ANALYSING THE FACTORS TO INCULCATE THE HAPPINESS INDEX IN ADOLESCENCE USING FUZZY COGNITIVE MAP

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by

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CERTIFICATE

This is to certify that the project work entitled **ANALYSING THE FACTORS TO INCULCATE THE HAPPINESS INDEX IN ADOLESCENCE USING FUZZY COGNITIVE MAP** submitted by **R.Swetha (Reg. No: U20MA067)** of Holy Cross College (Autonomous), Tiruchirappalli, in partial fulfilment of the requirements for the award of the degree of **MASTER OF SCIENCE IN MATHEMATICS**, during the academic year 2023 is a bonafide work done under my guidance.

Signature of the Candidate Signature of the Guide

Signature of the External Examiner Signature of the Head of the Department

Date:

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First of all, I enormously thank my almighty for being with me every single day and for showering his blessings throughout my research work to complete the project successfully.

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R. SWETHA

ANALYSING THE FACTORS TO INCULCATE THE HAPPINESS INDEX IN ADOLESCENCE USING FUZZY COGNITIVE MAP

ABSTRACT

The Fuzzy Cognitive Maps play a major role in solving complex data including indeterminate factors. A Fuzzy Cognitive Map is a directed graph which helps in analysing a person's thoughts through diagrammatic representation with help of nodes and edges. It represents a simple relationship between all the factors. Factors are very useful to set up the matrices for additional computation. It helps in decision-making. The basic factors which help in boosting the happiness in adolescence age is enumerated in this paper. This project is focused in finding the most influencing factor in boosting the happiness index in teens with the help of the Fuzzy Cognitive Map based on expert's opinion.

CONTENT

INTRODUCTION:

Sets with a degree of membership are called fuzzy sets. Lofti A. Zadeh proposed fuzzy sets in 1965 as an extension of the standard notion of a set. The incremental assessment of membership of elements in a set is possible using fuzzy set theory. The enclosed range [0,1] is used to value the membership function. Classical sets are generalised into fuzzy sets. These are commonly utilised in a variety of sectors where data is inadequate or inaccurate.[1]

In the year 1986, Bart Kosko designed the Fuzzy Cognitive Map. FCMs play a significant role, especially when dealing with unlabelled data. Furthermore, this method is easy to implement and most successful since it uses directed graphs and adjacency matrices to evaluate quantitative data.[2]

Happiness Index is the extensive measure of human well-being. It is also a measure to look into the psychological state of individuals and their satisfaction with life. This survey is a tool to understand and enhance an individual person's happiness.[3]

The World Happiness Report contains the rankings of nation's happiness on the basis of an individual's life and in correlation with many factors. According to the report of 2022, Finland seems to be the happiest country. India ranks 136 out of 145 countries. In India, Himachal Pradesh claims to be the happiest state according to the Happiness Survey conducted in 2022.[4]

Happiness is a psychological state. It is the act of being jovial, and truly enjoying our life with pleasure and having the desire to do what's good for oneself. Children in their adolescence seems to be much happier when they are satisfied with their lives. And more over happiness comes from one's own actions. It is a positive effect which helps in uplifting the lives of young children and teens.[3]

The aim of the project is to analyse the factors to inculcate happiness index in adolescence.

Chapter 1: contains a basic definition and examples of Fuzzy Cognitive Map.

Chapter 2: consists algorithm of FCM and problem description.

Chapter 3: deals the factors for inculcating the happiness index in adolescence using Fuzzy Cognitive Map.

CHAPTER – I

PREMILINARIES

This chapter deals with some basic concepts of Fuzzy Cognitive Map

1.1 Graph Theory

1.1.1 Graph

A graph G consists of pair (V(G), X(G)) where V(G) is a non-empty finite set whose elements are called points or vertices and X(G) is a set of ordered pairs of distinct e lements of V(G). The elements of X(G) are called lines (or) edges of the graph G.[6]

1.1.1 Example

Let us assume that, V = {A, B, C, D, E, F, G} and V is a vertex set.

X = {(A, B), (A, D), (B, C), (C, D), (D, E), (E, F), (F, G), (D, G)} and X is a edge set.

The below graph G = (V, X) is a (7,8) can be represented by diagram is given s follows.[10]

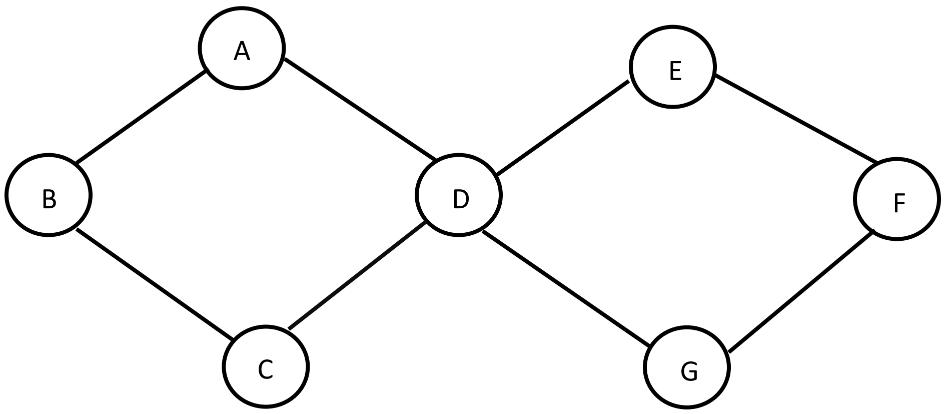


Fig: 1.1.1 (Graph)

1.1.2 Directed Graph

A directed graph (or) diagraph is a set of nodes connected by edges, where the edges have a direction associated with them.[6]

1.1.2 Example

[11]

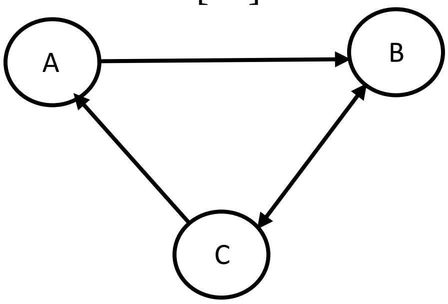


Fig 1.1.2 (Directed Graph)

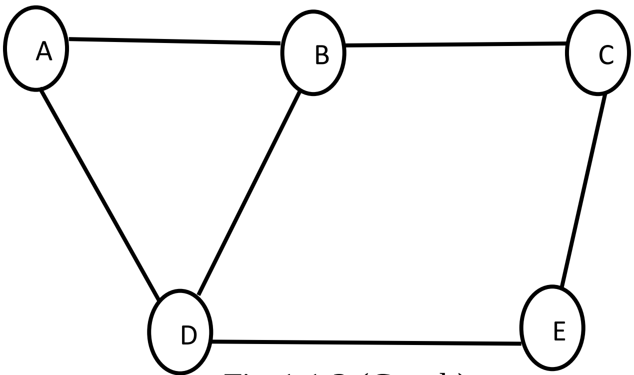
1.1.3 Adjacency Matrix

Consider the nodes concepts C_1, C_2, C_3, …, C_n of the FCM. Suppose the directed graph is drawn using the edge weight $e_{ij} \epsilon \{0, 1, -1\}$ where e_{ij} is the weight of the directed graph $C_{i<j}$. E is called the adjacency matrix of the FCM, also known as the connection matrix of the FCM.

The important note is all matrices associated with an FCM are always square matrices with a diagonal entry as zero.[6]

1.1.3 Example

[12]



$$\begin{bmatrix} 0 & 1 & 0 & 1 & 0 \\ 1 & 0 & 1 & 1 & 0 \\ 0 & 1 & 0 & 0 & 1 \\ 1 & 1 & 0 & 0 & 1 \\ 0 & 0 & 1 & 1 & 0 \end{bmatrix}$$

Fig 1.1.3 (Graph)

Adjacency matrix[]

Source: Arumugam.S and Ramachandran.S, (1997), "INVITATION TO GRAPH THEORY",pp:

1.2 FUZZY SET THEORY

1.2.1 Membership Function

Let X be a universal set. Let A $\subset$ X, define A: X $\rightarrow$ [0,1] is called membership function of D (or) grade function (or) degree of comparability (or) degrees of truth.[9]

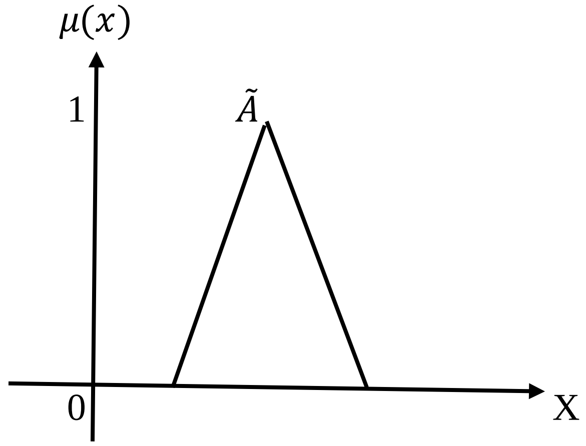


Fig: 1.2.1 (Membership function) [7]

1.2.2 Fuzzy Sets

A fuzzy set is any set that allows its members to have different degree of membership function called, that is called membership function.

Any set A defined by its membership function A(x) is called fuzzy set denoted by

$$A = \{x, A(x); x \in X\}[9]$$

1.2.2 Example

Let us consider X = $\{g_1, g_2, g_3, g_4\}$ be the reference set of students.

