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A Solution of Combined Disjoint Block Fuzzy Cognitive Maps Under the Decision Mathematical Approach

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Abstract

Fuzzy optimization is a branch of mathematical optimization that utilizes fuzzy set theory to tackle uncertainty, imprecision, and vagueness in decision-making processes. Unlike traditional optimization, which relies on precise data, fuzzy optimization accommodates the ambiguous data typical in complex real-world scenarios, such as in engineering and finance. Through fuzzy sets, decision variables and constraints are represented by degrees of membership instead of fixed values, allowing a broader range of feasible solutions. This approach supports linear and nonlinear programming, making it a versatile tool in fields where incomplete data and fluctuating conditions prevail. Consequently, fuzzy optimization has become essential for solving complex, real-world problems characterized by uncertainty, offering robust, adaptable methodologies for both theoretical and applied optimization. Separately, a fuzzy mathematical approach has been applied to analyze transgender issues in Tamil Nadu using a combined disjoint block fuzzy cognitive map. This method, based on the fuzzy cognitive map concept by Kandasamy and Smarandache [1], organizes and analyzes social problems by grouping concepts in large numbers. The study is structured into four sections: solutions to transgender issues, background on the combined disjoint block FCM, analysis of hidden patterns in transgender issues, and conclusions and recommendations based on the findings.

Keywords: FCMs, Combined disjoint block FCMs, Fixed point, Hidden pattern, Unsupervised trans-genders, Decision making and optimization.

1 | Introduction

Transgender is an Umbrella term for persons whose gender identity and gender expressions or behavior do not conform to that typically associated with the sex to which they were assigned at birth. Gender Identity refers to a person's internal sense of being male, female, or something else. Gender expression refers to how a person communicates gender identity to others through behavior, clothing, hairstyles, voice or body characteristics, etc.

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Gender identity or sexual orientation: transgender people may be straight, lesbian, gay, or bisexual, just as non-gender people can be. There are many types of trans-people, like Lesbian, Gay, Bisexual, and Transgender, and in short, they are called LGBT due to some common concern requiring intervention from the Government through policy measures to resolve certain basic problems.

Lesbian or gay woman: a transgender woman or a person who is assigned male at birth and transitions to female, who is attracted to other women, would be identified as a lesbian or gay woman.

Gay man: a transgender man or a person who is assigned female at birth and transitions to male, who is attracted to other men, would be identified as a gay man. Transgender has the third gender by God-given. Owing to the inhuman attitude of society, it wouldn't be an overstatement that the third genders face numerous problems from getting a job to a job. These people are born as one gender and later realize authentically who they are. They are perturbed and lose self-confidence since they don't get proper recognition. Even those with the talent to become entrepreneurs die as beggars in railway stations. Due to this hormonal change, the transgender depend on their parent, but the irony is that the latter is not ready to accept them. Thus, these people look for organizations that give food and shelter to such people.

The problems they face are innumerable, starting with poverty. Since most of the transgender are uneducated, they are unable to get jobs. And they are not allowed to make decisions on their own. On the whole, the people are not given the respect they deserve. Though the Indian government has given equal rights, they are kept away from them. As a result of poverty, they could not proceed with their desired higher education. Even in institutes, they are not given admission. Even if they are admitted, they are ill-treated by their peers. Thus, the atlas doesn't even have proof of identification. They also face similar problems in getting a job. And with no stones unturned, these people just have two choices - to beg or to get involved in sex work.

Transgender are forced into prostitution by society, and they have to remain detached from the same society and die as an individual who has no relations to share their happiness and sorrows. What could be worse than leaving the world without a true heart that cares for u and loves u with no condition?

1.1 | Previous Research

Fuzzy sets were proposed by Lofti Zadeh [2] in his paper entitled None Other than Fuzzy Sets. This paper laid the foundation for all fuzzy logic, followed by mathematically defining fuzzy sets and their properties. The definition of a fuzzy set, then, from Zadeh's paper, is Let X be a space of points, with a generic element of X denoted by x. Thus , $X = \{x\}$. Professor Ebrahim Mamdani [3] of London University built one of the first fuzzy systems to control a steam engine and boiler combination. He applied a set of fuzzy rules supplied by experienced human operators. Kosko [4] introduced Fuzzy Cognitive Maps (FCMs) as fuzzy-graph structures to represent causal reasoning. Their fuzziness allows hazy degrees of causality between hazy causal concepts. Axelrod [5] proposed cognitive maps as a formal tool for decision-making. He used the matrix representation of the directed graph to represent and study social scientific knowledge. His FCM is signed digraphs. Nodes are variable concepts, and edges are causal connections. Kandasamy and Smarandache [1] has constructed the fuzzy relational models and FCMs and has effectively used the fuzzy models in analyzing the problems of displaced persons, school drop-outs, AIDs patients, Dalits, Rag pickers, PWDs, etc.

