

Mathematical Modelling for Interpretation of HIV /AIDS Infection in Human Body by Using IFCMs

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Abstract- In this paper we have to explain about HIV/AIDS (Human Immunodeficiency Virus / Acquired Immuno Deficiency Syndrome). We discuss about symptoms of HIV infection, relation between symptoms and interpretation for most probable symptoms of HIV infection. For this purpose here we use Induced Fuzzy Cognitive Maps.

Key words: - Fuzzy Cognitive Maps, Induced Fuzzy Cognitive Maps, Symptoms of HIV infection, Interpretation of Infection.

I. INTRODUCTION ABOUT HIV/AIDS

HIV / AIDS, human immunodeficiency virus (HIV) is a disease of the human immune system caused by. During the initial infection, a person may experience a brief period of influenza-like illness is. It is usually without symptoms are followed by a prolonged period. The disease progresses more generally people with working immune system that do not affect opportunistic infections, including infections and tumours, making people more likely to get, the greater the interference with the immune system. HIV is mainly pregnancy, childbirth, or during breastfeeding, contaminated blood transfusions and hypodermic needles, and from mother to child (including anal and oral sex) is transmitted through unprotected sexual intercourse. Such as saliva and tears some bodily fluids, HIV is not transmitted. A safe sex and needle-exchange program mainly through the prevention of HIV infection, to control the spread of disease is a key strategy. There is no cure or vaccine; however, antiretroviral therapy can slow the course of disease and may lead to a near-normal life expectancy. Antiretroviral treatment reduces the risk of death and complications from the disease, while these drugs are expensive and may be associated with side effects. HIV genetic research during the early twentieth century originated in West-Central Africa that indicates. AIDS for the first time in 1981 for Disease Control and Prevention (CDC) was recognized by the Centre for HIV infection and its cause was identified in the early part of this decade. Since its discovery, AIDS has caused 30 million deaths. By 2010, approximately 34 million people worldwide have contracted HIV. AIDS epidemic as a disease and as a source of discrimination, both in a large area and has had a great influence on society actively spreading. HIV/AIDS which means a disease outbreak is considered. The disease also has significant economic impacts. That way it can be transmitted through casual non-sexual contact that belief as HIV / AIDS There are many misconceptions about. The disease also has been the subject of many controversies associated with religion. (Known as vertical transmission), pregnancy, childbirth, or breastfeeding during sexual contact, exposure to infected body fluids or tissues, and from mother to child HIV is transmitted in three main ways. These are contaminated with blood, unless the stool, nasal secretions, saliva, sputum, sweat, tears, urine, or vomit in touch if there is no risk of acquiring HIV. It's already the opposite-people contacts across the world with the majority of cases of HIV infection is responsible for carrying the HIV condition known as HIV super infection. Unprotected sex more than one strain of HIV by co-infection is possible to sex the same sex contacts globally, accounting for more cases. However, the pattern of transmission varies considerably between countries. In the United States, as of 2009, most sexual transmission of all concerned, unsafe heterosexual contact, accounting for 64% of new cases. As with this population occurred in men who have

sex with men, HIV per sexual act the risk of transmission of the estimates appears low-income countries than in high-income countries four to ten times more. In low-income countries, female-to-male and male-to-female transmission of the risk of transmission, according to the Act is estimated as 0.38%. The risk of transmission in heterosexual anal intercourse from 1.4 to 1.7% for the law as well as the estimated homosexual contacts is especially high. The risk of transmission from oral sex is relatively low, it still exists.

II. SYMPTOMS OF HIV/AIDS

Disease Control and Prevention (CDC), according to the Centre for HIV / AIDS, in the United States more than 1.1 million people are living with HIV infection. Almost one in six of the group that are unaware they are infected. A person at the time of HIV infection often does not have any noticeable symptoms. They are being linked to any symptoms of HIV is unlikely to be recognized as. Someone is diagnosed with HIV, it can change. Flulike symptoms near the time of their infection may be able to remember. However, at times, they are probably simply because they had the flu. Before a person becomes infected with HIV, they are said to be in a state of transition intense. Acute phase the virus is multiplying very rapidly when a time. At this stage, activating the immune system tries to fight the infection. Symptoms of infection may occur during this phase. Unless you know what you've been exposed, however, is difficult to identify the symptoms of HIV. Acute HIV Symptoms are similar to those of other viral infections. They include: the standard antibody test to detect HIV infection at this stage may not be able to. If you experience these symptoms and may have either been or surely you know recently been exposed to HIV, tell your doctor. Alternative test to identify early HIV infection can be used. Once installed the virus in the body, you will feel sick now. It is the chronic phase of HIV infection. It can last for many years. During this time, you likely will not have any signs of infection. Without treatment, the virus will continue to do damage to your immune system. You may eventually develop AIDS (Symptoms mentioned in Fig (1)).

