

A STUDY ON THE SYMPTOMS OF BREAST CANCER USING FUZZY COGNITIVE MAPS (FCMs)

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ABSTRACT:

FCM have been applied in many fields successfully to show the relationship between the nodes. In this paper we analyzed the symptoms of breast cancer as it is the second major cause of cancer death in among women. It is reported that one in 22 women in India is likely to suffer from breast cancer during her life time. This paper has five sections. Section one gives literature survey of fuzzy cognitive maps (FCMs). Section two gives the preliminaries of FCM. Section three gives the description of breast cancer and its symptoms. Section four gives the adaption of FCM to the problem. Final section derives the Conclusion based on our study.

Key Words: Fuzzy Cognitive Maps (FCM) and Symptoms of breast cancer

1. INTRODUCTION:

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. in this paper. we recall the notion of Fuzzy Cognitive Maps (FCMs), which was introduced by Bart Kosko in the year 1986. We also give several of its interrelated definitions. FCMs have a major role to play mainly when the data concerned is an unsupervised one. Further this method is most simple and an effective one as it can analyse the data by directed graphs and connection matrices.

2. 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 world as a collection of classes and causal relations between classes.

2.1 Definition:

A FCMs is a directed graph with concepts like policies, events etc, as nodes and causalities as edges. It represents causal relationship between concepts.

2.2 Definition:

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

2.3 Definition:

FCMs with edge weights or causalities from the set $\{-1, 0, 1\}$ are called simple FCMs

2.4 Definition:

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

2.5 Definition:

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

2.6 Definition:

Let C_1, C_2, \dots, C_n be the nodes of the FCM. Let $A = \{a_1, a_2, \dots, a_n\}$, where $a_i \in \{0, 1\}$. A is called the instantaneous state neutrosophic vector and it denotes the on-off state position of the node at an instant

$$a_i = 0 \text{ if } a_i \text{ is off (no effect)}$$

$$a_i = 1 \text{ if } a_i \text{ is on (has effect)}$$

2.7 Definition:

Let C_1, C_2, \dots, C_n be the nodes of the FCM. Let $\overline{C_1 C_2}, \overline{C_2 C_3}, \dots, \overline{C_i C_j}$ be the edges of the FCM. 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.

2.8 Definition:

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

2.9 Definition:

Let $\overline{C_1 C_2}, \overline{C_2 C_3}, \dots, \overline{C_{n-1} C_n}$ be cycle, when C_i is switched on and if the causality flow 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 $i = 1, 2, \dots, n$ the equilibrium state for this dynamical system is called the hidden pattern.

2.10 Definition:

If the equilibrium state of a dynamical system is a unique state vector, then it is called a fixed point. Consider the FCM 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 FCM settles down with C_1 and C_n on, i.e. the state vector remain as $(1, 0, \dots, 1)$ this state vector $(1, 0, \dots, 0, 1)$ is called the fixed point.

2.11 Definition:

If the FCM settles with a 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 FCM.

3. DESCRIPTION OF BREAST CANCER :

Breast cancer is an uncontrolled growth of breast cells. To better understand breast cancer, it helps to understand how any cancer can develop. Cancer occurs as a result of mutations, or abnormal changes, in the genes responsible for regulating the growth of cells and keeping them healthy. The genes are in each cell's nucleus, which acts as the "control room" of each cell. Normally, the cells in our bodies replace themselves through an orderly process of cell growth: healthy new cells take over as old ones die out. But over time, mutations can "turn on" certain genes and "turn off" others in a cell. That changed cell gains the ability to keep dividing without control or order, producing more cells just like it and forming a tumor. A tumor can be