Let A be the fuzzy set of brilliant students. where brilliant is a fuzzy term.

$$A = \{(g_1, 0.5), (g_2, 0.7), (g_3, 0.3), (g_4, 1)\}$$

Here $\tilde{A}$ indicates the brilliant of g_1 is 0.5 and g_2 is 0.7 and g_3 is 0.3 and g_4 is 1.[8]

Source: Zimmermann.H.J. (2006), “FUZZY SET THEORY AND ITS APPLICATIONS, Springer International Edition, New York”

1.3 FUZZY COGNITIVE MAP

1.3.1 Fuzzy Cognitive Map

A fuzzy cognitive map is a directed graph with concepts like policies, events etc. As a node and causalities as edges. It represents a causal relationship between concepts.[5]

1.3.1 Example

In Tamil Nadu (a southern state in India) in the last decade several new engineering colleges has been approved and started. The resultant increase in the production of engineering graduates in these years is disproportionate with the need of engineering graduates. This has resulted in thousands of unemployed and underemployed graduate engineers. Using an experts opinion we study the effect of such unemployed people on the society. An expert spell out the major concepts relating to the unemployed graduated engineers as

E_1 - Frustration

E_2 - Unemployment

E_3 - Increase of educated criminals

E_4 - Under employment

E_5 - Taking up drugs etc.

The directed graph where E_1, E_2, …, E_5 are taken as the nodes causalities as edges as given by an expert in the following figure [5]

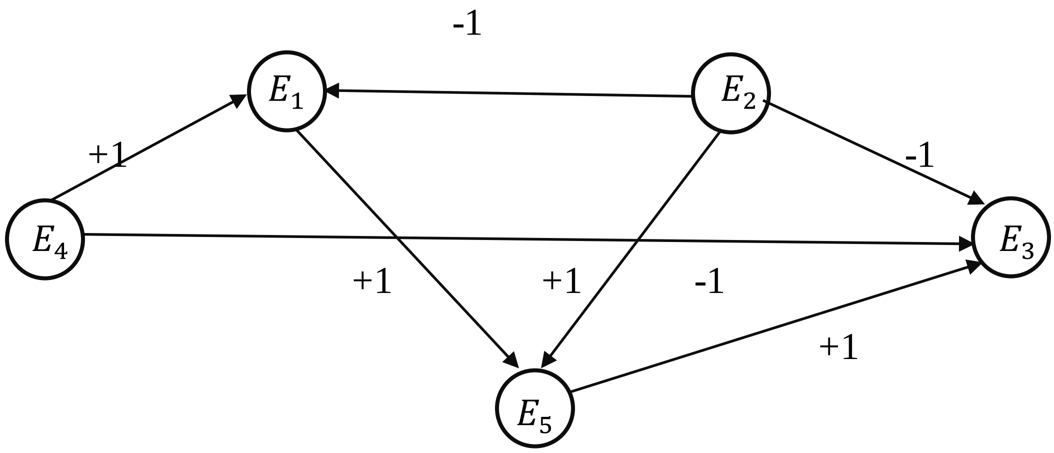


Fig 1.3.1 Fuzzy Cognitive Map

According to this expert, increase in unemployment increases frustration. Increase in unemployment, increase the educated criminals. Frustration increases the graduates to take up to evils like drugs extra. Unemployment also leads to increase in number of person who take up to drinks, drugs, extra. To forgot their worries and unoccupied time. Under unemployment forces the to do criminal acts like theft and murder for want of more money and so on. Thus one cannot actually get data for this but can use the experts opinion for this consupervisited data to obtain some data about the real plight of the situation. This is just an illustration to show how FCM is described by a directed graph. [5]

If increase (or decrease) in one concept leads to 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 decrease (or increase) another, then we give the value -1. Thus, FCMs are described in this way.[5]

1.3.2 Fuzzy Nodes

When the nodes of the FCM are fuzzy sets then they are called as fuzzy nodes.[5]

1.3.3 Types of FCM

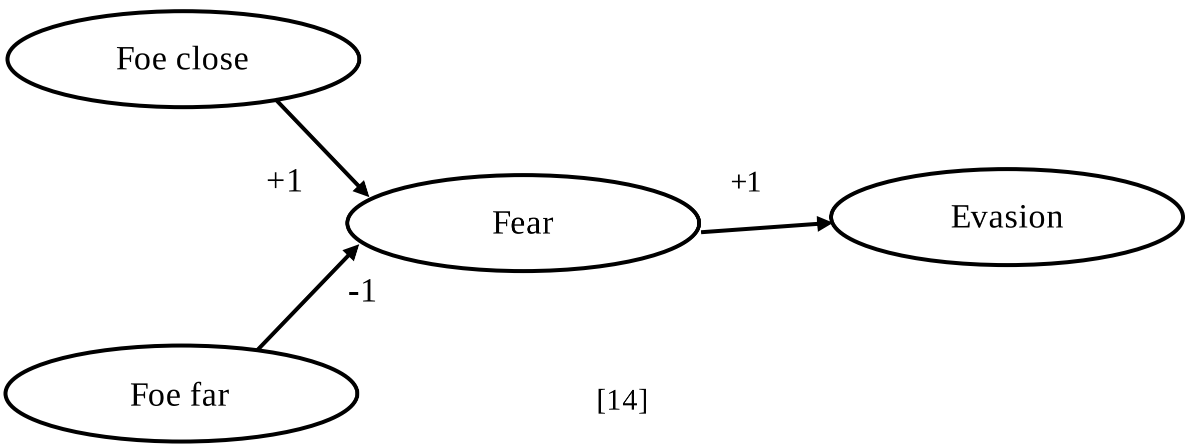
(i) Simple FCM

(ii) Weighted FCM

Simple FCM

FCMs with edge weights (or) causalities form the set {-1, 0, 1} are called simple FCMs.[5]

Example

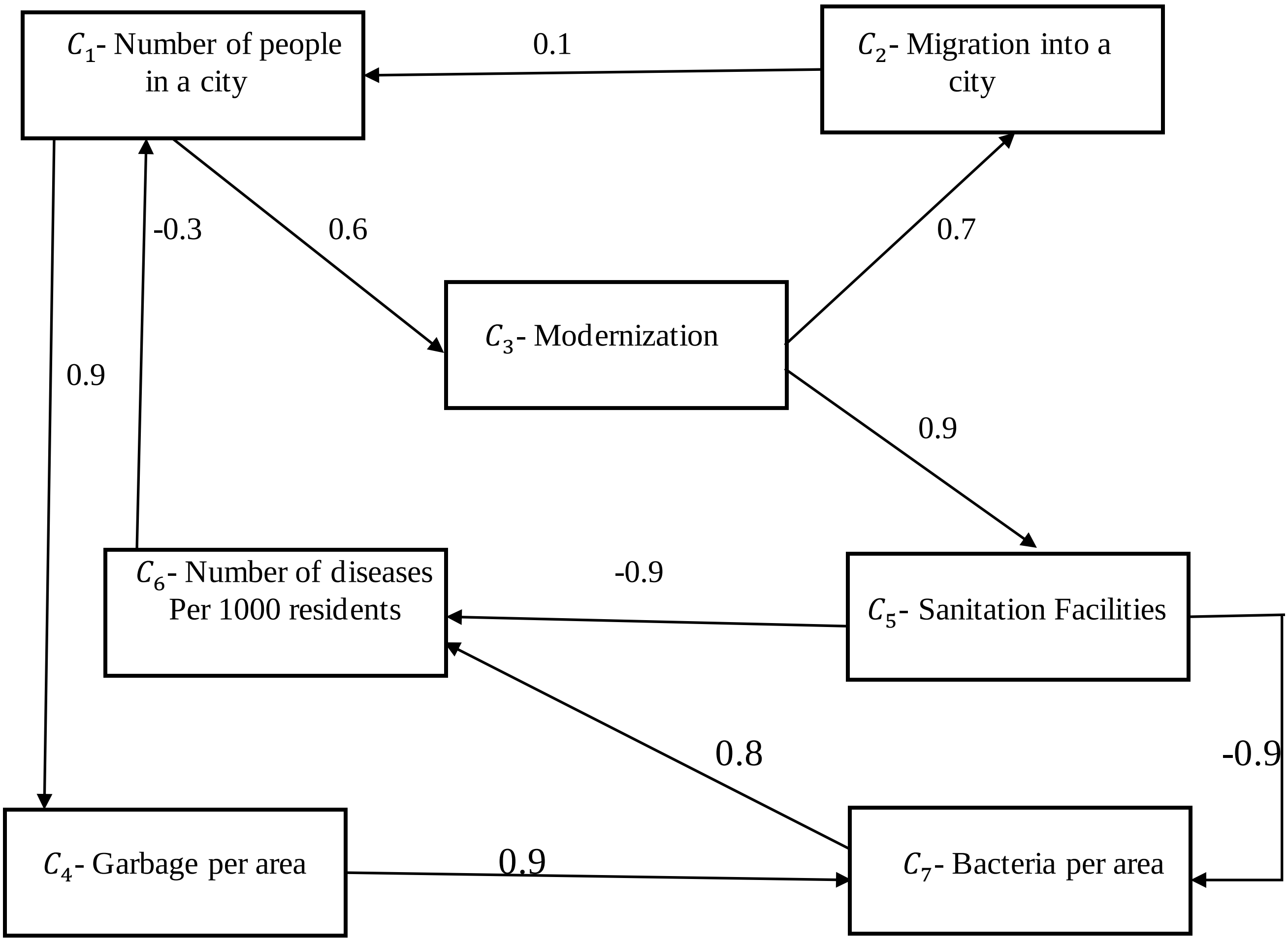


[14]

Weighted FCM

FCM eith edge weights (or) causalities frim the interval [-1, 1] are called a weighted FCM.[5]

Example



It is the example of a weighted fuzzy cognitive map, illustrating weighted edge relationship (-1, 1) between system elements C_1, C_2, C_3, C_4, C_5, C_6 and C_7.[13]

1.3.4 Instantaneous Vector

Ler us consider, C_1, C_2, C_3, …, C_n be the node of an FCM. A= (a_1, a_2, a_3, …, 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.

