Chapter 4

THE EMPOWERMENT OF WOMEN IN PROMOTING HAPPINESS IN HER OWN ENVIRONMENT USING INDUCED FUZZY COGNITIVE MAPS

4.1 Introduction

Happiness is the motive of all human aspirations. Indian philosophical traditions have viewed attainment of happiness as the ultimate goal of human life. Countries like Bhutan have chosen the idea of happiness as a guiding policy for all their development programmes. The fundamental principle that underlies this decision is that development should be understood as a process that seeks to maximize happiness rather than economic growth. This view can be extended to define the empowerment of women through promotion of happiness.

Happiness can be defined as an ease of living and a feeling of security, autonomy and continuity, a life that is full of relative freedom of choice to do what we like. We are happy when we are secure. The essential ingredients that underpin our sense of well-being and complement our happiness are the hope for the future and our faith in the family and abiding closeness that knits our social structure together. This experience of well-being is linked to mental as well as physical fulfillment of needs.
4.1.1 Concept of empowerment of women

Women's empowerment is a process in which women gain greater share of control over resources - material, human and intellectual like knowledge, information, ideas and financial resources like money - and access to money and control over decision-making in the home, community, society and nation, and to gain `power'. According to the Country Report of Government of India, "Empowerment means moving from a position of enforced powerlessness to one of power" (Government of India, 2008). There are various fields of empowerment related to women. In particular here we analyze the problem of social empowerment of women in the areas of education, health, nutrition, drinking water and sanitation, environment, science and technology. The empowerment leads to equality, sustainability, and happiness of women in their environment.

4.1.2 Empowerment and Happiness

As stated earlier, happiness comes from the feeling of security, autonomy, freedom to choose, hope for the future, faith in the family and mental and physical wellbeing. One can easily observe that these are exactly the needs of someone who needs to be empowered. There is no empowerment if women do not feel secure and do not have autonomy, freedom of choice, hope for the future, faith in the family (and in the social system). If the physical and mental wellbeing is not catered to there is no empowerment. Our analysis in the previous chapters showed that women in India lack all these. The feeling of security is very less among women as violence against women has only increased in the past.
Power to make decision in a family, society, or country usually lies with men. Women are not even consulted when a decision is made in a family. Since the representation of women in government bodies is minimal, they do not partake in decision making process. They do not enjoy freedom of choice. Looking at the statistics available we can also easily infer that their physical and mental wellbeing is not taken care of by the government and the society. The literacy rate shows that women are left behind men and the health indices show that the physical wellbeing of women is lower than that of men. Therefore the attainment of happiness and of empowerment goes hand in hand for women in India. Therefore in this chapter we analyze the empowerment of women through promotion of happiness.

4.2 Induced Fuzzy Cognitive Maps (IFCM)

Axelrod (1976) introduced cognitive maps for representing social scientific knowledge. Axelrod’s cognitive maps are signed directed graphs. Then the notion of fuzzy cognitive maps was introduced and developed by Kosko (1986). Fuzzy cognitive maps are fuzzy–graph structures for representing causal reasoning. Their fuzziness allows hazy degrees of causality between hazy causal objects. Their graph structure allows systematic causal propagation, in particular forward and backward chaining, and it allows knowledge bases to be grown by connecting different FCMs (Kosko, 1986). Cole and Persichitte (2000) proposed the use of FCMs for creating metaknowledge and exploring hidden implications of a learner’s understanding. Zhang et al. (2003) proposed a new decomposition theory for Fuzzy Cognitive maps called Quotient FCMs. This newly
The proposed theory is constructed in two steps: first by partitioning the set of vertices of an FCM into blocks according to an equivalence relation, and by regarding these blocks as vertices constructing a quotient FCM. Second, each of these newly built blocks induces a natural sectional FCM of the original FCM, which inherits the topological structure as well as the inference from the original FCM. In this way, the original FCM is decomposed into a quotient FCM and some sectional FCMs. Therefore now the analysis of the original FCM is reduced to the analysis of the quotient and sectional FCMs, which are often much smaller in size and complexity. This is very useful when one has to analyze large-scale FCMs.

