

Let $\overline{C_1C_2}, \overline{C_2C_3}, \ldots\ldots\ldots, \overline{C_iC_j}$ be the edges of the FCM ($i \neq j$).An FCM is said to be cyclic if it possesses a directed cycle otherwise it is called acyclic.[3]

Definition 2.2.7

Where there is a feedback an FCM,i.e, when the causal relations flow through a cycle in a revolutionary way, the FCM is called a dynamical system.[3]

Definition 2.2.8

Let $\overline{C_1C_2}, \overline{C_2C_3}, \ldots\ldots\ldots, \overline{C_iC_j}$ be a cycle. When C_i is switched on and if the causality flows through the edges of a cycle and if it again cause C_i, we say that the dynamical system goes round and round. This true for any node C_i for i=1,2,3…n. The equilibrium state for this dynamical system is called the hidden patterns. [3]

Definition .2.2.9

If an unique state vector exists in a dynamical system then it is called a fixed point.. [3]

Definition 2.2.10

If the FCM settles down with a state vector repeating in the form $A_1 \rightarrow A_2 \rightarrow \ldots\ldots A_i \rightarrow A_1$ then this equilibrium is called limit cycle. .[3]

2.3 Definitions of the New Neutrosophic Associative Fuzzy Cognitive Map(NAFCM)

Definition 2.3.1:

M is said to be biset if $M= M_1 \cup M_2$ where M_1, M_2 are non-empty sets.

Example: M = (5 4 1 2),(2 3 0 7) $\cup$ (2 2 1),(3 8 9).clearly M is a biset.

Definition 2.3.2

Let $A_1 = (a_1, a_2, \ldots, a_n), A_2 = (a_1', a_2', \ldots, a_n')$ be two vectors of length n and m respectively. Then $A= A_1 \cup A_2$ is a Neutrosophic bivectors. Example $A= A_1 \cup A_2$ =(5 2I 8) $\cup$ (4 3I 1) , A is a Neutrosophic bivectors.

Definition 2.3.3:

Let G is said to be bigraph where G= $G_1 \cup G_2$

Definition 2.3.4

Let F=$F_1 \cup F_2$ be a Neutrosophic bimatrix. Then the bitranspose of the bimatrix F is defined as $F^t = (F_1 \cup F_2)^t = F_1^t \cup F_2^t$

Definition 2.3.5

A Neutrosophic Associative Fuzzy Cognitive Map (NAFCM) is a directed bigraph with concepts like policies, events as a nodes and causalities as edges. It represents causal relationship between concepts. In a NAFCM the pair of associated nodes as binodes. If the order of the bimatrix associated with the NAFCM is a p× m matrix and a n × n square matrix then the binodes are bivectors of length (m,n) or (p,n).

Definition 2.3.6

Consider the binodes {$C_1,C_2\ldots,C_n$} and {$E_1,E_2\ldots,E_n$} of the NAM and { $A_1,A_2\ldots,A_n$} of the FCM of the NAFCM of the bimodal. The bimatrix F=$F_1 \cup F_2$ is defined as $e_{ij}^1 \cup e_{mn}^2$ where e_{ij}^1 is the directed edge of C_iE_j and e_{mn}^2 is the directed edge of A_mA_n. F=$F_1 \cup F_2$ is called as adjacency matrix.

Definition 2.3.7

Simple NAFCM consist edge biweights {1,0,-1, I}. Let {{$C_1,C_2\ldots,C_n$}, {$E_1,E_2\ldots,E_n$}} $\cup$ { $A_1,A_2\ldots,A_n$} be the binodes of an NAFCM. A=$A_1 \cup A_2$ = {$C_1,C_2\ldots,C_n$} or{$E_1,E_2\ldots,E_n$} $\cup$ { $A_1,A_2\ldots,A_n$} where C_i, E_j, $A_m \in \{0,1,I\}$. $1 \le i \le l, 1 \le j \le n, 1 \le m \le k$ A is called instantaneous state bivectors and it denotes ON-OFF-INDETERMINATE position of the node at an instant.

$C_i = 0, E_j = 0, A_m = 0$ if C_i, E_j, A_m are in off position.

$C_i = 1, E_j = 1, A_m = 1$ if C_i, E_j, A_m are in on position

$C_i = I, E_j = I, A_m = I$ if C_i, E_j, A_m are in Indeterminate position.