$a_i = 0$ if a_i is off and

$a_i = 1$ if a_i is on. For i= 1, 2, 3, …, n. [5]

1.3.5 Cyclic

Let us assume that C_1, C_2, C_3, …, C_n be the nodes of an FCM. Let $\overline{C_{1,}C_2}$, $\overline{C_{2,}C_3}$, $\overline{C_{3,}C_4}$, …, $\overline{C_{i,}C_j}$ be the edges of the FCM ($i \neq j$). Then the edges from 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.[5]

1.3.6 Feed Back

An FCM with cycle is said to have feedback.[5]

1.3.7 Dynamical System

When there is a feedback in an FCM, (i.e.)., when the causal relations through a cycle in a revolutionary way, the FCM is called a dynamical system.[5]

1.3.8 Hidden Pattern

Let us consider, $\overline{C_1C_2}$, $\overline{C_2C_3}$, $\overline{C_3C_4}$ ..., $\overline{C_{n-1}C_n}$ 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 tree for any node C_i, for i =1, 2, 3, ..., n. The equilibrium state for this dynamical system is called the hidden pattern.[5]

1.3.9 Fixed Point

If the equilibrium state of a dynamical system is a unique state vector. Then it is called fixed point.[5]

1.3.9 Example

Let us consider a FCM with C_1, C_2, C_3, …, C_n as nodes. For example, let us start the dynamical system by switching on C_1. Let us assume that the FCM settle down with C_1 and C_n. (i.e.)., the state vector remains as (1, 0, 0, …, 1) this state vector.

(1, 0, 0, …, 1) is called the fixed point[5].

1.3.10 Limit Cycle

If the FCM settle down with a state vector repeating in the form $A_1 \rightarrow A_2 \rightarrow A_3 \rightarrow \ldots \rightarrow A_i \rightarrow A_I$. Then this equilibrium is called a limit cycle.[5]

1.3.11 Combined FCM

Finite number of FCM can be combined together to produce the joint effect of all the FCMs. Let E_1, E_2, E_3, …, E_p be the adjacency matrices of the FCMs with nodes C_1, C_2, C_3, …, C_n then the combined FCM is got by adding all the adjacency matrices.

We denote the combined FCM adjacency matrix by $E_1+E_2+ E_3+\ldots+E_p$.[5]

1.3.12 Notation

Suppose A = (a_1, a_2, a_3, …, a_n) is a vector which is passed into a dynamical system E. Then AE = $(a^1_{1,}\ a^1_{2,}\ \ a^1_3\ \ \ldots, a^1_{n,})$ after thresholding and updating the vector suppose we get (b_1, b_2, b_3, …, b_n) we denote that by

$$(a^1_{1,}\ a^1_{2,}\ \ a^1_3\ \ \ldots, a^1_{n,}) \to (b_1, b_2, b_3, \ldots, b_n)$$

Thus, the symbol "→" means the resultant vector has been threshold and uploaded.[5]

Source: W.B. Vasantha Kandasamy, Florentin Smarandache,(2004), ' Fuzzy Cognitive Maps and Neutrosophic Cognitive Maps, Xiquan phoenix', pp:7-9.

Literature Review

- Fuzzy Cognitive Map – (Bart Kosko, 1986).
- Fuzzy Associative Memory System – (Bart Kosko, 1992).
- Extended Fuzzy Cognitive Map – (Hagiwara,M., 1992).
- Combined Matrices of FCM – (Silva.P.C., 1995).
- Contextual FCM – (Liu,Z.Q. et.al., 1999).
- Multi-Step Fuzzy Cognitive Map – (Ozesmi,U. et.al., 1999).
- Rule Based FCM – (Carvalho, J.P et.al.,2001).
- Dynamic FCM – (Aguliar, J., 2003).
- Neutrosophic Cognitive Map – (Vasantha Kandasamy, W. B.et.al., 2003).
- Genetically Evolved FCM – (Andreou et.al., 2005).
- Evolutionary Multi-Layered FCM – (Mateou et. Al., 2006).
- Fuzzy Cognitive Network – (Kottas, T.L. et.al., 2007).
- Temporal FCM – (Zhong, H et.al., 2008).
- Augmented FCM – (Salmeron., 2009).
- Fuzzy Grey Cognitive Maps – (Salmeron et.al., 2010).
- Intutionistic Fuzzy Cognitive Map – (lakovidis et.al., 2011).
- Ranking FCM – (Salmeron, J.L. et. Al., 2012).
- Flexible FCM – (Chen, C.T. et.al., 2016).
- New RB-FCMs – (Zdanowicz, P. et.al., 2018).

CHAPTER – II

ALGORITHMIC APPROACH OF FCM

This chapter about implementation of induced Fuzzy Cognitive Map.

2.1 Algorithmic Approach in Fuzzy Cognitive Map

The steps below should be followed to arrive at an optimistic solution to the problem with unsupervised data.

Step 1: Collect unstructured data, that is, in deterministic, for the given societal issue. Nodes are what we call factors.

Step 2: Make the simple FCM with edge value e_{ij}, as recommended by the experts (-1, 0, 1).

Step 3: From the directed graph, obtain a connection matrix, M_1 (FCM). The number of rows in the specified matrix equals the set of steps to be completed.

Step 4: Take a look at the state vector C_1, which is currently in the ON position. Locate C_1. M_1. At each stage, the state vector is updated with the threshold.

Step 5: To find the threshold value, allocate 1 to values greater than 0 and 0 to values less than 0. The symbol "→" stands for the result's threshold value.

Step 6: The value is deemed the fixed point when the same thresholding appears twice. The iterations will come to an end at this point.

Step 7: Assign the element of the state vector C_1 to 1 and the rest of the elements to 0. Steps 4–6 should be followed to complete the computation.

Step 8: Repeat steps 7 and 8 for each state vector, looking for the hidden pattern.[5]

CHAPTER – III

PROBLEM DISCRIPTION AND IMPLEMENTATION

This chapter deals with happiness index and its factors for benefiting adolescence.

3.1 Problem Description

Happiness

Happiness is a psychological state of being happy. Where the mind and soul have positive thoughts and which helps in leading a healthy lifestyle. It is an emotion. Happiness is being joyous.[15]

3.1.1 Four Levels of Happiness

Aristotle's four levels of happiness

(i) Level 1 – Laetus (short lived – gained through material things)

(ii) Level 2 – Felix (through comparison and achievements)

(iii) Level 3 – Beatitudo (doing good to others)

(iv) Level 4 - Sublime (eternal – completeness and fulfillment)[16]

3.1.2 Happiness Index

Happiness Index is the extensive measure of human well-being. It helps to look into the psychological state of individuals and their satisfaction with life. This is a survey to understand and enhance an individual person's happiness.[3]

The World Happiness Report contains the rankings of nation's happiness on the basis of an individual's life and in correlation with few many factors. According to the report of 2022, Finland seems to be the happiest country. India ranks 136 out of 145 countries.[4]

Happiness is a state of mind. It is the act of being jovial, and truly enjoy ing life with pleasure and having the desire to do what's good for oneself. And more over happiness comes from one's own actions. It has a positive effect in uplifting the lives of young children and teens.[17]

3.1.3 Lack of happiness in adolescence

Happiness comes from within. Our young generation who are in their early and late adolescent period are lacking it. Now-a-days children seems to spend much time in online and forget to live in the moment, they don't give attention to what is happening around them. They are worried about life events and their future.[18]

Many don't have a proper sleep which makes them feel tired and stressful. Lacking motivation and feeling worthless also has a negative impact. Not looking after oneself while some are addicted to drugs. Even family situations make them worried.[18]

Not having a friendly environment in schools and neighbourhood and some are even bullied. When young children are not satisfied in what they do, they lose interest in everything.[18]

We can create our own happiness through positive thinking. The first step in that is accepting ourselves the way we are. Accepting our flaws and owning our quirks. Try to ignore negative thoughts. The way we see things and react are one of the aspects in being happy.[18]

3.2 Factors to inculcate happiness index in adolescence

Studies show that it is important for teenagers to experience happiness for their future well-being. Based on the articles from public health notes and hindu website, the beneficial factors to boost happiness in adolescence are analysed and framed.