Malhotra et al. [6] estimated the effects of gold plating, and we designed a tool based on FCMs. With the help of this tool, the developer can know the effects of gold plating on the project, and based on the tool's output, the developer can make subsequent decisions regarding the project. Chrispen Murungwen et al. [7] found that the interactive nature of FCMs reveals hidden knowledge and insights that improve the understanding of the complexity of livelihood systems in a way that stakeholders better appreciate. Bing-ru Yang et al. [8] propose research one kind of Two-layer True-Tree FCM (TTFCM) to model the system with the relational data in the form of E-R schema through analyzing the relational database and the multi-relational characteristic. The TTFCM includes one high-level FCM and many low-level FCMs, forming a two-level tree. Also, their analysis of vulnerability using the FCM method showed that policy issues, such as changing situations at borders, can strongly aggravate vulnerability to climate change by increasing the drought sensitivity of livelihoods.

Vidhya Kannan et al. [9] studied the fuzzy floyd warshall and fuzzy rectangular algorithms to find the shortest path. Broumi, Said et al. [10] made an efficient approach for solving the time-dependent shortest path problem under the fermatean neutrosophic environment. Vidhya Kannan et al. [11] proposed a novel method for finding the shortest path with two objectives under trapezoidal intuitionistic fuzzy arc costs. Prakash et al. [12] presented an optimal solution for a fully spherical fuzzy linear programming problem. Saraswathi [13] developed a fuzzy-trapezoidal DEMATEL approach for solving uncertain decision-making problems. Dharmaraj et al. [14] have applied a modified gauss elimination technique for separable fuzzy nonlinear programming problems. Vidhya Kannan et al. [15] investigated the A* search algorithm for the shortest path under an interval-valued Pythagorean fuzzy environment.

Saraswathi et al. [16] solved a new approach for solving the minimal flow, which was the shortest. Route, maximal flow, and the critical path using network. Appasamy Saraswathi [17] used a triangular fuzzy clustering model under uncertainty. Yuvashri et al. [18] studied a novel approach for a multi-objective linear programming model under spherical fuzzy environment and its application. Karthick et al. [19] used a neutrosophic linear fractional programming problem using the denominator objective restriction method. dynamics of continuous Nedumaran et al. [20] developed a comparative study to find the critical path using triangular fuzzy numbers. Using a weighted fuzzy graph, Nedumaran et al. [20] enhanced the optimum route finding in tourism transportation in tamil nadu.

2|Basic Definitions and Notations of FCMs

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 classes and causal relations between classes. FCMs are fuzzy signed directed graphs with feedback. The directed edge e_{ij} from causal concept C_i to concept C_j measures how much C_i causes C_j. The time-varying concept function $C_i(t)$ measures the non-negative occurrence of some fuzzy event, perhaps the strength of political sentiment, historical trend. The edges e_{ij} take values in the fuzzy causal interval [-1, 1]. $e_{ij} = 0$ indicates no causality, $e_{ji} > 0$ indicates causal increase, C_j increases as C_i increases (or C_j decreases as C_i decreases). $e_{ji} < 0$ indicates a causal decrease or negative causality. C_j decreases as C_i increases (or C_j increases as C_i decreases), simple FCMs have edge values in {-1, 0, 1}.

2.1|Fuzzy Cognitive Maps

FCMs can successfully represent knowledge, and human experience introduces concepts to represent the essential elements and the cause-and-effect relationship among the concepts to model the behavior of any system. It is a very convenient, simple, and powerful tool used in numerous fields such as social, economic, educational, political, medical, and technical. The FCMs work on the opinion of experts. FCMs model the world as a collection of classes and causal relationships between classes. FCMs are signed and directed graphs with feedback. The directed edge C_{ij} from causal concept C_i to concept C_j measures how much C_i causes C_j. Here C_i, ….. C_n are concepts or nodes of FCMs. The edge weights or causalities C_{ij} are taken from the set {-1, 0, 1}. The directed graph is drawn using edge weights e_{ij}. The Matrix E is 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 FCM. It will work as a dynamical system to identify the joint effects of all the interacting fuzzy knowledge from Experts.

Cognitive maps are techniques: that attempt to depict and analyze the cognitive process of human thinking and human behavior in specific domains by creating models. These models are represented by assigned directed graphs of concepts and by the various casual relationships that exist between the concepts.