Definition 2.3.8

Let {{C_1,C_2…,C_y}, {E_1,E_2…,E_q}} $\cup$ { A_1,A_2…,A_n} be the binodes of an NAFCM. Let C_o $E_p \cup A_c$ A_s be the biedges where $1 \le o \le y, 1 \le p \le q$, $1 \le c, 1 \le s$ ($s \ne c$). Then the biedges form bidirected cycle. A NAFCM is said to be bicylic if it possesses a directed bicycle.

Definition 2.3.9

If the NAFCM settles down with a bistate, bivectors repeats in the form of $C_1 \to C_2 \to .....C_i \to C_1$ or $E_1 \to E_2 \to .....E_J \to E_1 \cup A_1 \to A_2 \to .....A_m \to A_1$ then this equilibrium is called as limit bicycle.

Definition 2.3.10

The biedges $e_{ij} = \left(e_{mn}^1\right) \cup \left(e_{ij}^2\right)$ takes the values in fuzzy casual binterval [-1,1] $\cup$ [-1,1] $\cup$ I.

$e_{ij} = 0$ indicates no causality occurs between the binodes

$e_{ij} > 0$ indicates that $\left(e_{mn}^1\right) > 0$ and $\left(e_{ij}^2\right) > 0$ implies that increase in the binodes $C_i \cup X_k$(or Y_s) implies increase in the binodes $C_i \cup X_s$ (or Y_k)

$e_{ij} < 0$ indicates that $\left(e_{mn}^1\right) < 0$ and $\left(e_{ij}^2\right) < 0$ implies that decrease in the binodes $C_i \cup X_k$(or Y_s) implies decrease in the binodes $C_i \cup X_s$(or Y_k)

$e_{ij} =$ I indicates Indeterminate position occurs between the binodes.

We can also have possibilities other than $e_{ij} = 0$, $e_{ij} > 0$, $e_{ij} < 0$

$e_{ij} = \left(e_{mn}^1\right) \cup \left(e_{ij}^2\right)$ if $\left(e_{mn}^1\right) > 0$ and $\left(e_{ij}^2\right) = 0$. Indicates that no relation in $\left(e_{ij}^2\right)$ and increase in $\left(e_{mn}^1\right)$

$e_{ij} = \left(e_{mn}^1\right) \cup \left(e_{ij}^2\right)$ if $\left(e_{mn}^1\right) < 0$ and $\left(e_{ij}^2\right) = 0$. Indicates that no relation in $\left(e_{ij}^2\right)$ and decrease in $\left(e_{mn}^1\right)$

$e_{ij} = \left(e_{mn}^1\right) \cup \left(e_{ij}^2\right)$ we can have $\left(e_{mn}^1\right) > 0$ and $\left(e_{ij}^2\right) \le 0$

$e_{ij} = \left(e_{mn}^1\right) \cup \left(e_{ij}^2\right)$ we can have $\left(e_{mn}^1\right) = 0$ and $\left(e_{ij}^2\right) < 0$

$e_{ij} = \left(e_{mn}^1\right) \cup \left(e_{ij}^2\right)$ we can have $\left(e_{mn}^1\right) = 0$ and $\left(e_{ij}^2\right) > 0$

$e_{ij} = \left(e_{mn}^1\right) \cup \left(e_{ij}^2\right)$ we can have $\left(e_{mn}^1\right) = 0$ and $\left(e_{ij}^2\right) > 0$

In NAFCM there are nine possibilities where as in NAM or FCM there are only four possibilities. Thus extra possibilities make the resultant more sensible

3. DESCRIPTION OF THE PROBLEM:

Child marriage is defined as marriage which happens below the age of 18 years(UNIFPA 2006). Child marriage has been existed for centuries which has deep roots based on the gender inequality, tradition and poverty. More population, health care cost, loss of opportunities of human development are the burdens faced by society due to teenage pregnancies.[8]. Evidence show that early marriage makes girls more vulnerable to violence, abuse and exploitation. Young girls who marry before the age of 18 have a greater risk of becoming the victims of intimate partner violence that those who marry later [9]. Child marriage has been arranged in two ways with in a context of force and coercion either by parents or the person who has more authority in the family. The factor which is responsible for child marriage such as Avoiding expenditure on female education, poverty, social insecurity, single parent burden, minimizing marriage expenditure and avoiding share in ancestral property[10]. According to census 2011 report 5480 girls are married under the age of 15 years in Chennai whereas Coimbatore with 3025 married girls and 2000 girls are married under the age of 15 in Madurai, Tirunelvi, Tirupur and Salem[11]. It is estimated that 15 million girls are married each year before they turn 18 around the world and UNICEF estimates 720 million women alive today were married as children.[12].