III. INTRODUCTION ABOUT FUZZY COGNITIVE MAP

Fuzzy Cognitive Maps of researchers signed procedure may include different kinds of knowledge to draw and analyze complex operating system. During the process of learning and understanding mapping system between particular favours, in which the process of representation and public buildings researchers FCM certain perception of the obstacles created reason. A SEI consists of many elements / concepts / nodes / factors and their influences on one another, the chances of the weighted are depicted with arrows between the elements. The analysis of the relationship between the goal of beings found in a SEI detecting and interpreting the map and by understanding its structural properties and the dynamism. The structured ways of collecting and data coding enables comparison studies have been reused.

Definition 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. If increase (or decrease) in one concept, leads to increase (or decrease) in another, then give the value 1. If there exists no relation between two concepts, then the value 0 is given. If increase (or decrease) in one causalities decreases (or increases) another, then give the value -1 . Thus FCMs are described in this way.

Definition 3.2:- When the nodes of the FCM are fuzzy sets then they are called as fuzzy nodes.

Definition 3.3:- FCMs with edge weights or causalities from the set $\{-1, 0, 1\}$, are called simple FCMs.

Definition 3.4:- Consider the nodes or concepts $C_1, C_2, C_3, \dots, C_n$ 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 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 3.5:- Let $C_1, C_2, C_3, \dots, C_n$ be the nodes of an FCM. $A = (a_1, a_2, a_3, \dots, a_n)$, where $a_i \in \{0, 1\}$. A is called the instantaneous state vector and it denotes the on-off position of the node at an instant.

$$\begin{aligned}
 a_i &= 0 && \text{if } a_i \text{ is off and} \\
 a_i &= 1 && \text{if } a_i \text{ is on} \\
 &&& \text{for } i = 1, 2, 3, \dots, n
 \end{aligned}$$

Definition 3.6:- Let $C_1, C_2, C_3, \dots, C_n$ be the nodes of an FCM. Let $\overline{C_1 C_2}, \overline{C_2 C_3}, \overline{C_3 C_4}, \dots, \overline{C_i C_j}$ 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 3.7:- An FCM with cycles is said to have a feedback.

Definition 3.8:- 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 3.9:- $\overline{C_1 C_2}, \overline{C_2 C_3}, \overline{C_3 C_4}, \dots, \overline{C_{n-1} C_n}$ 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 $i = 1, 2, 3, \dots, n$. The equilibrium state for this dynamical system is called the hidden pattern.

Definition 3.10:- If the equilibrium state of a dynamical system is a unique state vector, then it is called a fixed point.

IV. ALGORITHM FOR INDUCED FUZZY COGNITIVE MAPS (IFCMS)

Induced Fuzzy Cognitive Maps is upgradation of Fuzzy Cognitive Maps. IFCMs has some modifications in algorithms. To interpret solution of the problem go through the following steps:

- Step 1:** For the given model collect the unsupervised data that is in determined factors called nodes.
- Step 2:** According to the expert opinion, draw the directed graph.
- Step 3:** Obtain the connection matrix, 'A' from the directed graph (FCMs). Here the number of rows in the given matrix is equal to number of steps to be performed.
- Step 4:** Consider the state vector C_1 which is in ON position. Find $C_1 \times A$. The state vector is updated and threshold at each stage.
- Step 5:** Threshold value is calculated by assigning 1 for the value greater than 1 and 0 for the values less than one. The symbol \rightarrow represents product of the result.
- Step 6:** Now each component in the C_1 vector is taken separately and product of the given matrix is calculated. The vector which has maximum number of one's which occurs first is considered as C_2 .
- Step 7:** When the same threshold value occurs twice, the value is considered as the fixed point. The iteration gets terminated.

V. ANALYSIS OF THE MATHEMATICAL MODEL

Now we explain a model for HIV infected people to find out most probable symptoms. At the first stage we have taken following seven arbitrary attributes $(S_1, S_2, S_3, S_4, S_5, S_6, S_7)$. The following attributes are taken as the main nodes for study.

