An Analysis on Novel Corona Virus by a Plithogenic Approach to Fuzzy Cognitive Map

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Abstract

In this paper a Plithogenic approach to Fuzzy cognitive map has been proposed to analyse the impact of novel corona virus.Contradiction degree is an advantageous feature of Plithogenic sets which highly deals with the uncertainty and it substantially increases the accuracy of results. In this research, a new approach is proposed to accumulate the opinions of experts.Using contradiction degree between opinions of experts and plithogenicoperator,the connection matrices obtained from distinct experts are aggregated to improvise a degree of uncertainty. An Analysis on covid-19 (causes, spread and precaution) is done based on the proposed methodology.

Keywords: Fuzzy cognitive maps,Plithogenic sets, Covid-19, Plithogenic operators

1.Introduction

The outbreak of the 2019 coronavirus (COVID-19) infections has spread worldwide, causing fever, severe respiratory illness and pneumonia. The virus is related to severe acute respiratory syndrome coronavirus (SARS-CoV) [27], as compared to MERS-CoV, and SARS-CoV, COVID-19 exhibits faster human transmission, leading to the declaration of a world-wide health emergency by world health organisation (WHO) [28]. No specific drugs or vaccines are available till date. The Clinical evidences of COVID-19 are characterized by cough, fever, bilateral infiltrates on chest imaging. After testing positive, majority of the affected individuals were experiencing moderate symptoms, whereas 20% of the affected people show severe respiratory failure and septic shock [29], gastrointestinal, lymphopenia, myalgias, and lung abnormalities [30]. The death causing ability of the virus is dependent on chronic disorders [29]. The infection has been reported to cause moralities in aged persons [32].

Axelrod [1] has initiated the concept of cognitive maps (CM), a directed graph which represents the causal relationship between the data in a specific field. In the cognitive maps the concepts and causal relationship are represented by the nodes and edges respectively. The edges have the weights representing the intensity of the causal relationship among the concepts. Regardless, CMs applicability is restrained as it has the limitation of disability to

DOI: 10.5281/zenodo.4127202
Received: Jun 13, 2020 Accepted: September 25, 2020

define the strength of interrelationship between the concepts/factors. To overcome the inadequacy, kosko[2] with the zadeh's concept of fuzzy[3] introduced fuzzy cognitive maps, as an extension of conventional CMs by defining the strength by fuzzy numbers. To construct the FCM the experts opinions were obtained based their experience in their field and the strength of the causal relationship between the factors can be estimated [4]. Several approaches are available for the specification of weights in FCM, in order to overcome the difficulty of assigning a crisp real number to express their views with regard to the strength of relationships which are uncertain, linguistic variables were preferred [5]. Triangular Fuzzy Numbers (TFNs) were used to represent relationships between the concepts instead of fuzzy singletons to get by efficiently with uncertainty and practice of fuzzy numbers will lead to more precise and information wealthy FCMs than the conventional FCMs[6] [7][8].FCM modelling has a wide range of application in the field of medicine and extensively reviewed in [20]. FCM was developed for medical decision support systems[21][22], prediction of probability occurance of stroke[23],for risk management in breast cancer[24], to define challenges and articulating solutions in nursing discipline[25] and to study the symptoms of migraine[26].

Fuzzy cognitive maps is extended to plithogenic fuzzy cognitive map (PFCM) which integrates the contradiction degree to the concepts and the methodology of FCM[9]. Smarandache [10] introduces the concept of Plithogenic sets, a generalization of crisp, fuzzy, intuitionistic fuzzy and neutrosophic sets. Plithogenic sets rely on the principle of quantification of the qualitative aspects and degree of contradiction is also the distinguishing feature of Plithogenic sets.Abdel-Basset integrates the concept of Plithogenic sets in decision making for selecting supply chain sustainability metrics[11],evaluation of hospital medical care systems[12] and for evaluating the performance of IoT based supply chain[13], Plithogenic MCDM based onTOPSIS –CRITIC model for sustainable supply chain risk management[14].In another study, Plithogenic sets used for multi variable data analysis in [32-35].FCM depends totally on the expert's opinion, itlapse due to its uncertainty associate with the responses of each experts and contradiction between them.

This paper proposes a Plithogenic approach to fuzzy cognitive map to reform the drawback. The proposed model follows the methodology of FCM, in addition it merges the experts' opinionby using the Plithogenic operators, based on the contradiction degree between them.