4. ADAPTATION OF NAFCM TO THE PROBLEM:

Let us consider M be the connection bimatrix of NAFCM bimodal which consists of NAM and FCM components. Consider A_1 be the initial input bivectors which is kept in ON state and all other components are in OFF state. Pass the state vector A_1 through the connection bimatrix M and by using Max- Min principle the resultant vector are converted into signal function. In thresholding process the two highest values in NAM are taken as 1 and all other values as 0. Similarly in FCM the values which are greater than or equal to one are taken as 1 and other values as 0 . Then the resulting vector which is obtained in NAM is multiplied with M^T and thresholding yields new vector A_2 whereas the resulting vector is kept as it as in FCM. The process has been repeated for all the vectors separately. In NAM, the domain space consists of attributes related to problems of girls in child marriages and denoted as $P_1,P_2,P_3,P_4,P_5,P_6,P_7,P_8$. The range spaces denotes as E_1, E_2, E_3, E_4, E_5,E_6,E_7 consists of effects in child marriage.

FCM consists of main attributes and denoted as C_1, C_2, C_3, C_4, C_5, C_6, C_7, C_8. The datas are collected from 95 women in Chennai by using unsupervised method.

The attributes related to the problem of girls in child marriages

P_1 -Sexual harassment

P_2- Dowry problem

P_3- Economic Independence

P_4- Insecurity

P_5- Lack of mobility

P_6- High age difference

P_7- Torture by in-laws

P_8- Husband addict to alcoholism\irresponsible husband

Effects of the child marriage

E_1- Psychological problem

E_2 - Discrimination in food

E_3 - Domestic violence

E_4 - Risk of mortality rates

E_5 – Run away from home

E_6 - Divorce

E_7 - Inability to manage family responsibilities

The main attributes related to the problems of girls in child marriage

A_1 -Domestic violence

A_2- Economic independence

A_3 -Psychological problems

A_4 -Burden in Domestic works

A_5 - High age difference between bride and bride groom

A_6 - Health complications

A_7 - Denial of education

A_8 - Inability to manage family responsibilities

The expert's opinion is given in the form of connection Bimatrix M

$$\begin{array}{c} \\ P_1 \\ P_2 \\ P_3 \\ P_4 \\ P_5 \\ P_6 \\ P_7 \\ P_8 \end{array}\begin{array}{c} \begin{array}{ccccccc} E_1 & E_2 & E_3 & E_4 & E_5 & E_6 & E_7 \end{array} \\ \left[\begin{array}{ccccccc} 0.7 & 0.2 & 0.8 & 0.6 & 0.7 & 0.8 & 0.3 \\ 0.7 & 0.5 & 0.6 & 0.4 & 0.5 & 0.2 & 0 \\ 0.8 & 0 & 0.7 & 0 & 0 & 0 & 0 \\ 0.8 & 0.2 & 0.7 & 0.3 & 0.6 & 06 & 0.4 \\ 0.6 & 0.2 & 0.7 & 0 & 0.3 & 0.4 & 0.2 \\ 0.8 & 0 & 0.4 & 0 & 0.4 & I & 0.7 \\ 0.5 & 0.3 & 0.4 & 0 & 0 & 0.2 & 0.6 \\ 0.8 & 0 & 0.7 & 0.3 & 0.4 & 0.2 & 0.6 \end{array}\right] \end{array} \cup \begin{array}{c} \\ C_1 \\ C_2 \\ C_3 \\ C_4 \\ C_5 \\ C_6 \\ C_7 \\ C_8 \end{array}\left[\begin{array}{cccccccc} 0 & 1 & 1 & 1 & 1 & 0 & 1 & 0 \\ 1 & 0 & 1 & 1 & 0 & 0 & 0 & 0 \\ 1 & 1 & 0 & 1 & 1 & 0 & 1 & 0 \\ 1 & 1 & 1 & 0 & 0 & 0 & 1 & 0 \\ 1 & 1 & 1 & 0 & 0 & 1 & 0 & 1 \\ 0 & 0 & 1 & 0 & 0 & 0 & 0 & 1 \\ 1 & 1 & 1 & 1 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 1 & 1 & 0 & 0 & 0 \end{array}\right]$$