Nasserzadeh et al. (2008) use Fuzzy Cognitive Maps as a decision making tool in banking industry as the customer satisfaction in banking industry involves complexity and vagueness due to several factors involved. Perusich (2010) used Fuzzy Cognitive maps for system diagnosis. Shayji et al. (2011) used Fuzzy Cognitive Map theory for political decision making. In this paper, the authors propose an FCM scheme to demonstrate the causal inter-relationship between certain political factors that affect political decision making in order to provide insight into better understanding about the interdependencies of these factors. They present fuzzy causal algebra for governing causal propagation on FCMs. Singh et al. (2011) used FCM to analyse the evaluation of cricket player’s batting performance and the impact of his performance on his ICC ranking. Zarrazvand and Shojafar (2012) also used FCM to analyzing and implementation of Information Technology Infrastructure Library (ITIL) processes.
Devadoss and Jiny (2013) made a study on finding the key motives of happiness using FCM. From the study researcher identified that happiness is a solution for lot of social problems like violence, breaking of rules, terrorism and so on. Devadoss and Hameed (2013) used CFCMs to study the attitudes of the road user in enhancing gross national happiness. Jose (2013) examined a group of student teachers improve their perception of a complex socio-scientific issue through activities based on FCMs. Devadoss and Ismail (2013) made a study on sustainable development using this model.

4.2.1 Basic Definitions of FCM

**Definition 4.2.1** An FCM is a directed graph with concepts like policies, events etc. as nodes and causalities as edges. It represents causal relationship between concepts.

**Definition 4.2.2** When the nodes of the FCM are fuzzy sets then they are called as fuzzy nodes.

**Definition 4.2.3** FCMs with edge weights or causalities from the set \{-1, 0, 1\} are called simple FCMs.

**Definition 4.2.4** 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 \(C_1, \ldots, C_n\) increase (or decrease) in another, then we give the value 1. If there exists no relation between two concepts, the value 0 is given. If increase (or decrease) in one concept decreases (or increases) another, then we give the value \(-1\). Thus FCMs are described in this way. Consider the nodes or concepts of the FCM. Suppose the directed graph is drawn using edge weight \(e_{ij}\) \{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 4.2.5** Let \(C_1, C_2, \ldots, C_n\) be the nodes of an FCM. Let \(A = (a_1, a_2, \ldots, a_n)\), where \(a_i (i \neq j) \{0,1\}\). \(A\) is called the instantaneous state vector and it denotes the on-off position of the node at an instant.

\[
\begin{align*}
a_i &= 0 & \text{if } a_i \text{ is off} \\
a_i &= 1 & \text{if } a_i \text{ is on, where } i = 1, 2, \ldots, n
\end{align*}
\]

**Definition 4.2.6** Let \(C_1, C_2, \ldots, C_n\) be the nodes of an FCM. Let \(\overline{C_1C_2}, \overline{C_2C_3}, \overline{C_3C_4}, \ldots, \overline{C_iC_j}\) 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 cyclic. An FCM is said to be acyclic if it does not possess any directed cycle.
**Definition 4.2.7** An FCM with cycles is said to have a feedback.

**Definition 4.2.8** 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 4.2.9** Let $C_1, C_2, C_3, C_4, \ldots, C_{n-1}, C_n$ 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 4.2.10** If the equilibrium state of a dynamical system is a unique state vector, then it is called a fixed point. Consider an 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 i.e., the state vector remain as $(1, 0, 0, \ldots, 1)$. This state vector $(1, 0, \ldots, 0, 1)$ is called the fixed point.

**Definition 4.2.11** If the FCM settles down with a state vector repeating in the form $A_1 \rightarrow A_2 \rightarrow \ldots \rightarrow A_i \rightarrow A_1$ then this equilibrium is called a limit cycle of the FCM.

4.2.2 Method of determining the Hidden Pattern

Suppose that there are $n$ attributes, say $x_1, x_2, \ldots, x_n$, where $n$ is finite, associated with the factors of domestic violence and let $y_1, y_2, \ldots, y_p$ be the attributes associated with the loss of women’s rights. Using the expert opinion the connection matrix $M$ of order $n \times p$ is obtained. Let $C_1$ be the initial input vector. A particular component, say $C_1$, is kept in ON state and all other components in OFF state and we pass the state vector $C_1$ through
the connection matrix $M$. To convert the resultant vector as a signal function, choose the first two highest values to ON state and other values to OFF state with 1 and 0 respectively. Denote this process by the symbol $\rightarrow$. The resulting vector is multiplied with $M^T$ and thresholding obtain a new vector $C_1$. This vector is related with the connection matrix and that vector which gives the highest number of attributes to ON state is chosen as $C_2$. That is, for each positive entry we get a set of resultant vectors; among these vectors the one which contains maximum number of 1s is chosen as $C_2$. If there are two or more vectors in ON state with equal number of 1s, choose the first occurring one as $C_2$. Repeat the same procedure till a fixed point or a limit cycle is obtained. This process is done to give due importance to each vector separately as one vector induces another or many more vectors into ON state. Get the hidden pattern by the limit cycle or by getting a fixed point.