2. Materials and methods

2.1 Fuzzy cognitive maps

Fuzzy cognitive maps(FCMS) are well developed computational method which combines the neural networks and fuzzy logic. FCMs are the fuzzy directed graphs with nodes representing the factors of the system considered and edges represents the causal relationship between the concepts/factors. The edges are characterised by the weights w_{ij}, which represents the strength of the causality between the concepts.The values of FCM are fuzzy, so the weights are represented in terms of linguistic variables [15]. Fuzzy linguistic scales are then interpreted to the fuzzy numbers through the information provided by the experts. A simple example of FCM is depicted in Figure-1.

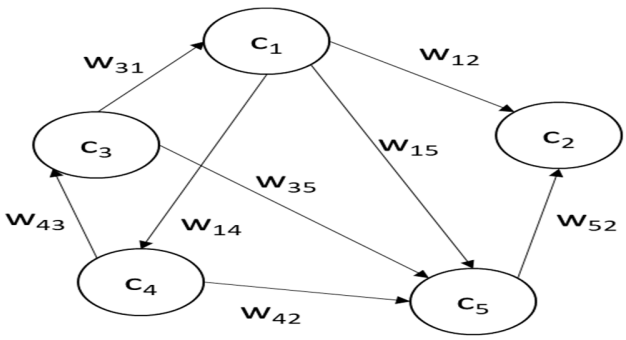

Figure 1. Fuzzy Cognitive Map

DOI: 10.5281/zenodo.4127202

The influence of an individual concept on other concepts of the system is calculated by using the equation (1), the inference of FCM.

$$A(t+1) = f(A(t) * TrF(M)) \quad (1)$$

where $A(t+1)$ and$A(t)$ is the strength of the concept C_i at step t+1 and t respectively and$TrF(M)$ is a connection matrix containing the strengths of the causalty between the concepts. Here$f$ represents the threshold function,for activating the successive vector after each pass and to settle down to a fixed point which is the hidden pattern of the system for that corresponding state vector [16]. The iteration proceeds until the limit cycle [16] obtained.Though there were several threshold functions available,a conventional threshold function is considered. To establish the causal influence among the concepts fuzzy inference with IF THEN ruleused is as follows:

IF C_i is ON THEN C_j is A(The influence of C_i on C_j is A) (2)

2.2 Triangular Fuzzy number

A fuzzy number generalises the concept of crisp numbers. For simplicity and accuracythe scales of the linguistic variables are interrelated with the Triangular fuzzy numbers, triangular form can easily grasp the uncertainty in the human perception with better approximation [18].

The fuzzy number $\tilde{A} = (a, b, c)$is a triangular fuzzy number if its membership function is $\mu_{\tilde{A}}(x) =$

$$\begin{cases} 0 & x < a \\ \dfrac{x-a}{b-a} & a \le x \le b \\ \dfrac{c-x}{c-b} & b \le x \le c \\ 0 & x \ge c \end{cases} \quad (3)$$

The triangular fuzzy number is graphically represented in Figure 2.

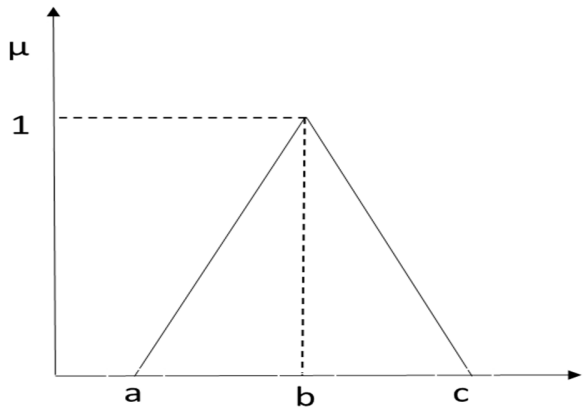

Figure-2 Triangular fuzzy number with parameters (a,b,c)

2.3 Plithogenic operator

Plithogenic set a generalisation of the crisp, fuzzy, intuitionistic fuzzy and neutrosophicsets,is highly focused on uncertainty of the information. The two main features of plithogenic sets are its contradiction degree and degree of appurtenance. The contradiction degree is defined between the attribute values to the dominant attribute value and in fact it is the core elementof plithogenic aggregation operators which increases the accuracy of results. This advantage is the motivation for current study which integrates the plithogenic aggregation operator to combine the connection matrix obtained from the experts' opinion.Plithogenic operators are defined as

DOI: 10.5281/zenodo.4127202

Plithogenic fuzzy set intersection:

$$a \wedge_P b = (1-c)[a \wedge_F b] + c[a \vee_F b] \quad (4)$$

Plithogenic fuzzy set union:

$$a \vee_P b = (1-c)[a \vee_F b] + c[a \wedge_F b] \quad (5)$$

where a and b are the degree of appurtenance of the attribute with respect to the expert A and expert B respectively, c represents the contradiction degree, $a \wedge_F b$ and $a \vee_F b$ are the fuzzy t-norms and t-co-norms respectively.