S_1 = Diarrhea

S_2 = Fever

S_3 = Weight Loss

S_4 = Fatigue

S_5 = Skin Rashes

S_6 = Chills

S_7 = Shortness of Breath

Directed Graph by using Symptoms of HIV Infection

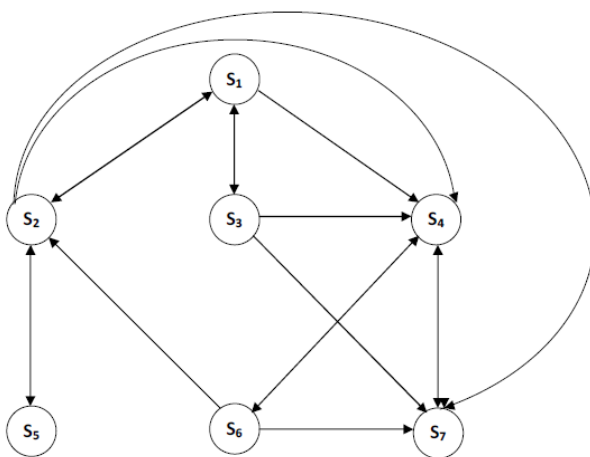


Fig (1) : Directed graph by using symptoms of HIV infection

VI. IMPLEMENTATION OF MATHEMATICAL MODEL

According to the study we found symptoms for being infected by HIV now here implementation of model, for this let a matrix A such as,

$$A = [a_{ij}] = \begin{matrix} & S_1 & S_2 & S_3 & S_4 & S_5 & S_6 & S_7 \\ \begin{matrix} S_1 \\ S_2 \\ S_3 \\ S_4 \\ S_5 \\ S_6 \\ S_7 \end{matrix} & \begin{bmatrix} 0 & 1 & 1 & 1 & 0 & 0 & 0 \\ 1 & 0 & 0 & 1 & 1 & 0 & 1 \\ 1 & 0 & 0 & 1 & 0 & 0 & 1 \\ 0 & 0 & 0 & 0 & 0 & 1 & 1 \\ 0 & 1 & 0 & 0 & 0 & 0 & 0 \\ 0 & 1 & 0 & 1 & 0 & 0 & 1 \\ 0 & 1 & 0 & 1 & 0 & 0 & 0 \end{bmatrix} \end{matrix}$$

Initially we start from S_1 (Diarrhea) to interpret the problem here we suppose that only S_1 state is ON and others are OFF.

Then,

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

Multiply C_1 with matrix 'A',

$$C_1A = (0 \ 1 \ 1 \ 1 \ 0 \ 0 \ 0) \sim (1 \ 1 \ 1 \ 1 \ 0 \ 0 \ 0)$$

i.e.,

$$C_1^1A = (1 \ 1 \ 1 \ 1 \ 0 \ 0 \ 0) \dots\dots\dots(2)$$

In the calculated value first zero (0) in first place is replaced by one because of our hypothesis that only S_1 state is ON and others are OFF.

As we know threshold value is calculated by assuming one (1) for the values greater than one and zero (0) for the values less than zero.

Now, calculation for threshold values by iteration method, in this process we suppose ON one by one all S_i 's as we supposed for S_1 ,

So,

$$C_1^1A \sim (1 \ 0 \ 0 \ 0 \ 0 \ 0 \ 0)A \rightarrow (0 \ 1 \ 1 \ 1 \ 0 \ 0 \ 0) \dots\dots\dots(3)$$

$$C_1^1A \sim (0 \ 1 \ 0 \ 0 \ 0 \ 0 \ 0)A \rightarrow (1 \ 0 \ 0 \ 1 \ 1 \ 0 \ 1) \dots\dots\dots(4)$$

$$C_1^1A \sim (0 \ 0 \ 1 \ 0 \ 0 \ 0 \ 0)A \rightarrow (1 \ 0 \ 0 \ 1 \ 0 \ 0 \ 1) \dots\dots\dots(5)$$

$$C_1^1A \sim (0 \ 0 \ 0 \ 1 \ 0 \ 0 \ 0)A \rightarrow (0 \ 0 \ 0 \ 0 \ 0 \ 1 \ 1) \dots\dots\dots(6)$$

$$C_1^1A \sim (0 \ 0 \ 0 \ 0 \ 1 \ 0 \ 0)A \rightarrow (0 \ 1 \ 0 \ 0 \ 0 \ 0 \ 0) \dots\dots\dots(7)$$

$$C_1^1A \sim (0 \ 0 \ 0 \ 0 \ 0 \ 1 \ 0)A \rightarrow (0 \ 1 \ 0 \ 1 \ 0 \ 0 \ 1) \dots\dots\dots(8)$$

$$C_1^1A \sim (0 \ 0 \ 0 \ 0 \ 0 \ 0 \ 1)A \rightarrow (0 \ 1 \ 0 \ 1 \ 0 \ 0 \ 0) \dots\dots\dots(9)$$