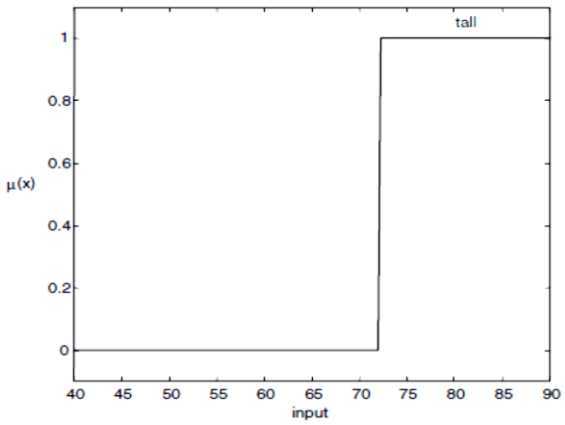


Fig. 1. Crisp membership function.

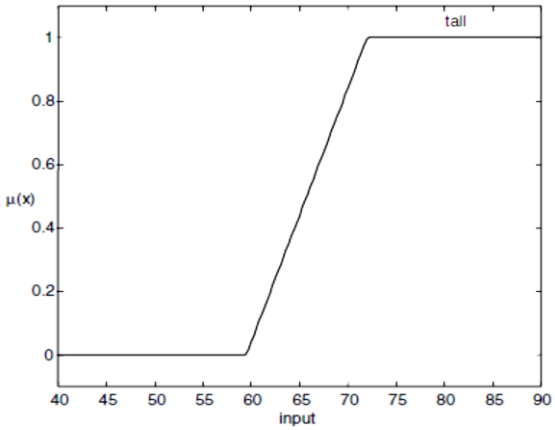


Fig. 2. Fuzzy-membership.

In 1965, Lotfi Zedah [2] proposed FCM based on his Fuzzy Sets. In a crisp set, membership or non-membership of element' x' in set $\mu_A(x)$, where $\mu_A(x)=1$ if $x \in A$ and $\mu_A(x)=0$ if $x \notin A$, A is described by a characteristic function, fuzzy set theory extends this concept by defining partial membership. A fuzzy set A on a universe of discourse U is characterized by a membership function that $\mu_A(x)$ takes values in the interval [0, 1].

Uncertain causal knowledge is stored in FCMs. FCMs are fuzzy signed digraphs with feedback. The sign (+ or -) of FCM edges indicates a causal increase or decrease. The fuzzy degree of causality is indicated by a number in [−1, 1]. FCMs learn by modifying their causal connections in sign and magnitude, structurally analogous to how neural networks learn. An appropriate causal learning law for inductively inferring FCMs from time-series data is the differential Hebbian law, which modifies causal connections by correlating time derivatives of FCM node outputs. The differential Hebbian law contrasts with the Hebbian output-correlation learning laws of adaptive neural networks.

FCM nodes represent variable phenomena or fuzzy sets. An FCM node nonlinearly transforms weighted summed inputs into numerical output, again in analogy to a model neuron. Unlike expert systems, which are feed-forward search trees, FCMs are nonlinear dynamical systems. FCM resonant states are limit cycles or time-varying patterns. An FCM limit cycle or hidden pattern is an FCM inference. Experts construct FCMs by drawing causal pictures or digraphs. The corresponding connection matrices are used for inference. By additively combining augmented connection matrices, any number of FCMs can be naturally combined into a single knowledge network. The credibility w_i in [0, 1] of the i^{th} expert is included in this learning process by multiplying the i^{th} expert's augmented FCM connection matrix by w_i. Combining connection matrices is a simple type of adaptive inference. An unsupervised learning law, such as the differential Hebbian learning

law, generally modifies connection matrices. Under special conditions, differential Hebbian dynamical systems are proved globally stable: they resonate on fixed-point attractors.

FCMs are more applicable when the data in the first place is an unsupervised one. The FCMs work on the opinion of experts.FCM has a major role, mainly when the data concerned is unsupervised. Further, this method is the simplest and most effective one as it can analyze the data by directed graphs and connection matrices. FCMs model the world as a collection of classes and casual relations between classes, which was introduced by Bart Kosko [21] in the year 1986. It is a very convenient, simple, and powerful tool used in numerous fields such as social, economic, medical, etc., illustrated by Kandasamy and Smarandache [1] in her book, application of fuzzy models in social sciences.

2.2 | Properties of FCM Matrix

*Let $C_1,C_2…….C_n$ be causal concepts and let $e_{ij}=e(C_i,Cj)$ be the causal edge function value, the amount of causality C_i imparts to C_j. For a Cognitive map,e_{ij}=0,1 or -1.

*Letb $E=(eij)_{1\le i,j\le n}$, represents the matrix of causal edge values for the given FCM.

Suppose the FCM is a cognitive cognitive map. Then, E is an adjacency matrix. It lists all one-edge paths on the cognitive map.