2.4 Defuzzification method

Defuzzification is the process of converting the fuzzified value to the crisp value and is done by a centroid based method[19].

3. Proposed methodology

In this paper, a plithogenic approach to a fuzzy cognitive mapis proposed for an analysis on covid-19 which deals with the imprecise data. In this work, the opinion obtained from three different experts has been combined by plithogenic operators and the analysis is done by fuzzy cognitive maps modelling. Plithogenic set plays an evident role in handling imprecise judgements by taking both truth and false degrees of membership [13]. In addition plithogenic operator has the advantage of contradiction degree which ensures the more accurate results thanpreviously existing models. As far as medical field is concern it is very necessary to get opinion from more than one expert to reach the conclusion for any kind of disease. Different experts have different opinions regarding the Covid-19 spreading and controlling, Plithogenic set combines all the expertsopinion to analyze the virus Covid-19 via possibility of spreading and controlling measures. This is entirely a different way of analysing Covid-19 mathematically using Plithogenic sets. In this aspect,the current study interprets the benefits of Plithogenicoperator and fuzzy cognitive map modelling.Since the fuzzy cognitive map's principle totally rely on the expert's opinion, the authors have considered the contradiction degree for the experts instead of contradiction degree between the factors, to improve the results and also to accommodate the efficiency of Plithogenic operator.

3.1 Determining the factors and construction of FCM for analysis

Based on the field of system considered, select a panel of expert members to monitor the evaluation process. Obtain the concepts/factors of the system from the expert members and construct the FCM by defining the nodes, edges and their weights representing the strength of the interrelationship between the concepts. The experts prefer to afford their opinion in terms of linguistic variables rather than the crisp values due to uncertainties associated with factors of the system considered. Linguistic variables are interpreted to the fuzzy linguistic values from the linguistic scales obtained from the expert members. In this study the linguistic values assigns triangular fuzzy numbers for its accuracy and simplicity. From the data acquired, connection matrix is constructed for every individual expert's opinion whose entries are in terms of linguistic variables.$CM(E_k) = \left(x_{ij}\right)_{n\times n}$a connection matrix, where x_{ij} is the linguistic expression obtained from the expert(E_k)opinion representing influence of concept C_i on C_j.

3.2 Plithogenic aggregation of weights

In the aspect of increasing an accuracy of results, plithogenic operators are utilized to accumulate the opinions of experts. This study determines the contradiction degree between the experts instead of attributes [9][12]. Let us compute the aggregation matrix of the system by using plithogenic operators (3) rely on contradiction degree between experts opinion. $M = (y_{ij})$, where y_{ij} is strength of the influence between concept C_i on C_j obtained by accumulating the values obtained from all the experts.

DOI: 10.5281/zenodo.4127202

3.3 Determining the influence of concepts

Fuzzy cognitive map approach is used for simulation of results. To determine the influence of an individual concept on every other concepts of the system, initiate an instantaneous state vector by keeping the corresponding concept in ON position. Passing the instantaneous vector on to the connection matrix, a resultant vector is obtained and is updated by applying the threshold function. This paper adapts conventional threshold function. The updated vector is again passed on to connection matrix and the procedure is repeated until the fixed point attains, a limiting cycle of the FCM [16].

3.4 Algorithm of the proposed model

The steps involving in the proposed model are as follows and is pictorially presented in Figure3.

Step1: Consider the evaluation system.

Step2: Form a committee of expert members in the field of a system considered.

Step3: From the experts' knowledge, obtain the concepts for the construction of FCM and linguistic expressions representing strength of the interrelationship between the concepts.

Step 4: Form the connection matrices from a data acquired from the experts whose entries are linguistic variables. The linguistic variables are then interpreted to a triangular membership values, formed from the linguistic scales given by the experts.

Step 5: The connection matrices are then accumulated to a single matrix using plithogenic operator equation (4).

Step 6: To determine the effect a concept (say(N_1)) on other factors of the system, consider the initial state vector by kept N_1 in ON and remaining concepts in OFF state.