C_1 – Focusing mental health and psychological well being

C_2 – Maintaining physical fitness and practicing healthy lifestyle

C_3 – Healthy relationships in families and neighbourhood

C_4 – Good in time management

C_5 – Focusing on goals and achievement on daily basis

C_6 – Enjoying the art of learning everyday

C_7 – Practising mindfulness – living in the moment

C_8 - Helping others and showing gratitude

C_9 - Financial awareness and management

C_{10} – Accepting yourselves the way you are

C_{11} – Stick on to spirituality and emotional well-being

C_1 - Focusing mental health and psychological well being

Mental health has a direct impact on happiness. It involves emotional, social and psychological well-being. Mental health includes coping with stress, realizing our abilities, learning and working well and contributing to our community. It impacts our thoughts, actions and emotions. It is very essential for leading a balanced and happy life. It helps in realizing our full potential. Mental health is as important as physical health. It results in being enthusiastic and having a passion for life, accepting both good and bad situations, having a sense of purpose and contentment. People with good mental health will have high self-confidence and self-esteem. Enjoying our life with satisfaction ultimately helps in being happy.[19]

C_2 – Maintaining physical fitness and practicing healthy lifestyle

Healthy lifestyle not only keeps our body physical fit but all also contributes to psychological health. Intake of nutritious food makes you healthy and happy. Exercising helps in reducing anxiety and depression. It increases the production of brain chemicals like endorphins, dopamine, adrenaline and endocannabinoid. These chemicals help to feel capable, makes a person happy and boosts confidence. Exercise has influence on a person's mental health which leads to happiness. It helps in improving the relationship around family and friends.[20]

C_3 – Healthy relationships in families and neighbourhood

Young children feel loved and secured when they have a positive and strong family relationships. Families help in resolving conflicts, helps to work in teams. People are connected with some strong emotions. When we are supported, we have a greater sense of belonging. People who have close friendship or relationship with others tend to be happier, because they can share their personal thoughts which relieves stress and depression. This leads to better health and even longer life.[21]

C_4 – Good in time management

Effective time management improves work-life and increases happiness. It reduces stress and helps in achieving our goals faster. It benefits every area of life. This helps to work smarter and results in high productivity. They reduce procrastination and distractions. It helps to focus better and reduces stress. Time management helps to focus on the things that are really most important to a young individual. It gives more time to spend with our loved ones. When one is satisfied with their life, they tend to be happier.[22]

C_5 – Focusing on goals and achievement on daily basis

Setting a goal makes a person to feel more optimistic about their future. When one is optimistic, then they are healthy, happy and can cope with challenges of their life. There is a sense of purpose and accomplishment. When someone is striving to achieve something bigger, they get more satisfaction out of it. When we reach our goal, it makes us happy. But even if one fails to achieve, it helps in improving a person's well-being.[23]

C_6 – Enjoying the art of learning everyday

Learning is in correlation with happiness and well-being. Learning, growing and challenging ourselves helps in gaining happiness. This helps to develop oneself and be better. Learning empowers young students, gives them self-confidence, helps in building resilience and motivation. When someone learn new things with interest, definitely they will feel the sense of fulfilment and satisfaction. Learning new skill boosts happiness. New experiences and learning from childhood generate new brain and neural cells and strengthens the brain, which is associated with happy and healthy life ahead.[24]

C_7 – Practising mindfulness – living in the moment

Mindfulness is associated with high levels of happiness. It lowers anxiety and helps to manage one's reactions and emotions. It benefits students in schools and their colleges. Today all young generation have a long hours of screening time in their social media. Some are busy with their lives doing multi-tasks. Being mindful helps to be more attentive in the present, helps in noticing what we are experiencing. This helps in realising whether it is supportive or harmful for our well-being and makes us to focus on good. It also makes us calm and be in control. It even shows what we are capable of and helps in making wise choices.[25]

C_8 - Helping others and showing gratitude

Helping others and being kind not only contributes to the happiness of others, but it also makes us feel happier. Expressing gratitude is associated with a host of mental and physical benefits. Feeling thankful can improve sleep, mood and anxiety. Helping others and showing gratitude creates a sense of belonging and reduces tension. It helps to connect with others and helps in building stronger communities. It activates the emotions which are vital to maintain good health. It reduces negative attitudes. It gives satisfaction and boosts our self-confidence.[26]

C_9 - Financial awareness and management

Financial happiness is a state of mind which comes from knowing we have the money to buy things that will make our life better. But money can enhance happiness only to a certain extend. Financial literacy in teens helps to promote self-confidence and believe in their own abilities. They can learn to manage and save money from their successful choices as well as mistakes. This awareness from childhood results in financial well-being in their adulthood.[27]

C_{10} – Accepting yourselves the way you are

Self-acceptance is a key to happiness. When we are accepting ourselves, we embrace every part of ourselves including both the positive and negative things. It is being satisfied with you we are despite our flaws. Teens who show compassion to others have a difficult time to show that compassion to themselves. It increases stress and depression. Self-acceptance decreases depressive symptoms, desire to be approved by others, fear of failure and self-criticism. It increases self-worth, sense of freedom, self-esteem and gives positive emotions. It over all helps in individual’s wellbeing.[28]

C_{11} – Stick on to spirituality and emotional well-being

Spirituality is about seeking a meaningful connection with something bigger than yourself. Spiritual happiness comes with the sense of eternal hope and trust in universal perfection. It opens the door to everlasting peace, love and happiness. Spirituality is the science of the spirit. It reveals truth. It leads to self-realisation. A spiritual sense leads to motivation to fix things. It reduces depression and gives a peace of mind.[29]

3.3 Implementation of FCM In Problem

Beneficial factors to boost happiness in adolescence:

C_1 – Focusing mental health and psychological well being

C_2 – Maintaining physical fitness and practicing healthy lifestyle

C_3 – Healthy relationships in families and neighbourhood

C_4 – Good in time management

C_5 – Focusing on goals and achievement on daily basis

C_6 – Enjoying the art of learning everyday

C_7 – Practising mindfulness – living in the moment

C_8 - Helping others and showing gratitude

C_9 - Financial awareness and management

C_{10} – Accepting yourselves the way you are

C_{11} – Stick on to spirituality and emotional well-being

According to the domain expert the above factors have been analysed and the adjacency matrix of the Fuzzy Cognitive Map is given as follows:

The Adjacency Matrix is

$$M = \begin{array}{cc} & \begin{array}{ccccccccccc} C_1 & C_2 & C_3 & C_4 & C_5 & C_6 & C_7 & C_8 & C_9 & C_{10} & C_{11} \end{array} \\ \begin{array}{c} C_1 \\ C_2 \\ C_3 \\ C_4 \\ C_5 \\ C_6 \\ C_7 \\ C_8 \\ C_9 \\ C_{10} \\ C_{11} \end{array} & \begin{bmatrix} - & 0.7 & 0.9 & 0.6 & 0.7 & 0.5 & 1 & 0.8 & 0.6 & 0.9 & 0.6 \\ 0.5 & - & 0.5 & 0.8 & 0.8 & 0.4 & 0.6 & 0.3 & 0.5 & 0.9 & 0.5 \\ 0.8 & 0.6 & - & 0.6 & 0.7 & 0.3 & 0.5 & 0.9 & 0.6 & 0.8 & 0.7 \\ 0.7 & 0.5 & 0.4 & - & 0.9 & 0.7 & 0.6 & 0.5 & 0.8 & 0.6 & 0.6 \\ 0.8 & 0.8 & 0.5 & 0.9 & - & 0.6 & 0.7 & 0.8 & 0.9 & 0.7 & 0.5 \\ 0.7 & 0.7 & 0.8 & 0.7 & 0.6 & - & 0.7 & 0.6 & 0.8 & 0.7 & 0.7 \\ 0.8 & 0.8 & 0.8 & 0.9 & 0.9 & 0.8 & - & 0.9 & 0.8 & 0.9 & 0.8 \\ 0.8 & 0.3 & 0.9 & 0.6 & 0.7 & 0.6 & 0.8 & - & 0.5 & 0.7 & 0.7 \\ 0.8 & 0.5 & 0.3 & 0.9 & 0.8 & 0.6 & 0.5 & 0.5 & - & 0.7 & 0.6 \\ 0.9 & 0.8 & 0.8 & 0.2 & 0.7 & 0.6 & 0.7 & 0.6 & 0.2 & - & 0.7 \\ 0.8 & 0.7 & 0.8 & 0.5 & 0.7 & 0.7 & 0.8 & 0.8 & 0.5 & 0.9 & - \end{bmatrix} \end{array}$$

Calculations:

Step 1:

Let $C_1 = (1\quad 0\quad 0\quad 0\quad 0\quad 0\quad 0\quad 0\quad 0\quad 0\quad 0)$ be an instantaneous state vector.

It is an ON position.

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

$C_1 \times M = (1\quad 0\quad 0\quad 0\quad 0\quad 0\quad 0\quad 0\quad 0\quad 0\quad 0) \times$

$$\begin{bmatrix} - & 0.7 & 0.9 & 0.6 & 0.7 & 0.5 & 1 & 0.8 & 0.6 & 0.9 & 0.6 \\ 0.5 & - & 0.5 & 0.8 & 0.8 & 0.4 & 0.6 & 0.3 & 0.5 & 0.9 & 0.5 \\ 0.8 & 0.6 & - & 0.6 & 0.7 & 0.3 & 0.5 & 0.9 & 0.6 & 0.8 & 0.7 \\ 0.7 & 0.5 & 0.4 & - & 0.9 & 0.7 & 0.6 & 0.5 & 0.8 & 0.6 & 0.6 \\ 0.8 & 0.8 & 0.5 & 0.9 & - & 0.6 & 0.7 & 0.8 & 0.9 & 0.7 & 0.5 \\ 0.7 & 0.7 & 0.8 & 0.7 & 0.6 & - & 0.7 & 0.6 & 0.8 & 0.7 & 0.7 \\ 0.8 & 0.8 & 0.8 & 0.9 & 0.9 & 0.8 & - & 0.9 & 0.8 & 0.9 & 0.8 \\ 0.8 & 0.3 & 0.9 & 0.6 & 0.7 & 0.6 & 0.8 & - & 0.5 & 0.7 & 0.7 \\ 0.8 & 0.5 & 0.3 & 0.9 & 0.8 & 0.6 & 0.5 & 0.5 & - & 0.7 & 0.6 \\ 0.9 & 0.8 & 0.8 & 0.2 & 0.7 & 0.6 & 0.7 & 0.6 & 0.2 & - & 0.7 \\ 0.8 & 0.7 & 0.8 & 0.5 & 0.7 & 0.7 & 0.8 & 0.8 & 0.5 & 0.9 & - \end{bmatrix}$$