*$E^2=[eij^2]$=ExE lists all two-edge paths on the cognitive map. $e_{ij}^{(2)} = \sum_{k=1}^{n} e_{ik} \times e_{kj}$ is non-zero if there is a k such that $\mathbf{e_{ik}}$ and $\mathbf{e_{kj}}$ are non-zero. Similarly E_3, E_4…..E_{n-1} list the effect of summing all three-edge, four-edge……n-1 edge indirect effects.

*Then the total-effect matrix T is the sum of the powered matrices E^i $T = \sum_{i=1}^{n-1} E^i$.

*If the above process is repeated with E replaced E bar, the matrix of absolute values of E, then $ebar_{ij}^{(k)}$ is non-zero if and only if there are $ebar_{ij}^{(k)}$ many K-edge paths from C_i to C_j. Such information is useful when searching for forward and backward chains.

Definition 1. Fuzzy logic is a method of describing and processing ambiguous data. The more traditional propositional logic, such as 'it will rain tomorrow', must be either true or false. However, many facts humans use about the world have some ambiguity. Fuzzy- Not clear, distinct, or precise; blurred.

Definition 2. If X is a universal set and xX, ϵ then a fuzzy set $\tilde{A}$ is defined as a collection of ordered pairs, $\tilde{A} = \left\{\left(x, \mu\,\tilde{A}(x)\right), x\epsilon X\right\}$, Where $\mu\,\tilde{A}$ (x) is called the membership function that maps X to the membership space M.

Definition 3. A fuzzy set defined on the set R of real numbers is called a fuzzy number whose membership function is of the form Ã: R→ [0,1] under certain conditions.

I. Ã is normal.

II. Ã is convex.

III. Ã is piecewise continuous.

Definition 4. An FCM is a directed graph with concepts like policies, events, nodes, and causalities as edges. It represents a causal relationship between concepts. They are called fuzzy nodes.

Definition 5. FCMs with edge weights or causalities from the set {-1, 0, 1} are called simple FCMs.

Definition 6. Consider the nodes/concepts $C_1,...C_n$ 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_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.

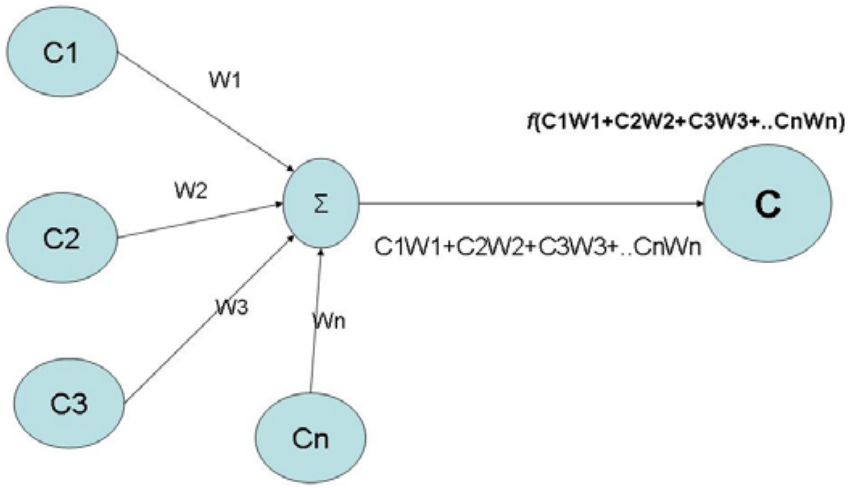
Definition 7. A finite number of FCMs can be combined to produce the joint effect of all the FCMs. Let $E_1, E_2, ...E_p$ be the adjacency matrices of the FCMs with nodes $C_1, ...C_n$ then the combined FCM is got by adding all the adjacency matrices $E_1, E_2, ...E_p$.

We denote the combined FCM adjacency matrix by $E = E_1 + E_2 + ... + E_p$.

Suppose $A = (a_1, a_2, .., a_n)$ is a vector that is passed into a dynamical system E. Then $AE = (a_1', a_2', ..., a_n')$ after thresholding and updating the vector suppose we get $(b_1, b_2, .., b_n)$ we denote that by $(a_1', a_2', ..., a_n') \mapsto (b_1, b_2, .., b_n)$. Thus, the symbol '$\mapsto$' means the resultant vector has been thresholded and updated.