Step 7: The influence of the concepts of the system is calculated by using the equation $A(t+1) = f(A(t) * TrF(M))$, the inference of FCM. Threshold the resultant vector to activate the successive vectors. The vector updated is passed on to the connection matrix and the process is repeated till fixed point is arrived.

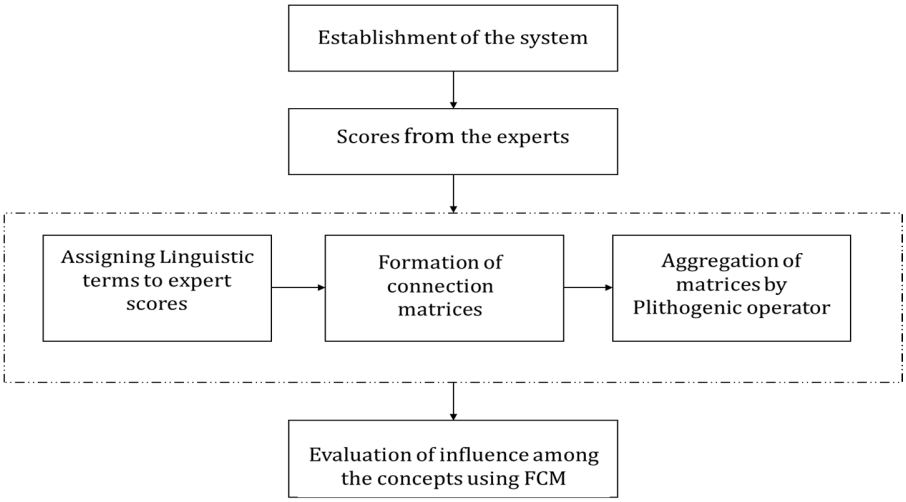

Figure-3 Flow Chart of Proposed Methodology

DOI: 10.5281/zenodo.4127202

4.Application of Plithogenic FCM in Analysis of Covid-19 (causes, spread and precautions)

The outbreak of covid-19 is considered for the analysis, to test the accuracy of the proposed methodology.This work mainlyfocuses on causes, spread and precaution.

4.1 Factors considered for analysis

The factors/concepts considered for the analysis was obtained from the experts and is listed below.

- N1-Symptomatic Covid-19(Symptoms like cold, cough, fever and breathing problems).
- N2-Asymptomatic Covid-19(No symptoms mentioned in N1).
- N3-Maintaining social distance, wearing mask and continuous hand wash.(Precaution measure to prevent from Covid-19).
- N4-Chronic disease patients (High blood pressure, diabetes, tuberculosis, cancer patient, elder people) violating N_3.
- N5- Travelling history(Person travelling from country to country).
- N6-Possibility of Covid-19.
- N7-High risk factor for getting Covid-19
- N8-Prevention measures from Covid-19

4.2 Results and Discussion

For this study three experts were asked to provide their opinion on covid-19 for the analysis, the connection matrix is constructed based on the data obtained from the knowledge of experts and their field experiences. The cognitive maps drawn from the opinions ofexpert1,expert2 and expert3 are depicted in Figure-3, Figure-4 and Figure-5 respectively, theirconnection matrices are presented in equation (5),(6) and(7) respectively. The entries are presented in terms of linguistic variables. Using triangular fuzzy numbers the linguistic variables are quantified and presented in Table1 and is graphically presented in Figure-4.

Linguistic variable	Linguistic value
Very Low	(0,0.2,0.3)
Low	(0.2,0.3,0.4)
Medium	(0.3,0.4,0.5)
High	(0.5,0.6,0.7)
Very High	(0.7,0.8, 1)