$= (0\quad 0.7\quad 0.9\quad 0.6\quad 0.7\quad 0.5\quad 1\quad 0.8\quad 0.6\quad 0.9\quad 0.6)$

$\rightarrow (1\quad 1\quad 1\quad 1\quad 1\quad 1\quad 1\quad 1\quad 1\quad 1\quad 1) = C_1'$

$C_1' \times M = (1\quad 1\quad 1\quad 1\quad 1\quad 1\quad 1\quad 1\quad 1\quad 1\quad 1) \times$

$$\begin{bmatrix} - & 0.7 & 0.9 & 0.6 & 0.7 & 0.5 & 1 & 0.8 & 0.6 & 0.9 & 0.6 \\ 0.5 & - & 0.5 & 0.8 & 0.8 & 0.4 & 0.6 & 0.3 & 0.5 & 0.9 & 0.5 \\ 0.8 & 0.6 & - & 0.6 & 0.7 & 0.3 & 0.5 & 0.9 & 0.6 & 0.8 & 0.7 \\ 0.7 & 0.5 & 0.4 & - & 0.9 & 0.7 & 0.6 & 0.5 & 0.8 & 0.6 & 0.6 \\ 0.8 & 0.8 & 0.5 & 0.9 & - & 0.6 & 0.7 & 0.8 & 0.9 & 0.7 & 0.5 \\ 0.7 & 0.7 & 0.8 & 0.7 & 0.6 & - & 0.7 & 0.6 & 0.8 & 0.7 & 0.7 \\ 0.8 & 0.8 & 0.8 & 0.9 & 0.9 & 0.8 & - & 0.9 & 0.8 & 0.9 & 0.8 \\ 0.8 & 0.3 & 0.9 & 0.6 & 0.7 & 0.6 & 0.8 & - & 0.5 & 0.7 & 0.7 \\ 0.8 & 0.5 & 0.3 & 0.9 & 0.8 & 0.6 & 0.5 & 0.5 & - & 0.7 & 0.6 \\ 0.9 & 0.8 & 0.8 & 0.2 & 0.7 & 0.6 & 0.7 & 0.6 & 0.2 & - & 0.7 \\ 0.8 & 0.7 & 0.8 & 0.5 & 0.7 & 0.7 & 0.8 & 0.8 & 0.5 & 0.9 & - \end{bmatrix}$$

$= (7.6\quad 6.4\quad 6.7\quad 6.7\quad 7.5\quad 5.8\quad 6.9\quad 6.7\quad 6.2\quad 7.8\quad 6.4)$

$\rightarrow (1\quad 1\quad 1\quad 1\quad 1\quad 1\quad 1\quad 1\quad 1\quad 1\quad 1) = C_1''$

$C''_1 \times M = (1 \quad 1 \quad 1 \quad 1 \quad 1 \quad 1 \quad 1 \quad 1 \quad 1 \quad 1 \quad 1) \times$

$$\begin{bmatrix} - & 0.7 & 0.9 & 0.6 & 0.7 & 0.5 & 1 & 0.8 & 0.6 & 0.9 & 0.6 \\ 0.5 & - & 0.5 & 0.8 & 0.8 & 0.4 & 0.6 & 0.3 & 0.5 & 0.9 & 0.5 \\ 0.8 & 0.6 & - & 0.6 & 0.7 & 0.3 & 0.5 & 0.9 & 0.6 & 0.8 & 0.7 \\ 0.7 & 0.5 & 0.4 & - & 0.9 & 0.7 & 0.6 & 0.5 & 0.8 & 0.6 & 0.6 \\ 0.8 & 0.8 & 0.5 & 0.9 & - & 0.6 & 0.7 & 0.8 & 0.9 & 0.7 & 0.5 \\ 0.7 & 0.7 & 0.8 & 0.7 & 0.6 & - & 0.7 & 0.6 & 0.8 & 0.7 & 0.7 \\ 0.8 & 0.8 & 0.8 & 0.9 & 0.9 & 0.8 & - & 0.9 & 0.8 & 0.9 & 0.8 \\ 0.8 & 0.3 & 0.9 & 0.6 & 0.7 & 0.6 & 0.8 & - & 0.5 & 0.7 & 0.7 \\ 0.8 & 0.5 & 0.3 & 0.9 & 0.8 & 0.6 & 0.5 & 0.5 & - & 0.7 & 0.6 \\ 0.9 & 0.8 & 0.8 & 0.2 & 0.7 & 0.6 & 0.7 & 0.6 & 0.2 & - & 0.7 \\ 0.8 & 0.7 & 0.8 & 0.5 & 0.7 & 0.7 & 0.8 & 0.8 & 0.5 & 0.9 & - \end{bmatrix}$$

$= (7.6 \quad 6.4 \quad 6.7 \quad 6.7 \quad 7.5 \quad 5.8 \quad 6.9 \quad 6.7 \quad 6.2 \quad 7.8 \quad 6.4)$

$\rightarrow (1 \quad 1 \quad 1 \quad 1 \quad 1 \quad 1 \quad 1 \quad 1 \quad 1 \quad 1 \quad 1) = C'''_1 = C''_1$

Therefore, $C'''_1 = C''_1 \Rightarrow$ fixed point is $C_1 = (1 \quad 0 \quad 0 \quad 0 \quad 0 \quad 0 \quad 0 \quad 0 \quad 0 \quad 0 \quad 0)$

Step 2:

Let $C_2 = (0 \quad 1 \quad 0 \quad 0 \quad 0 \quad 0 \quad 0 \quad 0 \quad 0 \quad 0 \quad 0)$ be an instantaneous state vector.

It is an ON position.

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

$C_2 \times M = (0 \quad 1 \quad 0 \quad 0 \quad 0 \quad 0 \quad 0 \quad 0 \quad 0 \quad 0 \quad 0) \times$

$$\begin{bmatrix} - & 0.7 & 0.9 & 0.6 & 0.7 & 0.5 & 1 & 0.8 & 0.6 & 0.9 & 0.6 \\ 0.5 & - & 0.5 & 0.8 & 0.8 & 0.4 & 0.6 & 0.3 & 0.5 & 0.9 & 0.5 \\ 0.8 & 0.6 & - & 0.6 & 0.7 & 0.3 & 0.5 & 0.9 & 0.6 & 0.8 & 0.7 \\ 0.7 & 0.5 & 0.4 & - & 0.9 & 0.7 & 0.6 & 0.5 & 0.8 & 0.6 & 0.6 \\ 0.8 & 0.8 & 0.5 & 0.9 & - & 0.6 & 0.7 & 0.8 & 0.9 & 0.7 & 0.5 \\ 0.7 & 0.7 & 0.8 & 0.7 & 0.6 & - & 0.7 & 0.6 & 0.8 & 0.7 & 0.7 \\ 0.8 & 0.8 & 0.8 & 0.9 & 0.9 & 0.8 & - & 0.9 & 0.8 & 0.9 & 0.8 \\ 0.8 & 0.3 & 0.9 & 0.6 & 0.7 & 0.6 & 0.8 & - & 0.5 & 0.7 & 0.7 \\ 0.8 & 0.5 & 0.3 & 0.9 & 0.8 & 0.6 & 0.5 & 0.5 & - & 0.7 & 0.6 \\ 0.9 & 0.8 & 0.8 & 0.2 & 0.7 & 0.6 & 0.7 & 0.6 & 0.2 & - & 0.7 \\ 0.8 & 0.7 & 0.8 & 0.5 & 0.7 & 0.7 & 0.8 & 0.8 & 0.5 & 0.9 & - \end{bmatrix}$$

$= (0.5 \quad 0 \quad 0.5 \quad 0.8 \quad 0.8 \quad 0.4 \quad 0.6 \quad 0.3 \quad 0.5 \quad 0.9 \quad 0.5)$

$\rightarrow (1 \quad 1 \quad 1 \quad 1 \quad 1 \quad 1 \quad 1 \quad 1 \quad 1 \quad 1 \quad 1) = C'_2$

$C_2' \times \mathrm{M} = (1 \quad 1 \quad 1 \quad 1 \quad 1 \quad 1 \quad 1 \quad 1 \quad 1 \quad 1 \quad 1) \times$
$$\begin{bmatrix} - & 0.7 & 0.9 & 0.6 & 0.7 & 0.5 & 1 & 0.8 & 0.6 & 0.9 & 0.6 \\ 0.5 & - & 0.5 & 0.8 & 0.8 & 0.4 & 0.6 & 0.3 & 0.5 & 0.9 & 0.5 \\ 0.8 & 0.6 & - & 0.6 & 0.7 & 0.3 & 0.5 & 0.9 & 0.6 & 0.8 & 0.7 \\ 0.7 & 0.5 & 0.4 & - & 0.9 & 0.7 & 0.6 & 0.5 & 0.8 & 0.6 & 0.6 \\ 0.8 & 0.8 & 0.5 & 0.9 & - & 0.6 & 0.7 & 0.8 & 0.9 & 0.7 & 0.5 \\ 0.7 & 0.7 & 0.8 & 0.7 & 0.6 & - & 0.7 & 0.6 & 0.8 & 0.7 & 0.7 \\ 0.8 & 0.8 & 0.8 & 0.9 & 0.9 & 0.8 & - & 0.9 & 0.8 & 0.9 & 0.8 \\ 0.8 & 0.3 & 0.9 & 0.6 & 0.7 & 0.6 & 0.8 & - & 0.5 & 0.7 & 0.7 \\ 0.8 & 0.5 & 0.3 & 0.9 & 0.8 & 0.6 & 0.5 & 0.5 & - & 0.7 & 0.6 \\ 0.9 & 0.8 & 0.8 & 0.2 & 0.7 & 0.6 & 0.7 & 0.6 & 0.2 & - & 0.7 \\ 0.8 & 0.7 & 0.8 & 0.5 & 0.7 & 0.7 & 0.8 & 0.8 & 0.5 & 0.9 & - \end{bmatrix}$$