Definition 8. Let $C_1, C_2, ...C_n$ be the nodes of an FCM. Let $\overrightarrow{C_1C_2}, \overrightarrow{C_2C_3}....\overrightarrow{C_iC_j}$, 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 cycle. An FCM is said to be acyclic if it does not possess any Directed cycle.

$$C_i^{(k+1)} = f\left(C_i^{(k+1)} + \sum_{\substack{j=1 \\ j \neq i}}^{N} C_i^{(k)} . W_{ji} \right).$$



Definition 9. Let $\overrightarrow{C_1C_2}, \overrightarrow{C_2C_3}....\overrightarrow{C_iC_j}$, 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 ….n. The equilibrium state for this dynamical system is called the Hidden pattern.

Definition 10. If the equilibrium state of a dynamical system is a unique state vector, it is called a fixed point. Consider an FCM with $C_1, C_2, ...C_n$ 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_2 on, i.e., the state vector remains as (1, 0, 0, ….,0, 1) this state vector (1, 0, 0,…,0, 1) is called the fixed point.

Definition 11. If the FCM settles down with a state vector repeating in the form $A_1 \to A_2 \to ....A_1 \to A_1$. Then, this equilibrium is called the Limit cycle.

Definition 12. A finite number of FCMs can be combined together to produce the joint effect of all the **FCM**s. Let $E_1, E_2, ...E_p$ be adjacency matrices of the FCMs with nodes $C_1, C_2, ...C_n$. Then, the combined FCM is got by adding all the adjacency matrices $E_1, E_2, ...E_p$. We denote the combined FCM adjacency matrix by $E = E_1 + E_2 + ... + E_p$.

Definition 13. Advantages and disadvantages of FCM

The main advantage of this method is that it is simple. It functions on an expert's opinion. When the data is unsupervised, the FCM comes in handy. This is the only known fuzzy technique that gives the hidden pattern of the situation, as we have a very well-known theory that states that the strength of the data depends on the number of experts' opinions; we can use combined FCMs with several experts' opinions.

At the same time, the disadvantage of the combined FCM is when the weights are1 and -1 for the same C_i C_j, we have the sum adding to zero; thus, at all times, the connection matrices E_1, E_2…… , E_k may not be conformable for addition.

Combined conflicting opinions tend to cancel out and are assisted by the strong law of large numbers. A consensus emerges as the sample opinion approximates the underlying population opinion. This problem will be easily overcome if the FCM entries are only 0 and 1. The knowledge of guidelines (instead of experts' knowledge) can be easily converted to a number of if-then rules, which are used to construct the FCM model.

Applications of FCM in various fields

Modeling-knowledge representation, Decision making, Enterprise Resource Management, Socio-economic systems, Engineering & Technology Management, Adaptation and Learning, Classification tasks, Robots and control, Political and Social Fields, Military planning, Production Systems, Prediction capabilities, Ecology and environmental

Definition 14. Let $C_1, C_2, ...C_n$ be n distinct attributes of a problem n very large and a non-prime. If we divide n into k equal classes. i.e., k/n and if $n/k = t$, which are disjoint, and if we find the directed graph of each of their classes of attributes with t attributes each, then their corresponding connection matrices are formed, and these connection matrices are joined as blocks to form a $n \times n$ matrix.

The $n \times n$ connection matrix forms the combined disjoint block FCM of equal classes. If the classes are not divided to have equal attributes but if they are disjoint classes, we have $n \times n$ a connection matrix called the combined disjoint block FCM of unequal classes/size.

Here we approach the problem through attributes using Combined Disjoint Block Fcms (CDBFCMs) that are basically matrices that predict the feelings of all the attributes under certain conditions. Before we apply combined o disjoint block FCMs (CDBFCMs) to this problem, we define a set of 20 attributes given by experts. We work with analyzing by using a directed graph and its connection matrices.

3 | Adaptation of CDBFCMs Related to Major Solution Transgender Issues in Tamilnadu

Here, we follow the seven steps of calculations

Step 1. Let $C_1, C_2, ...C_n$ be the nodes of an FCM with feedback. Let E be the associated adjacency matrix.

Step 2. Let us find the hidden pattern when C_1 is switched on.

Step 3. When an input is given as the vector $A_1 = (1, 0, 0, ...0)$, the data should pass through the relation matrix E. This is done by multiplying A_1 by the matrix E.

Step 4. let $A_1E = (a_1, ...a_n)$ with the threshold operation by replacing a_i by 1 if $a_i > k$ and a_i by 0 if $a_i < k$ (k is a suitable positive integer).

Step 5. We update the resulting concept. The concept C_6 is included in the updated vector by making the sixth coordinate as 1 in the resulting vector.

Step 6. Suppose $A_1E \to A_2$, then consider A_2E and repeat the same procedure.