Next we choose the vector with its second component in ON state and repeat the same to get another cycle. The same process is repeated for all the vectors separately. We observe the hidden pattern of some vectors found in all or many cases. Inference from this hidden pattern highlights the causes.

4.3 Adaptation of FCM to the problem

We use the following seven nodes of FCM which are labeled as follows

$C_1 – Education$

Equal access to education for women and girls needs to be ensured. Special measures should be taken to eliminate discrimination, universalize education, eradicate illiteracy,
create a gender-sensitive educational system, increase enrolment and retention rates of girls and improve the quality of education.

\[ C_2 - \textit{Health} \]

A holistic approach to women’s health which includes both nutrition and health services should be adopted and special attention should be given to the needs of women and the girl at all stages of the life cycle. The reduction of infant mortality and maternal mortality, which are sensitive indicators of human development, is a priority concern. Women’s traditional knowledge about health care and nutrition needs to be recognized through proper documentation and its use shall be encouraged.

\[ C_3 - \textit{Nutrition} \]

In view of the high risk of malnutrition and disease that women face at all the three critical stages viz., infancy and childhood, adolescent and reproductive phase, focused attention should be paid to meeting the nutritional needs of women at all stages of the life cycle.

\[ C_4 - \textit{Environment} \]

The vast majority of rural women still depends on the locally available non-commercial sources of energy such as animal dung, crop waste and fuel wood. In order to ensure the efficient use of these energy resources in an environmental friendly manner, we should aim at promoting the programmes of non-conventional energy resources. Women will be involved in spreading the use of solar energy, biogas, smokeless chulahs and other rural
application so as to have a visible impact of these measures in influencing eco system and in changing the life styles of rural women.

$C_5$ – *The role of mass media*

The media should be encouraged to develop codes of conduct, professional guidelines and other self-regulatory mechanisms to remove gender stereotypes and promote balanced portrayals of women and men.

$C_6$ – *Violence against women*

All forms of violence against women, physical and mental, whether at domestic or societal levels, including those arising from customs, traditions or accepted practices shall be dealt with effectively with a view to eliminate its incidence. Institutions and mechanisms/schemes for assistance should be created and strengthened for prevention of such violence, including sexual harassment at work place and customs like dowry; for the rehabilitation of the victims of violence and for taking effective action against the perpetrators of such violence. A special emphasis should also be laid on programmes and measures to deal with trafficking in women and girls.

$C_7$ – *Rights of the girl child*

All forms of discrimination against the girl child and violation of her rights shall be eliminated by undertaking strong measures both preventive and punitive within and outside the family. These should relate specifically to strict enforcement of laws against prenatal sex selection and the practices of female foeticide, female infanticide, child marriage, child abuse and child prostitution etc. Removal of discrimination in the
treatment of the girl child within the family and outside and projection of a positive image of the girl child should be actively fostered. In implementing programmes for eliminating child labor, there will be a special focus on girl children.

The expert’s opinion is given as directed graph as follows

![Directed Graph](image)

**Fig 4.1 Expert’s opinion in the form of FCM**

The related fuzzy relational matrix obtained from the directed graph is given below:
Let $E$ denotes the connection matrix of the directed graph. Now we proceed to find the stability of the dynamical system or to be more precise the hidden pattern of the system which may be a fixed point or a limit cycle.

We consider the state vector $C_1 = (1 \ 0 \ 0 \ 0 \ 0 \ 0 \ 0)$. That is, the attribute \textit{Education} is kept in ON state and all other nodes are in OFF state.