benign (not dangerous to health) or malignant (has the potential to be dangerous). Benign tumors are not considered cancerous: their cells are close to normal in appearance, they grow slowly, and they do not invade nearby tissues or spread to other parts of the body. Malignant tumors are cancerous. Left unchecked, malignant cells eventually can spread beyond the original tumor to other parts of the body. The term "breast cancer" refers to a malignant tumor that has developed from cells in the breast. Usually breast cancer either begins in the cells of the lobules, which are the milk-producing glands, or the ducts, the passages that drain milk from the lobules to the nipple. Less commonly, breast cancer can begin in the stromal tissues, which include the fatty and fibrous connective tissues of the breast. Breast cancer is always caused by a genetic abnormality (a "mistake" in the genetic material). However, only 5-10% of cancers are due to an abnormality inherited from your mother or father. About 90% of breast cancers are due to genetic abnormalities that happen as a result of the aging process and the "wear and tear" of life in general. Since it is the second major cause of the death in the world and many of the Indian women are not aware of that, we analyzed the symptoms of Breast Cancer. For that we interviewed 100 patients in Adyar cancer institute, Chennai and concern doctor in this field.

3.1 Symptoms of Breast Cancer:

In its early stages, breast cancer usually has no symptoms. As a tumor develops, you may note the following signs:

- A lump in the breast or underarm that persists after your menstrual cycle. This is often the first apparent symptom of breast cancer. Lumps associated with breast cancer are usually painless, although some may cause a prickly sensation. Lumps are usually visible on a mammogram long before they can be seen or felt.
- Swelling in the armpit.
- Pain or tenderness in the breast. Although lumps are usually painless, pain or tenderness can be a sign of breast cancer.
- A noticeable flattening or indentation on the breast, which may indicate a tumor that cannot be seen or felt.
- Any change in the size, contour, texture, or temperature of the breast. A reddish, pitted surface like the skin of an orange could be a sign of advanced breast cancer.
- A change in the nipple, such as a nipple retraction, dimpling, itching, a burning sensation, or ulceration. A scaly rash of the nipple is symptomatic of Paget's disease, which may be associated with an underlying breast cancer.

- Unusual discharge from the nipple that may be clear, bloody, or another color. It's usually caused by benign conditions but could be due to cancer in some cases.
- A marble-like area under the skin.
- An area that is distinctly different from any other area on either breast.

4. ADAPTATION OF FCM TO THE PROBLEM:

To analyze the symptoms of Breast Cancer, we have interviewed and discussed with 100 women in different ages from 26 to 65 in Adyar cancer institute and with the experts opinion we have taken the following attributes.

- c_1 - swelling of all or part of the breast
- c_2 -skin irritation or dimpling
- c_3 -breast pain
- c_4 -nipple pain or the nipple turning inward
- c_5 -redness, scaliness, or thickening of the nipple or breast skin
- c_6 -a nipple discharge other than breast milk
- c_7 -a lump in the underarm area

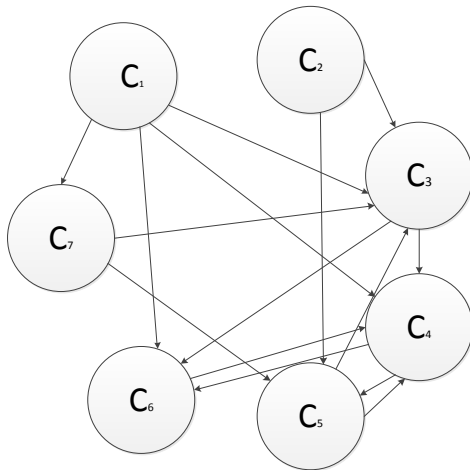


Figure-1

Figure-1 gives the directed graph with C_1, C_2, \dots, C_7 as nodes

The connection matrix E related to the graph in Figure-1. is given below

$$E = \begin{pmatrix} 0 & 0 & 1 & 1 & 0 & 1 & 1 \\ 0 & 0 & 1 & 0 & 1 & 0 & 0 \\ 0 & 0 & 0 & 1 & 0 & 1 & 0 \\ 0 & 0 & 0 & 0 & 1 & 1 & 0 \\ 0 & 0 & 1 & 1 & 0 & 0 & 0 \\ 0 & 0 & 0 & 1 & 0 & 0 & 0 \\ 0 & 0 & 1 & 0 & 1 & 0 & 0 \end{pmatrix}$$