Step 7. This procedure is repeated till we get a limit cycle or a fixed point. Using a questionnaire, the experts' opinion was arrived at by administering the same to 200 trans genders,10 parents, 10 NGO leaders, and 5 research community members. Here we take the 20 attributes of the Trans genders issues as listed below:

A_1 - Pension after 50 years

A_2 - Free shelter

A_3 - Hormones-free surgery

A_4 - Health city (camp)

A_5 - Proof of address, voter ID

A_6 - Permitted to have education

A_7 - Providing separate bathroom (restroom)

A_8 - Separate seats in bus, train

A_9 - Job allotment in military

A_{10} - Effective decent policies

A_{11} - Government employment quota

A_{12} - Awareness camp

A_{13} - Parents support (Acceptance)

A_{14} - Free accommodation

A_{15} - Legal punishment for the misbehavior towards them

A_{16} - Giving Psychiatry

A_{17} - Giving loan for self-business

A_{18} - Legalized Marriage

A_{19} - Legally adopting child

A_{20} - Take necessary steps against forcing sex and begging.

These 20 attributes are divided into 4 classes C_1, C_2, C_3, C_4 , with 5 in each class. Let

$C_1 = \{A_3, A_8, A_{10}, A_{16}, A_{18}\}$.

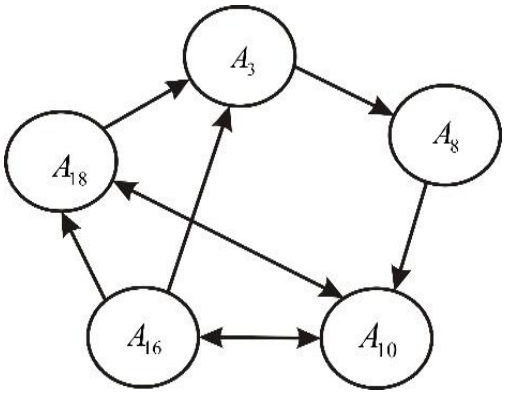
$C_2 = \{A_1, A_7, A_9, A_{14}, A_{17}\}$.

$C_3 = \{A_2, A_5, A_{11}, A_{15}, A_{19}\}$.

$C_4 = \{A_4, A_6, A_{12}, A_{13}, A_{20}\}$.

Case 1: the following is the directed graph obtained based on the first experts(transgenders) view.

The directed graph is given by the first expert $\{A_3, A_8, A_{10}, A_{16}, A_{18}\}$ which forms the class C_1.

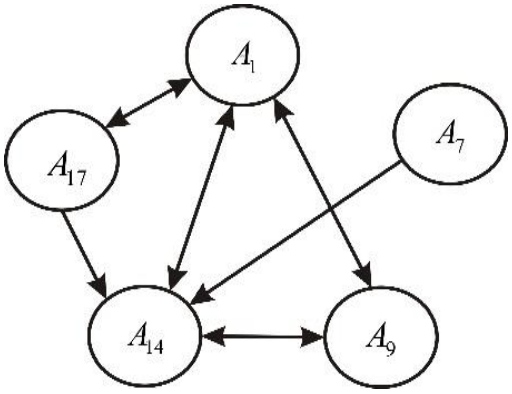


The related connection matrix E_1 is given by

$$E_1 = \begin{bmatrix} 0 & 1 & 0 & 0 & 0 \\ 0 & 0 & 1 & 0 & 0 \\ 0 & 0 & 0 & 1 & 1 \\ 0 & 0 & 1 & 0 & 1 \\ 1 & 0 & 1 & 0 & 0 \end{bmatrix}.$$

Case 2: the following is the directed graph obtained based on the second expert (parents of transgenders) view.

The directed graph is given by the second expert $\{A_1, A_7, A_9, A_{14}, A_{17}\}$, which forms the class C_2. The related connection matrix E_2 is given by

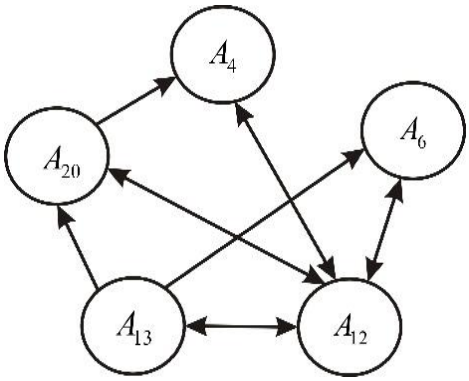


The related connection matrix E_1 is given by

$$E_2 = \begin{bmatrix} 0 & 0 & 1 & 1 & 1 \\ 0 & 0 & 0 & 1 & 0 \\ 1 & 0 & 0 & 1 & 0 \\ 1 & 0 & 1 & 0 & 0 \\ 1 & 0 & 0 & 1 & 0 \end{bmatrix}.$$

Case 3: the following is the directed graph obtained based on the third expert (NGO leaders of transgenders) view.