Table-1 Quantified linguistic variables

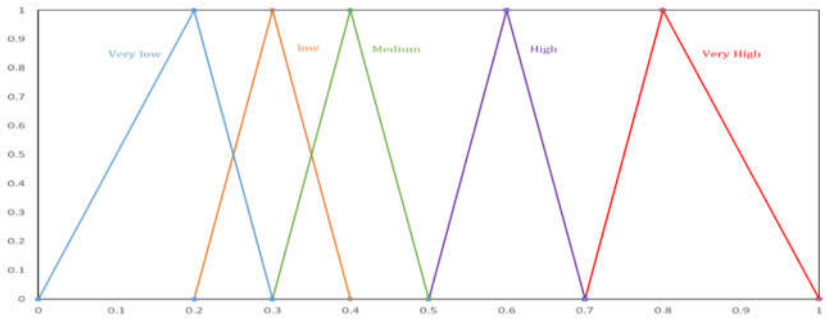

Figure-4 Triangular membership values

DOI: 10.5281/zenodo.4127202

$$CM(E_1) = \begin{array}{c} \\ N_1 \\ N_2 \\ N_3 \\ N_4 \\ N_5 \\ N_6 \\ N_7 \\ N_8 \end{array} \begin{array}{c} \begin{array}{cccccccc} N_1 & N_2 & N_3 & N_4 & N_5 & N_6 & N_7 & N_8 \end{array} \\ \begin{bmatrix} 0 & 0 & 0 & 0 & 0 & H & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & H & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & VL & L & H \\ 0 & 0 & 0 & 0 & 0 & H & H & 0 \\ 0 & 0 & 0 & 0 & 0 & H & VH & 0 \\ H & H & VL & H & H & 0 & 0 & 0 \\ 0 & 0 & L & H & VH & 0 & 0 & 0 \\ 0 & 0 & H & 0 & 0 & 0 & 0 & 0 \end{bmatrix} \end{array} \quad (6)$$

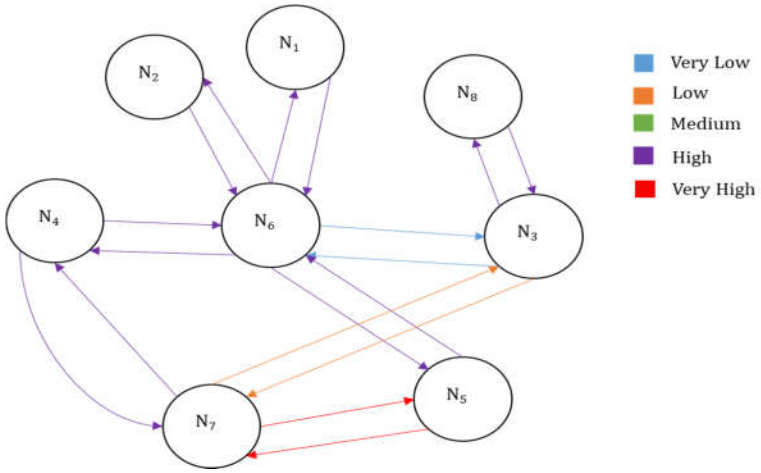

Figure-5 Fuzzy Cognitive Map(Expert 1)

$$CM(E_2) = \begin{array}{c} \\ N_1 \\ N_2 \\ N_3 \\ N_4 \\ N_5 \\ N_6 \\ N_7 \\ N_8 \end{array} \begin{array}{c} \begin{array}{cccccccc} N_1 & N_2 & N_3 & N_4 & N_5 & N_6 & N_7 & N_8 \end{array} \\ \begin{bmatrix} 0 & 0 & 0 & 0 & 0 & VH & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & M & L & 0 \\ 0 & 0 & 0 & 0 & 0 & VL & VL & VH \\ 0 & 0 & 0 & 0 & 0 & VH & VH & 0 \\ 0 & 0 & 0 & 0 & 0 & VH & H & 0 \\ VH & M & VL & VH & VH & 0 & 0 & 0 \\ 0 & L & VL & VH & H & 0 & 0 & 0 \\ 0 & 0 & VH & 0 & 0 & 0 & 0 & 0 \end{bmatrix} \end{array} \quad (7)$$

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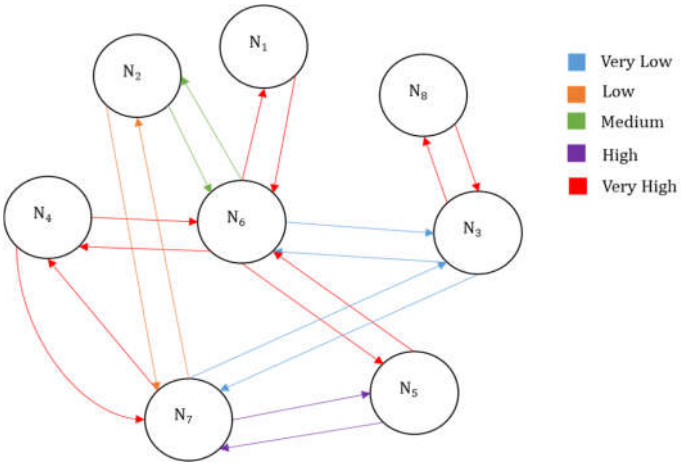