$= (7.6 \quad 6.4 \quad 6.7 \quad 6.7 \quad 7.5 \quad 5.8 \quad 6.9 \quad 6.7 \quad 6.2 \quad 7.8 \quad 6.4)$

$\rightarrow (1 \quad 1 \quad 1 \quad 1 \quad 1 \quad 1 \quad 1 \quad 1 \quad 1 \quad 1 \quad 1) = C_2''$

$C''_2 \times \mathrm{M} = (1 \quad 1 \quad 1 \quad 1 \quad 1 \quad 1 \quad 1 \quad 1 \quad 1 \quad 1 \quad 1) \times$
$$\begin{bmatrix} - & 0.7 & 0.9 & 0.6 & 0.7 & 0.5 & 1 & 0.8 & 0.6 & 0.9 & 0.6 \\ 0.5 & - & 0.5 & 0.8 & 0.8 & 0.4 & 0.6 & 0.3 & 0.5 & 0.9 & 0.5 \\ 0.8 & 0.6 & - & 0.6 & 0.7 & 0.3 & 0.5 & 0.9 & 0.6 & 0.8 & 0.7 \\ 0.7 & 0.5 & 0.4 & - & 0.9 & 0.7 & 0.6 & 0.5 & 0.8 & 0.6 & 0.6 \\ 0.8 & 0.8 & 0.5 & 0.9 & - & 0.6 & 0.7 & 0.8 & 0.9 & 0.7 & 0.5 \\ 0.7 & 0.7 & 0.8 & 0.7 & 0.6 & - & 0.7 & 0.6 & 0.8 & 0.7 & 0.7 \\ 0.8 & 0.8 & 0.8 & 0.9 & 0.9 & 0.8 & - & 0.9 & 0.8 & 0.9 & 0.8 \\ 0.8 & 0.3 & 0.9 & 0.6 & 0.7 & 0.6 & 0.8 & - & 0.5 & 0.7 & 0.7 \\ 0.8 & 0.5 & 0.3 & 0.9 & 0.8 & 0.6 & 0.5 & 0.5 & - & 0.7 & 0.6 \\ 0.9 & 0.8 & 0.8 & 0.2 & 0.7 & 0.6 & 0.7 & 0.6 & 0.2 & - & 0.7 \\ 0.8 & 0.7 & 0.8 & 0.5 & 0.7 & 0.7 & 0.8 & 0.8 & 0.5 & 0.9 & - \end{bmatrix}$$

$= (7.6 \quad 6.4 \quad 6.7 \quad 6.7 \quad 7.5 \quad 5.8 \quad 6.9 \quad 6.7 \quad 6.2 \quad 7.8 \quad 6.4)$

$\rightarrow (1 \quad 1 \quad 1 \quad 1 \quad 1 \quad 1 \quad 1 \quad 1 \quad 1 \quad 1 \quad 1) = C'''_2 = C''_2$

Therefore, $C'''_2 = C''_2 \Rightarrow$ fixed point is $C_2 = (0 \quad 1 \quad 0 \quad 0 \quad 0 \quad 0 \quad 0 \quad 0 \quad 0 \quad 0 \quad 0)$

Step 3:

Let $C_3 = (0 \quad 0 \quad 1 \quad 0 \quad 0 \quad 0 \quad 0 \quad 0 \quad 0 \quad 0 \quad 0)$ be an instantaneous state vector.

It is an ON position.

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

$C_3 \times \mathrm{M} = (0.8 \quad 0.6 \quad 0 \quad 0.6 \quad 0.7 \quad 0.3 \quad 0.5 \quad 0.9 \quad 0.6 \quad 0.8 \quad 0.7)$

$\rightarrow (1 \quad 1 \quad 1 \quad 1 \quad 1 \quad 1 \quad 1 \quad 1 \quad 1 \quad 1 \quad 1) = C_3'$

$C_3' \times \mathrm{M} = (7.6 \quad 6.4 \quad 6.7 \quad 6.7 \quad 7.5 \quad 5.8 \quad 6.9 \quad 6.7 \quad 6.2 \quad 7.8 \quad 6.4)$

$\rightarrow (1 \quad 1 \quad 1 \quad 1 \quad 1 \quad 1 \quad 1 \quad 1 \quad 1 \quad 1 \quad 1) = C_3''$

$C''_3 \times$ M = $(7.6 \quad 6.4 \quad 6.7 \quad 6.7 \quad 7.5 \quad 5.8 \quad 6.9 \quad 6.7 \quad 6.2 \quad 7.8 \quad 6.4)$

$\rightarrow (1 \quad 1 \quad 1 \quad 1 \quad 1 \quad 1 \quad 1 \quad 1 \quad 1 \quad 1 \quad 1) = C_3''' = C''_3$

Therefore, $C'''_3 = C''_3 \Rightarrow$ fixed point is $C_3 = (0 \quad 0 \quad 1 \quad 0 \quad 0 \quad 0 \quad 0 \quad 0 \quad 0 \quad 0 \quad 0)$

Step 4:

Let $C_4 = (0 \quad 0 \quad 0 \quad 1 \quad 0 \quad 0 \quad 0 \quad 0 \quad 0 \quad 0 \quad 0)$ be an instantaneous state vector.

It is an ON position.

$C_4 = (0 \quad 0 \quad 0 \quad 1 \quad 0 \quad 0 \quad 0 \quad 0 \quad 0 \quad 0 \quad 0)$

$C_4 \times$ M = $(0.7 \quad 0.5 \quad 0.4 \quad 0 \quad 0.9 \quad 0.7 \quad 0.6 \quad 0.5 \quad 0.8 \quad 0.6 \quad 0.6)$

$\rightarrow (1 \quad 1 \quad 1 \quad 1 \quad 1 \quad 1 \quad 1 \quad 1 \quad 1 \quad 1 \quad 1) = C_4'$

$C_4' \times$ M = $(7.6 \quad 6.4 \quad 6.7 \quad 6.7 \quad 7.5 \quad 5.8 \quad 6.9 \quad 6.7 \quad 6.2 \quad 7.8 \quad 6.4)$

$\rightarrow (1 \quad 1 \quad 1 \quad 1 \quad 1 \quad 1 \quad 1 \quad 1 \quad 1 \quad 1 \quad 1) = C_4''$

$C''_4 \times$ M = $(7.6 \quad 6.4 \quad 6.7 \quad 6.7 \quad 7.5 \quad 5.8 \quad 6.9 \quad 6.7 \quad 6.2 \quad 7.8 \quad 6.4)$

$\rightarrow (1 \quad 1 \quad 1 \quad 1 \quad 1 \quad 1 \quad 1 \quad 1 \quad 1 \quad 1 \quad 1) = C_4''' = C''_4$

Therefore, $C'''_4 = C''_4 \Rightarrow$ fixed point is $C_4 = (0 \quad 0 \quad 1 \quad 0 \quad 0 \quad 0 \quad 0 \quad 0 \quad 0 \quad 0 \quad 0)$.

Step 5:

Let $C_5 = (0 \quad 0 \quad 0 \quad 0 \quad 1 \quad 0 \quad 0 \quad 0 \quad 0 \quad 0 \quad 0)$ be an instantaneous state vector.

It is an ON position.

$C_5 = (0 \quad 0 \quad 0 \quad 0 \quad 1 \quad 0 \quad 0 \quad 0 \quad 0 \quad 0 \quad 0)$

$C_5 \times$ M = $(0.8 \quad 0.8 \quad 0.5 \quad 0.9 \quad 0 \quad 0.6 \quad 0.7 \quad 0.8 \quad 0.9 \quad 0.7 \quad 0.5)$

$\rightarrow (1 \quad 1 \quad 1 \quad 1 \quad 1 \quad 1 \quad 1 \quad 1 \quad 1 \quad 1 \quad 1) = C_5'$

$C_5' \times$ M = $(7.6 \quad 6.4 \quad 6.7 \quad 6.7 \quad 7.5 \quad 5.8 \quad 6.9 \quad 6.7 \quad 6.2 \quad 7.8 \quad 6.4)$

$\rightarrow (1 \quad 1 \quad 1 \quad 1 \quad 1 \quad 1 \quad 1 \quad 1 \quad 1 \quad 1 \quad 1) = C_5''$

$C_5'' \times$ M = $(7.6 \quad 6.4 \quad 6.7 \quad 6.7 \quad 7.5 \quad 5.8 \quad 6.9 \quad 6.7 \quad 6.2 \quad 7.8 \quad 6.4)$

$\rightarrow (1 \quad 1 \quad 1 \quad 1 \quad 1 \quad 1 \quad 1 \quad 1 \quad 1 \quad 1 \quad 1) = C_5''' = C''_5$

Therefore, $C'''_5 = C''_5 \Rightarrow$ fixed point is $C_5 = (0 \quad 0 \quad 0 \quad 0 \quad 1 \quad 0 \quad 0 \quad 0 \quad 0 \quad 0 \quad 0)$.