The directed graph is given by the third expert $\{A_2, A_5, A_{11}, A_{15}, A_{19}\}$, which forms the class C_3.

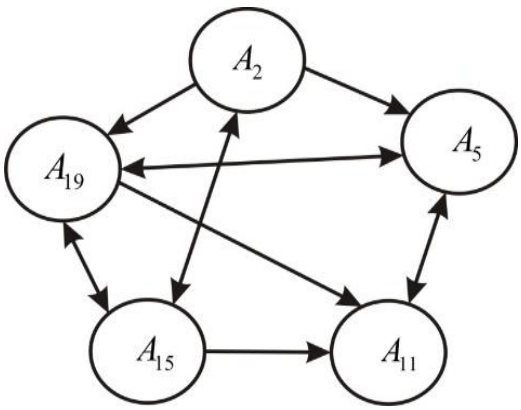


The related connection matrix E_3 is given by

$$E_3 = \begin{bmatrix} 0 & 1 & 0 & 1 & 1 \\ 0 & 0 & 1 & 0 & 1 \\ 0 & 1 & 0 & 0 & 0 \\ 1 & 0 & 1 & 0 & 1 \\ 0 & 1 & 1 & 1 & 0 \end{bmatrix}.$$

Case 4: the following is the directed graph obtained based on the fourth expert (research committee members) view.

The directed graph is given by the fourth expert $\{A_4, A_6, A_{12}, A_{13}, A_{20}\}$, which forms the class C_4 .



The related connection matrix E_4 is given by

$$E_4 = \begin{bmatrix} 0 & 0 & 0 & 0 & 1 \\ 0 & 0 & 1 & 0 & 0 \\ 1 & 1 & 0 & 1 & 0 \\ 0 & 1 & 1 & 0 & 1 \\ 1 & 0 & 1 & 0 & 0 \end{bmatrix}.$$

Now, we combined the disjoint block connection matrix of the fuzzy cognitive matrix of the FCMs M given by

$$M = \begin{array}{c} \\ A1 \\ A2 \\ A3 \\ A4 \\ A5 \\ A6 \\ A7 \\ A8 \\ A9 \\ A10 \\ A11 \\ A12 \\ A13 \\ A14 \\ A15 \\ A16 \\ A17 \\ A18 \\ A19 \\ A20 \end{array} \begin{array}{c} \begin{array}{cccccccccccccccccccc} A1 & A2 & A3 & A4 & A5 & A6 & A7 & A8 & A9 & A10 & A11 & A12 & A13 & A14 & A15 & A16 & A17 & A18 & A19 & A20 \end{array} \\ \begin{pmatrix} 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 1 & 0 & 0 & 0 & 0 & 1 & 0 & 0 & 1 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 1 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 1 & 0 & 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & 1 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 1 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 1 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 1 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 1 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 1 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 1 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 1 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 1 & 0 & 1 & 0 & 0 \\ 0 & 0 & 0 & 0 & 1 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 1 & 0 & 1 & 0 & 0 & 0 & 0 & 0 & 0 & 1 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 1 & 0 & 0 & 0 & 0 & 0 & 1 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 1 \\ 1 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 1 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 1 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 1 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 1 & 0 \\ 0 & 0 & 1 & 0 & 0 & 0 & 0 & 0 & 0 & 1 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 1 & 0 & 0 \\ 1 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 1 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 1 & 0 & 0 & 0 & 0 & 0 & 0 & 1 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 1 & 0 & 0 & 0 & 0 & 0 & 1 & 0 & 0 & 0 & 1 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 1 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 1 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \end{pmatrix} \end{array}.$$

Let the initial vector be

$$T = (0 \quad 1 \quad 0 \quad 0 \quad 0 \quad 0 \quad 0 \quad 0 \quad 0 \quad 0 \quad 1 \quad 0 \quad 1 \quad 0 \quad 0 \quad 0 \quad 0 \quad 0 \quad 0 \quad 0).$$

A_2 -Free shelter A_{11} -government employment quota, A_{13} -parents support (acceptance) are the ON state, and the rest of the nodes are OFF state. The effectiveness of T is

$$TM = (0 \quad 0 \quad 0 \quad 0 \quad 2 \quad 1 \quad 0 \quad 0 \quad 0 \quad 0 \quad 0 \quad 1 \quad 0 \quad 0 \quad 1 \quad 0 \quad 0 \quad 0 \quad 1 \quad 1).$$

