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A STUDY ON NEUTROSOPHIC COGNITIVE MAPS (NCM) AND ITS APPLICATIONS

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ABSTRACT

In the society there are several poor people are living. One of the sympathetic poor people is gypsies. They are moving from one place to another place towards survive of life because of not having any permanent place to live. In this paper we have interviewed 300 gypsies in Tamilnadu using a linguistic questionnaire. As the problems faced by them to improve their life at large involve so much of feeling, uncertainties and unpredictability's. I felt that it deem fit to use fuzzy theory in general and fuzzy Neutrosophic Cognitive maps inparticular.

Key Words: *FCM, NFCM, Gypsies, Cognitive Maps.*

1. INTRODUCTION TO FUZZY COGNITIVE MAPS

FCMs are the best suited tool in the study and analysis of the unsupervised data. For they are the only structures which can give the hidden pattern of the dynamical system. Let $C_1, ..., C_n$ be n attributes or nodes. Suppose there is some causal flow of relation between the concepts C_i and C_j where $1 \le i, j \le n$, this relation of how much the occurence of C_i influence variations or chagnes in C_j can be described by signed directed graphs with feed back. Fuzzy Cognitive Maps are fuzzy signed directed graphs with feed back. The directed edge e_{ij} from causal concept C_i to concept C_j measures how much C_i causes C_j. The edges e_{ij} take values in the real 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 that is C_j increases as C_i decreases or C_j decrease as C_i increases.

For more about FCM and its properties please refer [2].

2. INTRODUCTION TO NEUROSOPHIC LOGIC

Here we recall the notion of neutrosophic logic created by Florentin smarandache, which is an extension / combination of the fuzzy logic in which indeterminacy is included. It has become very essential that the notion of neutrosophic logic play a vital role in several of the real world problems like law, medicine, industry, finance, IT, stocks and share etc. Fuzzy theory only measures the grade of membership or the non-existence of a membership in the revolutionary way but fuzzy theory has failed to attribute the concept when the relations between notions or nodes or concepts in problems are indeterminate. In fact one can say the inclusion of the concept of indeterminate situation with fuzzy concepts will form the neutrosophic logic.

Definition 2.1: In the neutrosophic logic every logical variable x is described by an ordered triple x = (T, I, F) where T is the degree of truth, F is the degree of false and I the level of indeterminacy.

(A) To maintain consistency with the classical and fuzzy logics and with probability there is the special case where $T + I + F = 1$.
(B) But to refer to intuitionistic logic, which means incomplete information on a variable proposition or event one has $T + I + F < 1$.
(C) Analogically referring to Paraconsistent logic, which means contradictory sources of information about a same logical variable, proposition or event one has $T + I + F > 1$.

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Thus the advantage of using Neutrosophic logic is that this logic distinguishes between relative truth that is a truth is one or a few worlds only noted by 1 and absolute truth denoted by 1+. Likewise neutrosophic logic distinguishes between relative falsehood, noted by 0 and absolute falsehood noted by – 0.It has several applications.

Now we proceed on to define the concepts about NCMs.

Definition 2. 2: A Neutrosophic Cognitive Map (NCM) is a neutrosophic directedgraph with concepts like policies, events etc. as nodes and causalities or indeterminates as edges. It represents the causal relationship between concepts.

Let $C_1, C_2, \dots, C_n$ denote n nodes, further we assume each node is a neutrosophic vector from neutrosophic vector space V. So a node C_i will be represented by $(x_1, \dots, x_n)$ where x_k's are zero or one or I (I is the indeterminate introduced in Sections 2.2 and 2.3 of the chapter 2) and $x_k = 1$ means that the node C_k is in the on state and $x_k = 0$ means the node is in the off state and $x_k = I$ means the node's state is an indeterminate at that time or in that situation.

Let C_i and C_j denote the two nodes of the NCM. The directed edge from C_i to C_j denotes the causality of C_i on C_j called connections. Every edge in the NCM is weighted with a number in the set {-1, 0, 1, I}. Let e_{ij} be the weight of the directed edge C_iC_j, $e_{ij} \in \{-1, 0, 1, I\}$. $e_{ij} = 0$ if C_i does not have any effect on C_j, $e_{ij} = 1$ if increase (or decrease) in Ci causes increase (or decreases) in C_j, $e_{ij} = -1$ if increase (or decrease) in C_i causes decrease (or increase) in C_j . $e_{ij} = I$ if the relation or effect of C_i on C_j is an indeterminate.

Definition 2.3: NCMs with edge weight from {-1, 0, 1, I} are called simple NCMs.