Figure-6 Fuzzy Cognitive Map(Expert 2)

$$CM(E_3) = \begin{array}{c} \\ N_1 \\ N_2 \\ N_3 \\ N_4 \\ N_5 \\ N_6 \\ N_7 \\ N_8 \end{array} \begin{array}{c} \begin{array}{cccccccc} N_1 & N_2 & N_3 & N_4 & N_5 & N_6 & N_7 & N_8 \end{array} \\ \begin{bmatrix} 0 & 0 & 0 & 0 & 0 & VH & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & VH & VL & 0 \\ 0 & 0 & 0 & 0 & 0 & VL & L & H \\ 0 & 0 & 0 & 0 & 0 & H & VH & 0 \\ 0 & 0 & 0 & 0 & 0 & VH & VH & 0 \\ H & VH & VL & H & H & 0 & 0 & 0 \\ 0 & VL & L & VH & VH & 0 & 0 & 0 \\ 0 & 0 & VH & 0 & 0 & 0 & 0 & 0 \end{bmatrix} \end{array} \tag{8}$$

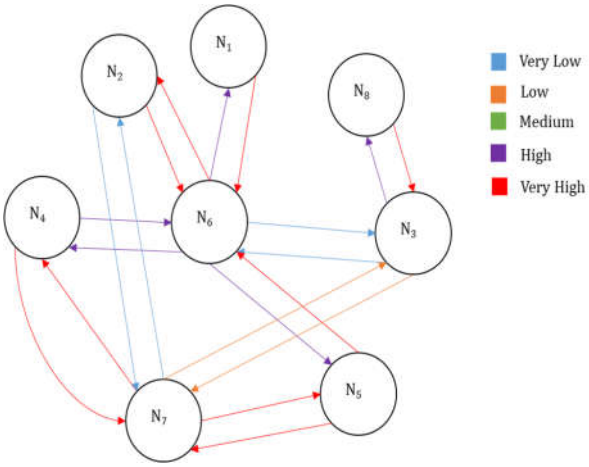

Figure-7 Fuzzy Cognitive Map(Expert 3)

Meanwhile Expert1's opinion is more appropriate than other two experts. Thus the contradiction degree of the dominant expert with respect to the other experts are considered as $d(E_1) = 0, d(E_2) = \frac{1}{3}$ and $d(E_3) = \frac{2}{3}$. The three matrices obtained from experts are accumulated using Plithogenic operator defined in equation (5). The aggregated matrix and the corresponding defuzzified matrix is given in Eqn (9) and Eqn (10) respectively.

DOI: 10.5281/zenodo.4127202

	N_1	N_2	N_3	N_4	N_5	N_6	N_7	N_8
N_1	0	0	0	0	0	(0.656 0.757 0.933)	0	0
N_2	0	0	0	0	0	(0.585 0.689 0.856)	(0.04 0.167 0.24)	0
N_3	0	0	0	0	0	(0 0.2 0.3)	(0.153 0.278 0.378)	(0.656 0.757 0.933)
N_4	0	0	0	0	0	(0.545 0.647 0.767)	(0.656 0.757 0.933)	0
N_5	0	0	0	0	0	(0.656 0.757 0.933)	(0.656 0.757 0.933)	0
N_6	(0.545 0.647 0.767)	(0.585 0.689 0.856)	(0 0.2 0.3)	(0.545 0.647 0.767)	(0.545 0.647 0.767)	0.653	0	0
N_7	0	(0.04 0.167 0.24)	(0.153 0.278 0.378)	(0.656 0.757 0.933)	(0.656 0.757 0.933)	0	0	0
N_8	0	0	(0.656 0.757 0.933)	0	0	0	0	0

(9)

$$TrF(M) = \begin{array}{c} \\ N_1 \\ N_2 \\ N_3 \\ N_4 \\ N_5 \\ N_6 \\ N_7 \\ N_8 \end{array} \begin{array}{c} \begin{array}{cccccccc} N_1 & N_2 & N_3 & N_4 & N_5 & N_6 & N_7 & N_8 \end{array} \\ \begin{bmatrix} 0 & 0 & 0 & 0 & 0 & 0.782 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0.711 & 0.149 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0.17 & 0.27 & 0.782 \\ 0 & 0 & 0 & 0 & 0 & 0.653 & 0.782 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0.782 & 0.782 & 0 \\ 0.653 & 0.711 & 0.17 & 0.653 & 0.653 & 0 & 0 & 0 \\ 0 & 0.149 & 0.27 & 0.782 & 0.782 & 0 & 0 & 0 \\ 0 & 0 & 0.782 & 0 & 0 & 0 & 0 & 0 \end{bmatrix} \end{array} \quad (10)$$

For instant, considering N3 is ON and the other states remains in an OFF state.N6 in ON state,compute the influence of Maintaining social distance, wearing mask and continuous hand wash on all the other factors considered and from the simulation results we can obtain the causal strength of the concepts.