Let A_1 = (10000000) $\cup$ (10000000)

A_1.M = (10000000). $M_1 \cup$ (10000000).M_2

= (0.7 0.2 0.8 0.6 0.7 0.8 0.3) $\cup$ (0 1 1 1 1 0 1 0)

↪ (1 0 1 0 11 0) $\cup$ (1 1 1 1 1 0 1 0)

= (1 0 1 0 11 0). $M_1^T \cup$ (1 1 1 1 1 0 1 0). M_2

= (0.8 0.7 0.8 0.8 0.7 1 0.5 0.8) $\cup$ (5 4 5 4 2 1 3 1)

= (1 0 1 1 0 1 0 1) $\cup$ (1 1 1 1 1 1 1 1) = A_2

A_2.M = (1 0 1 1 0 1 0 1). $M_1 \cup$ (1 1 1 1 1 1 1 1) . M_2

= (0.8 0.2 0.8 0.6 0.7 1 0.6) $\cup$ (5 4 6 5 3 1 3 2)

↪ (1 0 1 0 0 1 0) $\cup$ (1 1 1 1 1 1 1 1)

= (1 0 1 0 0 1 0). $M_1^T \cup$ (1 1 1 1 1 1 1 1). M_2

= (0.8 0.7 0.8 0.8 0.7 1 0.5 0.8) $\cup$ (5 4 6 5 3 1 3 2)

= (1 0 1 1 0 1 0 1) $\cup$ (1 1 1 1 1 1 1 1) = A_3

A_3.E= (1 0 1 1 0 1 0 1) . $M_1 \cup$ (1 1 1 1 1 1 1 1).M_2

= (0.8 0.2 0.8 0.6 0.7 1 0.6) $\cup$ (5 4 6 5 3 1 3 2)

↪ (1 0 1 0 0 1 0) $\cup$ (1 1 1 1 1 1 1 1)

= (1 0 1 0 0 1 0). $M_1^T \cup$ (1 1 1 1 1 1 1 1). M_2

= (0.8 0.7 0.8 0.8 0.7 1 0.5 0.8) $\cup$ (5 4 6 5 3 1 3 2)

= (1 0 1 1 0 1 0 1) $\cup$ (1 1 1 1 1 1 1 1) = A_4

Hence the limit points is (1 0 1 1 0 1 0 1), (1 0 1 0 0 1 0) $\cup$ (1 1 1 1 1 1 1 1)

The set of all limit points with respect to the different input vectors

Input Vectors	Limit Points
(10000000)	(1 0 1 1 0 1 0 1), (1 0 1 0 0 1 0) ∪(1 1 1 1 1 1 1 1)
(01000000)	(1 0 1 1 0 1 0 1), (1 0 1 0 0 1 0) ∪(1 1 1 1 1 1 1 1)
(00100000)	(1 0 1 1 0 1 0 1), (1 0 1 0 0 1 0) ∪(1 1 1 1 1 1 1 1)
(00010000)	(1 0 1 1 0 1 0 1), (1 0 1 0 0 1 0) ∪(1 1 1 1 1 1 1 1)
(00001000)	(1 0 1 1 0 1 0 1), (1 0 1 0 0 1 0) ∪(1 1 1 1 1 1 1 1)
(00000100)	(1 0 1 1 0 1 0 1), (1 0 1 0 0 1 0) ∪(1 1 1 1 1 1 1 1)
(00000010)	(1 0 1 1 0 1 0 1), (1 0 1 0 0 1 0) ∪(1 1 1 1 1 1 1 1)
(00000001)	(1 0 1 1 0 1 0 1), (1 0 1 0 0 1 0) ∪(1 1 1 1 1 1 1 1)

5. CONCLUSION:

By using the Neutrosophic Associative Fuzzy Cognitive Map the problems of girls faced by child marriage are analysed and it highlights that the problems such as P_1 (Sexual harassment), P_3 (Economic Independence),P_4 (Insecurity), P_6 (High age difference), P_8 (Husband addict to alcoholism\irresponsible husband), the effects are E_1 (Psychological problem), E_3 (Domestic violence), E_7 (Inability to manage family responsibilities) and C_1 (Domestic Violence),C_2 (Economic Independence),C_3(Psychological problems),C_4(Burdens in Domestic Works), C_5(High age difference),C_6(Health complications), C_7(Denial of education),C_8((Inability to manage family responsibilities).

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