Step 6:

Let $C_6 = (0 \quad 0 \quad 0 \quad 0 \quad 0 \quad 1 \quad 0 \quad 0 \quad 0 \quad 0 \quad 0)$ be an instantaneous state vector.

It is an ON position.

$C_6 = (0 \quad 0 \quad 0 \quad 0 \quad 0 \quad 1 \quad 0 \quad 0 \quad 0 \quad 0 \quad 0)$

$C_6 \times M = (0.7 \quad 0.7 \quad 0.8 \quad 0.7 \quad 0.6 \quad 0 \quad 0.7 \quad 0.6 \quad 0.8 \quad 0.7 \quad 0.7)$

$\rightarrow (1 \quad 1 \quad 1 \quad 1 \quad 1 \quad 1 \quad 1 \quad 1 \quad 1 \quad 1 \quad 1) = C_6'$

$C_6' \times M = (7.6 \quad 6.4 \quad 6.7 \quad 6.7 \quad 7.5 \quad 5.8 \quad 6.9 \quad 6.7 \quad 6.2 \quad 7.8 \quad 6.4)$

$\rightarrow (1 \quad 1 \quad 1 \quad 1 \quad 1 \quad 1 \quad 1 \quad 1 \quad 1 \quad 1 \quad 1) = C''_6$

$C_6'' \times M = (7.6 \quad 6.4 \quad 6.7 \quad 6.7 \quad 7.5 \quad 5.8 \quad 6.9 \quad 6.7 \quad 6.2 \quad 7.8 \quad 6.4)$

$\rightarrow (1 \quad 1 \quad 1 \quad 1 \quad 1 \quad 1 \quad 1 \quad 1 \quad 1 \quad 1 \quad 1) = C_6''' = C''_6$

Therefore, $C'''_6 = C''_6 \Rightarrow$ fixed point is $C_6 = (0 \quad 0 \quad 0 \quad 0 \quad 0 \quad 1 \quad 0 \quad 0 \quad 0 \quad 0 \quad 0)$.

Step 7:

Let $C_7 = (0 \quad 0 \quad 0 \quad 0 \quad 0 \quad 0 \quad 1 \quad 0 \quad 0 \quad 0 \quad 0)$ be an instantaneous state vector.

It is an ON position.

$C_7 = (0 \quad 0 \quad 0 \quad 0 \quad 0 \quad 0 \quad 1 \quad 0 \quad 0 \quad 0 \quad 0)$

$C_7 \times M = (0.8 \quad 0.8 \quad 0.8 \quad 0.9 \quad 0.9 \quad 0.8 \quad 0 \quad 0.9 \quad 0.8 \quad 0.9 \quad 0.8)$

$\rightarrow (1 \quad 1 \quad 1 \quad 1 \quad 1 \quad 1 \quad 1 \quad 1 \quad 1 \quad 1 \quad 1) = C_7'$

$C_7' \times M = (7.6 \quad 6.4 \quad 6.7 \quad 6.7 \quad 7.5 \quad 5.8 \quad 6.9 \quad 6.7 \quad 6.2 \quad 7.8 \quad 6.4)$

$\rightarrow (1 \quad 1 \quad 1 \quad 1 \quad 1 \quad 1 \quad 1 \quad 1 \quad 1 \quad 1 \quad 1) = C''_7$

$C_7'' \times M = (7.6 \quad 6.4 \quad 6.7 \quad 6.7 \quad 7.5 \quad 5.8 \quad 6.9 \quad 6.7 \quad 6.2 \quad 7.8 \quad 6.4)$

$\rightarrow (1 \quad 1 \quad 1 \quad 1 \quad 1 \quad 1 \quad 1 \quad 1 \quad 1 \quad 1 \quad 1) = C_7''' = C''_7$

Therefore, $C'''_7 = C''_7 \Rightarrow$ fixed point is $C_7 = (0 \quad 0 \quad 0 \quad 0 \quad 0 \quad 0 \quad 1 \quad 0 \quad 0 \quad 0 \quad 0)$

Step 8:

Let $C_8 = (0 \quad 0 \quad 0 \quad 0 \quad 0 \quad 0 \quad 0 \quad 1 \quad 0 \quad 0 \quad 0)$ be an instantaneous state vector.

It is an ON position.

$C_8 = (0 \quad 0 \quad 0 \quad 0 \quad 0 \quad 0 \quad 0 \quad 1 \quad 0 \quad 0 \quad 0)$

$C_8 \times M = (0.8 \quad 0.3 \quad 0.9 \quad 0.6 \quad 0.7 \quad 0.6 \quad 0.8 \quad 0 \quad 0.5 \quad 0.7 \quad 0.7)$

$\rightarrow (1 \quad 1 \quad 1 \quad 1 \quad 1 \quad 1 \quad 1 \quad 1 \quad 1 \quad 1 \quad 1) = C'_8$

$C'_8 \times M = (7.6 \quad 6.4 \quad 6.7 \quad 6.7 \quad 7.5 \quad 5.8 \quad 6.9 \quad 6.7 \quad 6.2 \quad 7.8 \quad 6.4)$

$\rightarrow (1 \quad 1 \quad 1 \quad 1 \quad 1 \quad 1 \quad 1 \quad 1 \quad 1 \quad 1 \quad 1) = C''_8$

$C''_8 \times M = (7.6 \quad 6.4 \quad 6.7 \quad 6.7 \quad 7.5 \quad 5.8 \quad 6.9 \quad 6.7 \quad 6.2 \quad 7.8 \quad 6.4)$

$\rightarrow (1 \quad 1 \quad 1 \quad 1 \quad 1 \quad 1 \quad 1 \quad 1 \quad 1 \quad 1 \quad 1) = C'''_8 = C''_8$

Therefore, $C'''_8 = C''_8 \Rightarrow$ fixed point is $C_7 = (0 \quad 0 \quad 0 \quad 0 \quad 0 \quad 0 \quad 0 \quad 1 \quad 0 \quad 0 \quad 0)$

Step 9:

Let $C_9 = (0 \quad 0 \quad 0 \quad 0 \quad 0 \quad 0 \quad 0 \quad 0 \quad 1 \quad 0 \quad 0)$ be an instantaneous state vector.

It is an ON position.

$C_9 = (0 \quad 0 \quad 0 \quad 0 \quad 0 \quad 0 \quad 0 \quad 0 \quad 1 \quad 0 \quad 0)$

$C_9 \times M = (0.8 \quad 0.5 \quad 0.3 \quad 0.9 \quad 0.8 \quad 0.6 \quad 0.5 \quad 0.5 \quad 0 \quad 0.7 \quad 0.6)$

$\rightarrow (1 \quad 1 \quad 1 \quad 1 \quad 1 \quad 1 \quad 1 \quad 1 \quad 1 \quad 1 \quad 1) = C'_9$

$C'_9 \times M = (7.6 \quad 6.4 \quad 6.7 \quad 6.7 \quad 7.5 \quad 5.8 \quad 6.9 \quad 6.7 \quad 6.2 \quad 7.8 \quad 6.4)$

$\rightarrow (1 \quad 1 \quad 1 \quad 1 \quad 1 \quad 1 \quad 1 \quad 1 \quad 1 \quad 1 \quad 1) = C''_9$

$C''_9 \times M = (7.6 \quad 6.4 \quad 6.7 \quad 6.7 \quad 7.5 \quad 5.8 \quad 6.9 \quad 6.7 \quad 6.2 \quad 7.8 \quad 6.4)$

$\rightarrow (1 \quad 1 \quad 1 \quad 1 \quad 1 \quad 1 \quad 1 \quad 1 \quad 1 \quad 1 \quad 1) = C'''_9 = C''_9$

Therefore, $C'''_9 = C''_9 \Rightarrow$ fixed point is $C_7 = (0 \quad 0 \quad 0 \quad 0 \quad 0 \quad 0 \quad 0 \quad 0 \quad 1 \quad 0 \quad 0)$

Step 10:

Let $C_{10} = (0 \quad 0 \quad 0 \quad 0 \quad 0 \quad 0 \quad 0 \quad 0 \quad 0 \quad 1 \quad 0)$ be an instantaneous state vector.

It is an ON position.

$C_{10} = (0 \quad 0 \quad 0 \quad 0 \quad 0 \quad 0 \quad 0 \quad 0 \quad 0 \quad 1 \quad 0)$

$C_{10} \times M = (0.9 \quad 0.8 \quad 0.8 \quad 0.2 \quad 0.7 \quad 0.6 \quad 0.7 \quad 0.6 \quad 0.2 \quad 0 \quad 0.7)$

$\rightarrow (1 \quad 1 \quad 1 \quad 1 \quad 1 \quad 1 \quad 1 \quad 1 \quad 1 \quad 1 \quad 1) = C'_{10}$

$C'_{10} \times M = (7.6 \quad 6.4 \quad 6.7 \quad 6.7 \quad 7.5 \quad 5.8 \quad 6.9 \quad 6.7 \quad 6.2 \quad 7.8 \quad 6.4)$

$\rightarrow (1 \quad 1 \quad 1 \quad 1 \quad 1 \quad 1 \quad 1 \quad 1 \quad 1 \quad 1 \quad 1) = C''_{10}$

$C''_{10} \times M = (7.6 \quad 6.4 \quad 6.7 \quad 6.7 \quad 7.5 \quad 5.8 \quad 6.9 \quad 6.7 \quad 6.2 \quad 7.8 \quad 6.4)$

$\rightarrow (1 \quad 1 \quad 1 \quad 1 \quad 1 \quad 1 \quad 1 \quad 1 \quad 1 \quad 1 \quad 1) = C'''_{10} = C''_{10}$

Therefore, $C'''_{10} = C''_{10}$ fixed point is $C_7 = (0 \quad 0 \quad 0 \quad 0 \quad 0 \quad 0 \quad 0 \quad 0 \quad 0 \quad 1 \quad 0)$

Step 11:

Let C_{11} = $(0 \quad 0 \quad 0 \quad 0 \quad 0 \quad 0 \quad 0 \quad 0 \quad 0 \quad 0 \quad 1)$ be an instantaneous state vector.