After thresholding and updating

$$TM = (0 \quad 1 \quad 0 \quad 0 \quad 1 \quad 1 \quad 0 \quad 0 \quad 0 \quad 0 \quad 1 \quad 1 \quad 1 \quad 0 \quad 1 \quad 0 \quad 0 \quad 0 \quad 1 \quad 1) = M_1.$$

$$TM1 = (0 \quad 1 \quad 0 \quad 2 \quad 3 \quad 2 \quad 0 \quad 0 \quad 0 \quad 0 \quad 2 \quad 3 \quad 1 \quad 0 \quad 2 \quad 0 \quad 0 \quad 0 \quad 3 \quad 2).$$

After thresholding and updating

$$TM_1 = (0 \quad 1 \quad 0 \quad 1 \quad 1 \quad 1 \quad 0 \quad 0 \quad 0 \quad 0 \quad 1 \quad 1 \quad 1 \quad 0 \quad 1 \quad 0 \quad 0 \quad 0 \quad 1 \quad 1) = M_2.$$

$$TM_2 = (0 \quad 1 \quad 0 \quad 2 \quad 3 \quad 2 \quad 0 \quad 0 \quad 0 \quad 0 \quad 3 \quad 4 \quad 1 \quad 0 \quad 2 \quad 0 \quad 0 \quad 0 \quad 3 \quad 3).$$

After thresholding and updating

$$TM_2 = (0 \quad 1 \quad 0 \quad 1 \quad 1 \quad 1 \quad 0 \quad 0 \quad 0 \quad 0 \quad 1 \quad 1 \quad 1 \quad 0 \quad 1 \quad 0 \quad 0 \quad 0 \quad 1 \quad 1) = M_3.$$

$M_2 = M_3$.

M_2 is a fixed point of the dynamical system.

4 | Conclusion

A_2 -Free shelter, A_4 - Health city (camp), A_5 - Proof of address, voter ID, A_6 - Permitted to have education, A_{15} -Legal punishment for the misbehavior towards them, A_{19} - Legally adopting child, A_{20} - Take necessary steps against forcing sex and beg are the main causes of the Transgenders by using this model CDBFCMs.

Transgender are thus abandoned by their parents at a very early age and so find no other way to come in contact with other Trans -people.

They stay away from their families and are forced to cut all relations with relatives. They are often abused by society and made to starve for want of food, shelter, education, and health and allied services. They should be provided with some organization to take care of their rights, and they should be provided with special quotas for jobs, education, and health services. Separate job allotment, like in the military, can be an effective solution to this problem. Effective policies should be considered for them to face their problem effectively. Wherever possible, corrective surgery can be made free of cost to rectify the hormonal imbalances.

CDBFCMs are one of the most powerful mathematical techniques to analyze the cognitive process of human thinking and human behavior on specific domains by creating models. Several authors, such as Kosko, Axelrod, Neha Malhotra, Chrispen Murungwen, and Zhen Peng, have proposed differe nt approaches for solving FCMs using decision-making.

Findings from CDBFCMs

The government can also reserve seats for the representatives of transgenders and persons with disability, as we have a representative for the minority Anglo-Indian community in the state assembly. Parents should not segregate the transgender and should take special care of them and treat them normally so that the transgender would be able to live in their respective families with dignity in society. They should be given equal rights of citizenship. Their names should be listed in the voters' list. Their complaints of abuse should be taken seriously and acted upon.

No restrictions regarding access to education, health services, public service, etc. Schools, Colleges, workplaces, and other public places should have separate toilet facilities, such as parks, beaches, cinema theaters, etc. Employment opportunities should be provided; free sex surgery should be organized if the disorder can be corrected with the willingness of the concerned persons. Social welfare schemes as applicable to persons with disabilities need to be provided. In healthcare facilities, the right to child adaptation and support from family members need to be addressed.

Suggestions based on CDBFCMs

Every transgender should have equal rights to express their thoughts, as they have freedom of speech. Numerous schemes and laws should be passed regarding their welfare. Reservation for jobs of transgender must be implemented. For this government to take actions such as counseling, job, education, etc., People should respect them properly. At least one seat should be reserved in parliament for representing the cause of Transgender. Their suggestions should be taken in public and anywhere. They should be accepted in the society with respect and dignity. Their complaints of abuse should be taken seriously and acted upon. There are no restrictions regarding access to education, health service, and public services. Employment opportunities should be provided. Opportunities for political participation are to be created. They should be given equal rights of citizenship.

Author Contributions

A. Saraswathi conceived and designed the study, conducted the fuzzy optimization analysis, and wrote the manuscript. Seyyd Ahmad Edalatpanah contributed to the development of the combined disjoint block fuzzy cognitive map methodology and assisted in drafting sections of the paper. Sanaz Hami Hassan Kiyadeh provided valuable insights into the transgender issues addressed in the study and contributed to the final revisions of the manuscript.

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Data Availability

The data and materials used in this study are available from the corresponding author upon reasonable request.

Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this research.

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