Passing $C_1$ in to the connection matrix $E$

\[ C_1E = (1 \ 1 \ 1 \ 0 \ 0 \ -1 \ 1) \]

After thresholding we get

\[ \Rightarrow(1 \ 1 \ 1 \ 0 \ 0 \ 0 \ 1) = C_2 \]

Now passing $C_2$ in to the connection matrix $E$

\[ C_2E = (2 \ 3 \ 3 \ 0 \ 0 \ -4 \ 1) \]

After thresholding we get

\[ \Rightarrow(1 \ 1 \ 1 \ 0 \ 0 \ 0 \ 1) = C_2 \]
Thus we conclude that hidden pattern is a fixed point which shows education, health and nutrition leads to increased rights of the girl child. This will create happiness in women’s life.

We consider the state vector $C_1 = (0 \ 1 \ 0 \ 0 \ 0 \ 0 \ 0)$

That is, the attribute Health is in ON state and all other nodes are in OFF state. Passing $C_1$ in to the connection matrix $E$

$C_1E = (1 \ 0 \ 1 \ 0 \ 0 \ -1 \ 0) \leftrightarrow (1 \ 0 \ 1 \ 0 \ 0 \ 0 \ 0) = C_2$

$\leftrightarrow (0 \ 1 \ 1 \ 0 \ 0 \ 0 \ 1) = C_3$

$C_3E = (2 \ 2 \ 2 \ 0 \ 0 \ -3 \ 0) \leftrightarrow (1 \ 1 \ 1 \ 0 \ 0 \ 0 \ 0) = C_4$

$C_4E = (1 \ 2 \ 2 \ 0 \ 0 \ -3 \ 1) \leftrightarrow (1 \ 1 \ 1 \ 0 \ 0 \ 0 \ 1) = C_5$

$C_5E = (2 \ 3 \ 3 \ 0 \ 0 \ -4 \ 1) \leftrightarrow (1 \ 1 \ 1 \ 0 \ 0 \ 0 \ 1) = C_5$

Therefore the fixed point is $(1 \ 1 \ 0 \ 0 \ 0 \ 1)$.

Let us consider the state vector $C_1 = (0 \ 0 \ 1 \ 0 \ 0 \ 0 \ 0)$.

That is, the attribute nutrition is kept in ON state and all other nodes are in OFF state.

Passing $C_1$ in to the connection matrix $E$

$C_1E = (0 \ 1 \ 1 \ 0 \ 0 \ -1 \ 0) \leftrightarrow (0 \ 1 \ 1 \ 0 \ 0 \ 0 \ 0) = C_2$

Now passing $C_2$ in to the connection matrix $E$

$C_2E = (1 \ 1 \ 2 \ 0 \ 0 \ -2 \ 0) \leftrightarrow (1 \ 1 \ 1 \ 0 \ 0 \ 0 \ 0) = C_3$
Again passing $C_3$ in to the connection matrix $E$

$$C_3E = (1 \ 2 \ 3 \ 0 \ 0 \ -3 \ 1) \rightarrow (1 \ 1 \ 1 \ 0 \ 0 \ 0 \ 1) = C_4$$

Similarly,

$$C_4E = (2 \ 3 \ 4 \ 0 \ 0 \ -4 \ 1) \rightarrow (1 \ 1 \ 1 \ 0 \ 0 \ 0 \ 1) = C_4$$

Therefore the fixed point is $(1 \ 1 \ 1 \ 0 \ 0 \ 0 \ 1)$.

Consider the state vector $C_1 = (0 \ 0 \ 0 \ 1 \ 0 \ 0 \ 0)$

That is, the attribute *Environment* is kept in ON state and all other nodes are in OFF state.

Passing $C_1$ in to the connection matrix $E$

we get

$$C_1E = (0 \ 1 \ 0 \ 0 \ 0 \ 0 \ 0) \rightarrow (0 \ 1 \ 0 \ 0 \ 0 \ 0 \ 0) = C_2$$

$$C_2E = (1 \ 0 \ 1 \ 0 \ 0 \ -1 \ 0) \rightarrow (1 \ 0 \ 1 \ 0 \ 0 \ 0 \ 0) = C_3$$

$$C_3E = (0 \ 2 \ 1 \ 0 \ 0 \ -2 \ 1) \rightarrow (0 \ 1 \ 1 \ 0 \ 0 \ 0 \ 1) = C_4$$

$$C_4E = (2 \ 2 \ 2 \ 0 \ 0 \ -3 \ 0) \rightarrow (1 \ 1 \ 1 \ 0 \ 0 \ 0 \ 0) = C_5$$

$$C_5E = (1 \ 2 \ 2 \ 0 \ 0 \ -3 \ 1) \rightarrow (1 \ 1 \ 1 \ 0 \ 0 \ 0 \ 1) = C_6$$

$$C_6E = (2 \ 3 \ 3 \ 0 \ 0 \ -4 \ 1) \rightarrow (1 \ 1 \ 1 \ 0 \ 0 \ 0 \ 1) = C_6$$