Maintaining social distance, wearing mask and continuous hand wash is in ON state then the initial state vector $A(0) = (0 \quad 0 \quad 1 \quad 0 \quad 0 \quad 0 \quad 0 \quad 0)$

Now

$$A(1) = A(0) \times TrF(M) = (0 \quad 0 \quad 0 \quad 0 \quad 0 \quad 0.17 \quad 0.27 \quad 0.782)$$
$$\hookrightarrow (0 \quad 0 \quad 1 \quad 0 \quad 0 \quad 0 \quad 0 \quad 1) = A(1) \quad (11)$$

$$A(2) = A(1) \times TrF(M) = (0 \quad 0 \quad 0.782 \quad 0 \quad 0 \quad 0.17 \quad 0.27 \quad 0.782)$$
$$\hookrightarrow (0 \quad 0 \quad 1 \quad 0 \quad 0 \quad 0 \quad 0 \quad 1) = A(2) = A(1). \quad (12)$$

The limiting cycle arrives and is observe that influence of state N3 is triggered the state N8, its well known that Maintaining social distance, wearing mask and continuous hand wash is also a part of preventive measures and a self-discipline to be followed byevery individual.

DOI: 10.5281/zenodo.4127202

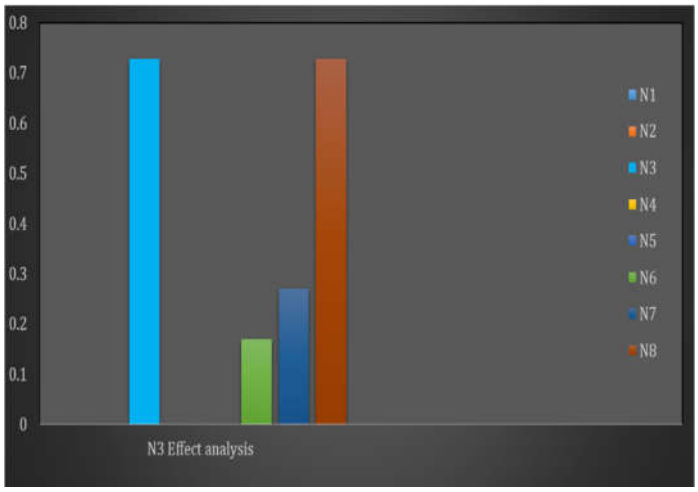

Figure-8 Influence of N3 on other concepts

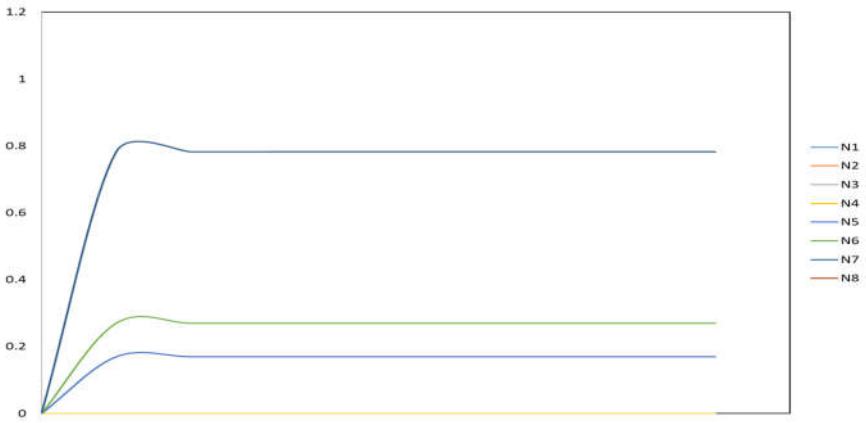

Figure-9 simulation convergence when N3 is ON

Similarly if N7 High risk factor for getting Covid-19is ON, its influence on others states is evaluated and is presented below.