Definition 2.4: Let $C_1, C_2, \dots, C_n$ be nodes of a NCM. Let the neutrosophic matrix N(E) be defined as $N(E) = (e_{ij})$ where e_{ij} is the weight of the directed edge $C_i C_j$, where $e_{ij} \in \{0, 1, -1, I\}$. N(E) is called the neutrosophic adjacency matrix of the NCM.

Definition 2.5: Let $C_1, C_2, \dots, C_n$ be the nodes of the NCM. Let $A = (a_1, a_2, \dots, a_n)$ where $a_i \in \{0, 1, I\}$. A is called the instantaneous state neutrosophic vector and it denotes the on – off – indeterminate state position of the node at an instant $a_i = 0$ if ai is off (no effect)
$a_i = 1$ if ai is on (has effect)
$a_i = I$ if ai is indeterminate(effect cannot be determined) for i = 1, 2,…, n.

Definition 2.6: Let $C_1, C_{2, \dots}, C_n$ be the nodes of an FCM. Let $\overrightarrow{C_1C_2}$, $\overrightarrow{C_2C_3}$, $\overrightarrow{C_3C_4}$, ... , $\overrightarrow{C_iC_j}$ be the edges of the NCM ($i \neq j$). Then the edges form a directed cycle. An NCM is said to be cyclic if it possesses a directed cycle. An NCM is said to be acyclic if it does not possess any directed cycle.

Definition 2.7: An NCM with cycles is said to have a feedback. When there is a feedback in the NCM i.e. when the causal relations flow through a cycle in a revolutionary manner the NCM is called a dynamical system.

Definition 2.8 Let $\overrightarrow{C_1C_2}$, $\overrightarrow{C_2C_3}$, ….., $\overrightarrow{C_{n-1}C_n}$ be 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 2.9: If the equilibrium state of a dynamical system is a unique state vector, then it is called a fixed point. Consider the NCM with $C_1, C_2, \dots, C_n$ as nodes.

For example let us start the dynamical system by switching on C_1. Let us assume that the NCM settles down with C_1 and C_n on, i.e. the state vector remain as (1, 0,…, 1) this neutrosophic state vector (1,0,…, 0, 1) is called the fixed point.

Definition 2.10: If the NCM settles with a neutrosophic state vector repeating in the form $A_1 \rightarrow A_2 \rightarrow \dots \rightarrow A_i \rightarrow A_1$, then this equilibrium is called a limit cycle of the NCM.

3. ADOPTATION OF NEUTROSOPHIC COGNITIVE MAPS

Neutrosophic Cognitive Maps method we taken the following eight concepts as { $A_1, A_2, \dots, A_8$}.

The following concepts are taken as the main nodes for our problem.
A_1 = Living Condition/ Health condition is very poor
A_2 = Reservation / social
A_3 = Inheritor property
A_4 = No education facilities
A_5 = Unemployment
A_6 = Child labor is at peak

A_7 = Govt. Indifference about the problem faced by gypsies
A_8 = Not owners of any property (or) land.

The related connection Matrix A is:

	A_1	A_2	A_3	A_4	A_5	A_6	A_7	A_8
A_1	0	**I**	1	0	0	1	1	1
A_2	0	0	**I**	0	0	0	0	1
A_3	1	0	0	0	0	1	**I**	1
A_4	**I**	1	0	0	1	1	0	0
A_5	1	1	0	1	0	1	0	0
A_6	0	0	0	0	1	0	0	0
A_7	1	**I**	0	0	0	0	0	0
A_8	1	0	0	0	**I**	0	0	0

Obtain the connection matrix, E, from the directed graph (NCM). Here the number of rows in the given matrix = number of steps to be performed.
i) Consider the state vector A_4 which is in ON position. (i.e.,)

Let the initial input vector be X=(0 0 0 1 0 0 0 0), where No education facilities is taken at the ON state and all other nodes are in the OFF state.

The effect of N on the dynamical system is given by
X = (0 0 0 1 0 0 0 0)

XA = (I 1 0 0 1 1 0 0)
↪(**I** 1 0 11 1 0 0) = X_1

X_1A = (1 1 **I** 11 1 I 1)
↪ (1 1 **I** 11 1 **I** 1) = X_2

X_2A = (1 1 1 11 1 1 1)
↪(1 1 1 11 1 1 1) = X_3

X_3A = (1 1 1 11 1 1 1)
↪(1 1 1 11 1 1 1) = X_4

Therefore X_3= X_4

Thus, this state vector N = (0 0 0 1 0 0 0 0) gives a fixed point (1 1 11 1 1 1 1)

CONCLUSION

- From our study the whole family works for over ten hours a day
- The Child labour is at peak
- When the Node A4 is ON state which gives all other nodes are ON state.
- A School must be built separately.

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