Consider the state vector $C_1 = (0 \ 0 \ 0 \ 0 \ 1 \ 0 \ 0)$

That is, the attribute *The role of mass media* is kept in ON state and all other nodes are in OFF state. Passing $C_1$ in to the connection matrix $E$
we get

\[ C_1 = (0 \ 0 \ 0 \ 0 \ 1 \ 0 \ 0) \]
\[ C_1E = (1 \ 1 \ 1 \ 0 \ 0 \ -1 \ 0) \rightarrow (1 \ 1 \ 1 \ 0 \ 0 \ 0 \ 0) = C_2 \]
\[ C_2E = (1 \ 2 \ 2 \ 0 \ 0 \ -3 \ 1) \rightarrow (1 \ 1 \ 1 \ 0 \ 0 \ 0 \ 1) = C_3 \]
\[ C_3E = (2 \ 3 \ 3 \ 0 \ 0 \ -4 \ 1) \rightarrow (1 \ 1 \ 1 \ 0 \ 0 \ 0 \ 1) = C_3 \]

Consider the state vector \( C_1 = (0 \ 0 \ 0 \ 0 \ 0 \ 1 \ 0) \)

That is, the attribute *violence against women* is kept in ON state and all other nodes are in OFF state. Passing \( C_1 \) in to the connection matrix \( E \)

we get

\[ C_1 = (0 \ 0 \ 0 \ 0 \ 1 \ 0) \]
\[ C_1E = (0 \ -1 \ -1 \ 0 \ -1 \ -1) \rightarrow (0 \ 0 \ 0 \ 0 \ 0 \ 0 = C_2 \]
\[ C_2E = (0 \ 0 \ 0 \ 0 \ 0 \ 0 \ 0) \rightarrow (0 \ 0 \ 0 \ 0 \ 0 \ 0 = C_2 \]

Consider the state vector \( C_1 = (0 \ 0 \ 0 \ 0 \ 0 \ 1) \)

That is, the *Rights of the girl child* is kept in ON state and all other nodes are in OFF state. Passing \( C_1 \) in to the connection matrix \( E \)

we get

\[ C_1E = (1 \ 1 \ 1 \ 0 \ 0 \ -1 \ 0) \rightarrow (1 \ 1 \ 1 \ 0 \ 0 \ 0 = C_2 \]
\[ C_2E = (1 \ 2 \ 2 \ 0 \ 0 \ -3 \ 1) \rightarrow (1 \ 1 \ 1 \ 0 \ 0 \ 0 \ 1 = C_3 \]
\[ C_3E = (2 \ 3 \ 3 \ 0 \ 0 \ -4 \ 1) \rightarrow (1 \ 1 \ 1 \ 0 \ 0 \ 0 \ 1 = C_3 \]

Therefore the fixed point is \( (1 \ 1 \ 0 \ 0 \ 0 \ 1) \).
The following table gives different limit points for various input vectors.

### Table: 4.1

<table>
<thead>
<tr>
<th>Input vector</th>
<th>Limit point</th>
</tr>
</thead>
<tbody>
<tr>
<td>(1 0 0 0 0 0 0)</td>
<td>(1 1 1 0 0 0 1)</td>
</tr>
<tr>
<td>(0 1 0 0 0 0 0)</td>
<td>(1 1 1 0 0 0 1)</td>
</tr>
<tr>
<td>(0 0 1 0 0 0 0)</td>
<td>(1 1 1 0 0 0 1)</td>
</tr>
<tr>
<td>(0 0 0 1 0 0 0)</td>
<td>(1 1 1 0 0 0 1)</td>
</tr>
<tr>
<td>(0 0 0 0 1 0 0)</td>
<td>(1 1 1 0 0 0 1)</td>
</tr>
<tr>
<td>(0 0 0 0 0 1 0)</td>
<td>(0 0 0 0 0 0 0)</td>
</tr>
<tr>
<td>(0 0 0 0 0 0 1)</td>
<td>(1 1 1 0 0 0 1)</td>
</tr>
</tbody>
</table>