It is an ON position.

$C_{11} = (0 \quad 0 \quad 0 \quad 0 \quad 0 \quad 0 \quad 0 \quad 0 \quad 0 \quad 0 \quad 1)$

$C_{11} \times M = (0.8 \quad 0.7 \quad 0.8 \quad 0.5 \quad 0.7 \quad 0.7 \quad 0.8 \quad 0.8 \quad 0.5 \quad 0.9 \quad 0)$

$\rightarrow (1 \quad 1 \quad 1 \quad 1 \quad 1 \quad 1 \quad 1 \quad 1 \quad 1 \quad 1 \quad 1) = C'_{11}$

$C'_{11} \times M = (7.6 \quad 6.4 \quad 6.7 \quad 6.7 \quad 7.5 \quad 5.8 \quad 6.9 \quad 6.7 \quad 6.2 \quad 7.8 \quad 6.4)$

$\rightarrow (1 \quad 1 \quad 1 \quad 1 \quad 1 \quad 1 \quad 1 \quad 1 \quad 1 \quad 1 \quad 1) = C''_{11}$

$C''_{11} \times M = (7.6 \quad 6.4 \quad 6.7 \quad 6.7 \quad 7.5 \quad 5.8 \quad 6.9 \quad 6.7 \quad 6.2 \quad 7.8 \quad 6.4)$

$\rightarrow (1 \quad 1 \quad 1 \quad 1 \quad 1 \quad 1 \quad 1 \quad 1 \quad 1 \quad 1 \quad 1) = C'''_{11} = C''_{11}$

Therefore, $C'''_{11} = C''_{11}$ fixed point is $C_7 = (0 \quad 0 \quad 0 \quad 0 \quad 0 \quad 0 \quad 0 \quad 0 \quad 0 \quad 0 \quad 1)$

DISCUSSION

Based on the calculation, it is proved that all the factors C_1, C_2, C_3, C_4, C_5, C_6, C_7, C_8, C_9, C_{10}, C_{11} are influencing the other factors. So, all the factors are impactful factors.

GROUP	INSTANTANEOUS VECTOR	FIXED POINT
C_1	(1 0 0 0 0 0 0 0 0 0 0)	(1 1 1 1 1 1 1 1 1 1 1)
C_2	(0 1 0 0 0 0 0 0 0 0 0)	(1 1 1 1 1 1 1 1 1 1 1)
C_3	(0 0 1 0 0 0 0 0 0 0 0)	(1 1 1 1 1 1 1 1 1 1 1)
C_4	(0 0 0 1 0 0 0 0 0 0 0)	(1 1 1 1 1 1 1 1 1 1 1)
C_5	(0 0 0 0 1 0 0 0 0 0 0)	(1 1 1 1 1 1 1 1 1 1 1)
C_6	(0 0 0 0 0 1 0 0 0 0 0)	(1 1 1 1 1 1 1 1 1 1 1)
C_7	(0 0 0 0 0 0 1 0 0 0 0)	(1 1 1 1 1 1 1 1 1 1 1)
C_8	(0 0 0 0 0 0 0 1 0 0 0)	(1 1 1 1 1 1 1 1 1 1 1)
C_9	(0 0 0 0 0 0 0 0 1 0 0)	(1 1 1 1 1 1 1 1 1 1 1)
C_{10}	(0 0 0 0 0 0 0 0 0 1 0)	(1 1 1 1 1 1 1 1 1 1 1)
C_{11}	(0 0 0 0 0 0 0 0 0 0 1)	(1 1 1 1 1 1 1 1 1 1 1)

CONCLUSION

In this project, the basic concepts of Fuzzy Cognitive Map and the factors to inculcate happiness index in adolescence were discussed. Happiness index actualizes and helps in sustaining healthy behaviour in teens. At times adolescence can be difficult, it is important for teens to experience happiness for their future well-being. This study analyses the most important factor in boosting happiness. All the factors are highly impactful factors in increasing the happiness index in adolescence. This paper helped me to learn about behaviour of teens and it will be basis for my future research.

ADVANTAGES OF FUZZY COGNITIVE MAP

- FCM is a broad term for a group of strategies that assist decision makers in obtaining an easy -to- understand graphical depiction of a person's viewpoint in respect to a specific conversation or problem.
- They are very useful modelling tool for designing and controlling of complex systems, commonly classified as a neuro-fuzzy technique.
- The capability integrating and apply human understanding is on e of their key benefits of FCM.
- They aid in the organisation of complicated issues, actions and the identification of structures and correlations.
- There are no visual standards that FCMs must follows. There are no restrictions on how far the thoughts their interactions are graphically displayed.
- It is a simplest way to give a clear picture of abstract ideas.
- It broadens the understanding between the patterns and concepts.
- It assists in integrating new insights into established frameworks.
- It condenses a complex eco-system into a single, shareable visualisation.
- In real-world applications, FCMs are fairly simple to compute.
    i. Medicine: It helps in modelling systems, providing diagnosis and develop decision support systems.
    ii. Engineering: It is used for modelling and controlling complex systems.
    iii. Business: It helps in decision making process for effective based planning.
    iv. Environmental and Agriculture: FCM helps in modelling and assessing factors that influence yields.
    v. Information technology: FCM based methodology helps in success modelling, risk analysis and assessments. [30, 31, 32, 33, 34]

BIBLIOGRAPHY

[1] http://en.wikipdia.org/wiki/Fuzzy_set received on 20th February, 2020.

[2]VasanthaKandasamy, W.B and Florentinsmarandache,(2003), "Fuzzy Cognitive Maps and Neuteoophic Cognitive Maps", Xiquan, 510E, Townley Ave., Phenix, A285020, USA.

[3] https://www.publichealthnotes.com/happiness-index/

[4] https://worldpopulationreview.com/country-rankings/happiest-countries-in-the-world

[5] W.B. Vasantha Kandasamy, Florentin Smarandache,(2004), ' Fuzzy Cognitive Maps and Neutrosophic Cognitive Maps, Xiquan phoenix', pp:7-9.

[6] Arumugam.S and Ramachandran.S, (1997), "INVITATION TO GRAPH THEORY",pp:

[7]https://www.tutorialspoint.com/fuzzy_logic/fuzzy_logic_membership_function.htm

[8] https://images.app.goo.gl/b9ytD6SzN7Y68wTz5

[9] Zimmermann.H.J. (2006), "FUZZY SET THEORY AND ITS APPLICATIONS, Springer International Edition, New York"

[10] https://images.app.goo.gl/YidEj9zAqS17tUUi6

[11] https://images.app.goo.gl/o44judbbkmSJUKBD9

[12]https://images.app.goo.gl/4uRAbNurvDyf3omw8

[13] https://images.app.goo.gl/AhG67UNZhk8we6rKA

[14] https://images.app.goo.gl/t65jc12TwE6i9N5X7

[15] https://www.verywellmind.com/what-is-happiness-4869755

[16] https://www.theworldcounts.com/purpose/four-levels-of-happiness

[17] https://www.happiness.com/magazine/inspiration-spirituality/why-happiness-is-a-state-of-mind/

[18] https://raisingchildren.net.au/teens/mental-health-physical-health/about-mental-health/happy-teens

[19] https://www.who.int/news-room/fact-sheets/detail/mental-health-strengthening-our-response

[20] https://www.foundationforpn.org/living-well/lifestyle/

[21] https://www.pursuit-of-happiness.org/science-of-happiness/relationships-and-happiness/

[22] https://www.insidehighered.com/advice/2016/03/09/time-management-key-happiness-essay

[23] https://happinesson.com/how-working-on-your-goals-makes-you-happy/

[24] https://www.onlinebusinessschool.com/how-to-enjoy-learning/

[25] https://actionforhappiness.org/10-keys/awareness

[26] https://www.health.harvard.edu/healthbeat/giving-thanks-can-make-you-happier#:~:text=In%20positive%20psychology%20research%2C%20gratitude,adversity%2C%20and%20build%20strong%20relationships.

[27] https://genbiz.com/how-financial-literacy-makes-us-happier

[28] https://www.vdh.virginia.gov/workforce-wellness/wellness-topics/self-acceptance/#:~:text=To%20be%20self%2Daccepting%20is,happiness%20you%20accept%20and%20enjoy.

[29] https://chopra.com/articles/the-correlation-between-spirituality-and-happiness#:~:text=Since%20spirituality%20is%20so%20deeply,able%20to%20cope%20with%20stress

[30] https://en.wikipedia.org/wiki/Fuzzy_cognitive_map

[31] https://link.springer.com/article/10.1007/s40747-020-00228-2

[32] https://www.nngroup.com/articles/cognitive-mind-concept/

[33] https://www.nngroup.com/articles/cognitive-mind-concept/

[34]https://scholar.google.com/scholar?hl=en&as_sdt=0%2C5&q=a+survey+of+fuzzy+cognitive+map+learning+methods+&btnG=#d=gs_qabs&u=%23p%3DiMBKXe-08xEJ