Let us start with the node C_3 is in the ON state i.e. breast pain and all other nodes are in the OFF condition. Input the vector

$$A_1 = 0 \ 0 \ 1 \ 0 \ 0 \ 0 \ 0$$

The effect of A_1 on the dynamical system E is given by

$$A_1 E = 0 \ 0 \ 0 \ 1 \ 0 \ 1 \ 0 \ \hookrightarrow$$

$$0 \ 0 \ 1 \ 1 \ 0 \ 1 \ 0 = A_2$$

$$A_2 E = 0 \ 0 \ 0 \ 2 \ 1 \ 2 \ 0 \ \hookrightarrow$$

$$0 \ 0 \ 1 \ 1 \ 1 \ 1 \ 0 = A_3$$

$$A_3 E = 0 \ 0 \ 1 \ 3 \ 1 \ 2 \ 0 \ \hookrightarrow$$

$$0 \ 0 \ 1 \ 1 \ 1 \ 1 \ 0 = A_4 = A_3$$

(where \hookrightarrow denotes the thresholding and updating of the resultant state vector)

The hidden pattern is the fixed point given by $0 \ 0 \ 0 \ 1 \ 1 \ 1 \ 0$ which implies that fourth, five and six attributes come to ON state.

Let us start with the node C_1 is in the ON state i.e. swelling of all or part of the breast and all other nodes are in the OFF condition.

Suppose the input vector

$$B_1 = 1 \ 0 \ 0 \ 0 \ 0 \ 0 \ 0$$

The effect of B_1 on the dynamical system E is given by

$$B_1 E = 0 \ 0 \ 1 \ 1 \ 0 \ 1 \ 1 \ \hookrightarrow$$

$$1 \ 0 \ 1 \ 1 \ 0 \ 1 \ 1 = B_2$$

$$B_2 E = 0 \ 0 \ 2 \ 3 \ 2 \ 3 \ 1 \ \hookrightarrow$$

$$1 \ 0 \ 1 \ 1 \ 1 \ 1 \ 1 = B_3$$

$$B_3 E = 0 \ 0 \ 3 \ 4 \ 2 \ 3 \ 1 \ \hookrightarrow$$

$$1 \ 0 \ 1 \ 1 \ 1 \ 1 \ 1 = B_4 = B_3$$

The hidden pattern is fixed point given by

0 0 1 1 1 1 1 which implies that three, four, five, six and seven attributes come to ON stage.

Table-1

	Input	Limit point
1	(10 0 0 0 0 0)	(1 0 1 1 1 1 1)
2	(0 1 0 0 0 0 0)	(0 1 1 1 1 1 0)
3	(0 0 1 0 0 0 0)	(0 0 1 1 1 1 0)
4	(0 0 0 1 0 0 0)	(0 0 1 1 1 1 0)
5	(0 0 0 0 1 0 0)	(0 0 1 1 1 1 0)
6	(0 0 0 0 0 1 0)	(0 0 1 1 1 1 0)
7	(0 0 0 0 0 0 1)	(0 0 1 1 1 1 1)

5. CONCLUSION AND SUGGESTIONS:

However the results by FCM gives when breast pain is ON stage, then nipple pain or the nipple turning inward, redness, scaliness, or thickening of the nipple or breast skin and a nipple discharge other than breast milk are on stage. Similarly when swelling of all or part of the breast is ON stage, then breast pain, nipple pain or the nipple turning inward, redness, scaliness, or thickening of the nipple or breast skin and a nipple discharge other than breast milk and a lump in the underarm area are in ON stage. So, when a women has a breast pain immediately she will have to go to hospital for check up. If the disease is in early-stage we can control it, by taking medicines, foods and xercises etc.

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