### 4.4 Analysis using IFCM

For analyzing the problem using Induced Fuzzy cognitive maps (IFCM) let us consider input vector $C_1 = (1 \ 0 \ 0 \ 0 \ 0 \ 0 \ 0)$ where the attribute $Education$ is in ON state and the rest are in OFF position. The limit points are obtained as follows:

**Step-1**

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

$C_1E = (0 \ 1 \ 1 \ 0 \ 0 \ -1 \ 1)$

$\Rightarrow (0 \ 1 \ 1 \ 0 \ 0 \ 0 \ 1) = C_1'$

$C_1'E^T = (3 \ 1 \ 1 \ 1 \ 2 \ -3 \ 2)$

$\Rightarrow (1 \ 0 \ 0 \ 0 \ 1 \ 0 \ 1) = C_1$

$C_1^{(1)} = (1 \ 0 \ 0 \ 0 \ 0 \ 0 \ 0)$

$C_1^{(2)} = (0 \ 0 \ 0 \ 0 \ 1 \ 0 \ 0)$
\( C_1^{(3)} = (0 \ 0 \ 0 \ 0 \ 0 \ 0 \ 1) \)
\( C_1^{(1)}E = (0 \ 1 \ 1 \ 0 \ 0 \ -1 \ 1) \)
\( \leftrightarrow (0 \ 1 \ 1 \ 0 \ 0 \ 0 \ 1) = C_1^{(3)} \)
\( C_1^{(1)}E^T = (3 \ 1 \ 1 \ 1 \ 2 \ -3 \ 2) \)
\( \leftrightarrow (1 \ 0 \ 0 \ 0 \ 1 \ 0 \ 1) \)

The Sum is 3.

\( C_1^{(2)}E = (1 \ 1 \ 1 \ 0 \ 0 \ -1 \ 0) \)
\( \leftrightarrow (1 \ 1 \ 1 \ 0 \ 0 \ 0 \ 0) = C_1^{(2)} \)
\( C_1^{(2)}E^T = (2 \ 2 \ 1 \ 1 \ 3 \ -2 \ 3) \)
\( \leftrightarrow (1 \ 1 \ 0 \ 0 \ 1 \ 0 \ 1) \)

The Sum is 4.

\( C_1^{(3)}E = (1 \ 1 \ 1 \ 0 \ 0 \ -1 \ 0) \)
\( \leftrightarrow (1 \ 1 \ 1 \ 0 \ 0 \ 0 \ 0) = C_1^{(3)} \)
\( C_1^{(3)}E^T = (2 \ 2 \ 1 \ 1 \ 3 \ -2 \ 3) \)
\( \leftrightarrow (1 \ 1 \ 0 \ 0 \ 1 \ 0 \ 1) \)

The Sum is 4.

Therefore \( C_2 = (1 \ 1 \ 0 \ 0 \ 1 \ 0 \ 1) \)
\( C_2E = (3 \ 3 \ 4 \ 0 \ 0 \ -4 \ 1) \)
\( \leftrightarrow (1 \ 1 \ 1 \ 0 \ 0 \ 0 \ 0) = C_2 \)
\( C_2E^T = (2 \ 2 \ 1 \ 1 \ 3 \ -2 \ 3) \)
\[ (1 \ 1 \ 0 \ 0 \ 1 \ 0 \ 1) = C_2 \]

\[ C^{(1)}_2 = (1 \ 0 \ 0 \ 0 \ 0 \ 0 \ 0) \]

\[ C^{(2)}_2 = (0 \ 1 \ 0 \ 0 \ 0 \ 0 \ 0) \]

\[ C^{(3)}_2 = (0 \ 0 \ 0 \ 0 \ 1 \ 0 \ 0) \]

\[ C^{(4)}_2 = (0 \ 0 \ 0 \ 0 \ 0 \ 0 \ 1) \]

\[ C^{(1)}_2 E = (0 \ 1 \ 1 \ 0 \ 0 \ -1 \ 1) \]

\[ \implies (0 \ 1 \ 1 \ 0 \ 0 \ 0 \ 1) = C^{(1)}_2 \]

\[ C^{(1)}_2 E^T = (3 \ 1 \ 1 \ 1 \ 2 \ -3 \ 2) \]

\[ \implies (1 \ 0 \ 0 \ 0 \ 1 \ 0 \ 1) \]