Let

$$C_2 = (1 \ 0 \ 0 \ 1 \ 1 \ 0 \ 1) \dots\dots\dots(10)$$

Because the threshold having maximum 1's will assumed as C_2 , then repeat the above process again,

So,

$$C_2A = (0 \ 1 \ 1 \ 1 \ 0 \ 1 \ 1) \sim (1 \ 1 \ 1 \ 1 \ 0 \ 1 \ 1)$$

$$C_2^1 = (1 \ 1 \ 1 \ 1 \ 0 \ 1 \ 1) \dots\dots\dots(11)$$

Now,

$$C_2^1A \sim (1 \ 0 \ 0 \ 0 \ 0 \ 0 \ 0)A \rightarrow (0 \ 1 \ 1 \ 1 \ 0 \ 0 \ 0) \dots\dots\dots(12)$$

$$C_2^1A \sim (0 \ 1 \ 0 \ 0 \ 0 \ 0 \ 0)A \rightarrow (1 \ 0 \ 0 \ 1 \ 1 \ 0 \ 1) \dots\dots\dots(13)$$

$$C_2^1 A \sim (0 \ 0 \ 1 \ 0 \ 0 \ 0 \ 0) A \rightarrow (1 \ 0 \ 0 \ 1 \ 0 \ 0 \ 1) \dots\dots\dots(14)$$

$$C_2^1 A \sim (0 \ 0 \ 0 \ 1 \ 0 \ 0 \ 0) A \rightarrow (0 \ 0 \ 0 \ 0 \ 0 \ 1 \ 1) \dots\dots\dots(15)$$

$$C_2^1 A \sim (0 \ 0 \ 0 \ 0 \ 1 \ 0 \ 0) A \rightarrow (0 \ 1 \ 0 \ 0 \ 0 \ 0 \ 0) \dots\dots\dots(16)$$

$$C_2^1 A \sim (0 \ 0 \ 0 \ 0 \ 0 \ 1 \ 0) A \rightarrow (0 \ 1 \ 0 \ 1 \ 0 \ 0 \ 1) \dots\dots\dots(17)$$

$$C_2^1 A \sim (0 \ 0 \ 0 \ 0 \ 0 \ 0 \ 1) A \rightarrow (0 \ 1 \ 0 \ 1 \ 0 \ 0 \ 0) \dots\dots\dots(18)$$

Let

$$C_3 = (1 \ 0 \ 0 \ 1 \ 1 \ 0 \ 1) \dots\dots\dots(19)$$

By using (10) & (19), we can see,

$$C_2 = C_3 = (1 \ 0 \ 0 \ 1 \ 1 \ 0 \ 1)$$

When the same threshold value occurs twice, the value is considered as the fixed point. Then terminate the iteration.

VII. CONCLUSION

After all the process now we can analyze the result:-

- When we put S_1 (Diarrhea) in ON position we found that the result is (1 0 0 1 1 0 1).
- S_1 (Diarrhea) could be a measure symptom of HIV infection if patient suffering from long time.
- We found that S_1, S_4, S_5, S_7 are measure symptoms in case of HIV infection.
- By observation of iterations we can see that S_4 (Fatigue) is the very strong symptom which will lead to further investigations.
- Shortness of Breath (S_7) is also a symptom which is duly related with S_4 .
- Skin Rashes (S_5) is also a measure symptom of HIV according to study.
- As per resistance power of person to person there will be variation but S_2 (Fever) is also a symptom if it repeated several times with some other symptoms.
- In this period S_3 (weight loss) is also a symptom which is directly related with immune system.

VIII. FUTURE SCOPE OF THE RESEARCH

As we can see by this research, here is an analysis regarding most probable symptoms of HIV infection. In next step we can go for analysis of causes of the disease and then after for prevention, treatment and also we can use this analysis in the making of medicines.

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