**The Sum is 3.**

\[ C^{(2)}_2 E = (2 \ 1 \ 2 \ 0 \ 0 \ -2 \ 0) \]

\[ \implies (1 \ 1 \ 1 \ 0 \ 0 \ 0 \ 0) = C^{(2)}_2 \]

\[ C^{(2)}_2 E^T = (2 \ 2 \ 1 \ 1 \ 3 \ -2 \ 3) \]

\[ \implies (1 \ 1 \ 0 \ 0 \ 1 \ 0 \ 1) \]

**The Sum is 4.**

\[ C^{(3)}_2 E = (1 \ 1 \ 1 \ 0 \ 0 \ -1 \ 0) \]

\[ \implies (1 \ 1 \ 1 \ 0 \ 0 \ 0 \ 0) = C^{(3)}_2 \]

\[ C^{(3)}_2 E^T = (2 \ 2 \ 1 \ 1 \ 3 \ -2 \ 3) \]

\[ \implies (1 \ 1 \ 0 \ 0 \ 1 \ 0 \ 1) \]

**The Sum is 4.**
\[ C_2^{(4)}E = (1 \ 1 \ 1 \ 0 \ 0 \ -1 \ 0) \]
\[ \leftrightarrow (1 \ 1 \ 1 \ 0 \ 0 \ 0 \ 0) = C_2^{(4)} \]

\[ C_2^{(4)}E^T = (2 \ 2 \ 1 \ 1 \ 3 \ -2 \ 3) \]
\[ \leftrightarrow (1 \ 1 \ 0 \ 0 \ 1 \ 0 \ 1) \]

The Sum is 4.

Therefore \[ C_3 = (1 \ 1 \ 0 \ 0 \ 1 \ 0 \ 1) \]

\[ C_3E = (3 \ 3 \ 4 \ 0 \ 0 \ -4 \ 1) \]
\[ \leftrightarrow (1 \ 1 \ 1 \ 0 \ 0 \ 0 \ 0) = C_3 \]

\[ C_3E^T = (2 \ 2 \ 1 \ 1 \ 3 \ -2 \ 3) \]
\[ \leftrightarrow (1 \ 1 \ 0 \ 0 \ 1 \ 0 \ 1) = C_3 = C_2 \]

Therefore the binary pair \{(1 \ 1 \ 0 \ 0 \ 0 \ 0), (1 \ 1 \ 0 \ 0 \ 1 \ 0)\} represents the fixed point of the dynamical system. This procedure can be repeated for other input vectors and the limit points can be determined. The following table gives all the pairs of limit points obtained for various input vectors and the triggering pattern for IFCM.
Table: 4.2

Limit Points and the Triggering pattern for IFCM

<table>
<thead>
<tr>
<th>Input vector</th>
<th>Limit point</th>
<th>Triggering pattern</th>
</tr>
</thead>
<tbody>
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<td>(1000000)</td>
<td>(1110000),(1100101)</td>
<td>C₁ ⇒ C₅ ⇒ C₂</td>
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<td>(0100000)</td>
<td>(1110000),(1100101)</td>
<td>C₂ ⇒ C₅ ⇒ C₂</td>
</tr>
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<td>(0010000)</td>
<td>(0100000),(1011101)</td>
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<tr>
<td>(0000001)</td>
<td>(1110000),(1100101)</td>
<td>C₇ ⇒ C₂</td>
</tr>
</tbody>
</table>

Fig. 4.2: The Triggering Pattern for IFCM
4.5 Conclusion

1. From the limit points obtained using FCM, we conclude that the empowerment of women depends more on giving priority to education, health, nutrition and the rights of the girl child.

2. The needs of the girl child and earmarking of substantial investments in the areas relating to food and nutrition, health and education, and in vocational education will improve happiness in woman’s life.

3. By educating its women, a country can reduce poverty, improve productivity, ease population pressure and offer its children a better future.

4. Rights of the girl child will lead to equality, sustainability, empowerment and happiness of women in their environment.

5. The triggering pattern obtained using IFCM shows that the node $C_2 (Health)$ is the converging point. Therefore health of women should be promoted for their empowerment.

6. It can also be observed that $C_4$ and $C_5$ play intermediary role. Therefore the environment and the role of mass media play crucial role in empowerment of women.

7. While inducing it was identified that $C_3$ also has the maximum sum implying that nutrition affects more number of other attributes. Therefore priority should be given to nutrition among women.