High risk factor for getting Covid-19 is in ON state then the initial state vector $A(0) = (0 \quad 0 \quad 0 \quad 0 \quad 0 \quad 0 \quad 1 \quad 0)$

Now

$$A(1) = \mathrm{A}(0) \times TrF(M) = (0 \quad 0.149 \quad 0.27 \quad 0.782 \quad 0.782 \quad 0 \quad 0 \quad 0)$$

$$\hookrightarrow (0 \quad 0 \quad 0 \quad 1 \quad 1 \quad 0 \quad 1 \quad 0) = A(1) \tag{13}$$

$$A(2) = \mathrm{A}(1) \times TrF(M) = (0 \quad 0.149 \quad 0.27 \quad 0.782 \quad 0.782 \quad 1.435 \quad 1.564 \quad 0)$$

$$\hookrightarrow (0 \quad 0 \quad 0 \quad 1 \quad 1 \quad 1 \quad 1 \quad 0) = A(2) \tag{14}$$

$$A(3) = \mathrm{A}(2) \times TrF(M) = (0.653 \quad 0.86 \quad 0.44 \quad 1.435 \quad 1.435 \quad 1.435 \quad 1.564 \quad 0)$$

$$\hookrightarrow (1 \quad 1 \quad 0 \quad 1 \quad 1 \quad 1 \quad 1 \quad 0) = \mathrm{A}(3) \tag{15}$$

DOI: 10.5281/zenodo.4127202

$$A(4) = \mathrm{A}(3) \times TrF(M) = (0.653 \quad 0.86 \quad 0.44 \quad 1.435 \quad 1.435 \quad 2.928 \quad 1.713 \quad 0)$$

$$\downarrow (1 \quad 1 \quad 0 \quad 1 \quad 1 \quad 1 \quad 1 \quad 0) = A(4) = A(3) \qquad (16)$$

Hence we obtain the limiting cycle with the resultant vector$(1 \quad 1 \quad 0 \quad 1 \quad 1 \quad 1 \quad 1 \quad 0)$. The triggering pattern is$\mathrm{N7} \rightarrow \mathrm{N4} \rightarrow \mathrm{N5} \rightarrow \mathrm{N6} \rightarrow \mathrm{N1} \rightarrow \mathrm{N2}$. From the limiting cycle obtained it is easy to predict that the High risk factor for getting Covid-19 is influenced from N1, N2, N4, N5 and N6. The evaluated results are well matched with current pandemic scenariosince, getting affected to Covid-19 may be symptomatic or asymptomatic and the patients with chronic diseases like diabetics, cancer,heart diseases etc., had a major risk of getting affected to this infectious disease. In addition, travelling historyis also had a greater influence in covid-19 outbreak.

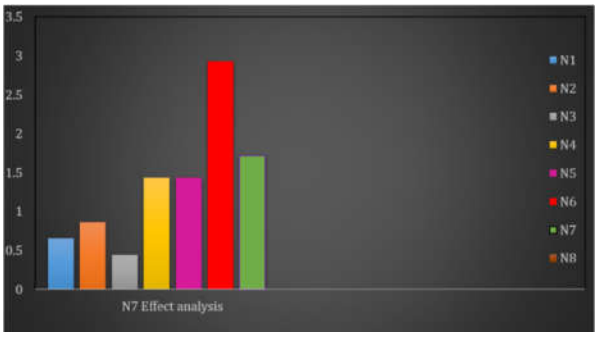

Figure-10 Influence of N7 on every concepts

Varying initial state vector by consequently stimulating each state and executing simulation process, a final state is attained after several iterations. Limiting cycle for each state is attained in this proposed methodology whose results are well matched with the real time situations.

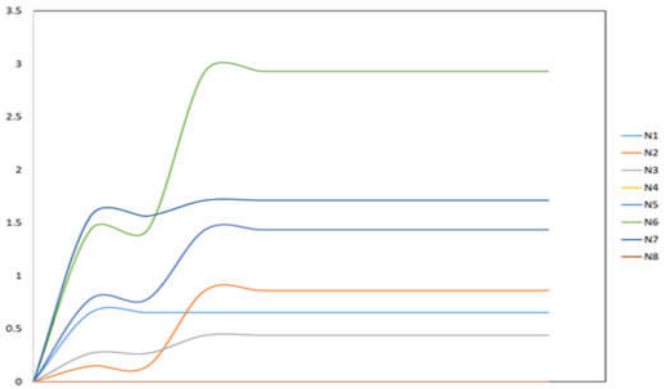

Figure-11 simulation convergence when N7 is ON

5.Comparison analysis

To show the benefits of the proposed method the comparative analysis is made between contradiction degree of the factors and that of the experts. As shown in the previous section the contradiction degree for the experts is considered and the connection matrix is combined using Plithogenic operator. To compare the methods , consider Maintaining social distance, wearing mask and continuous hand wash is in ON state then the initial state vector $\mathrm{A}(0) = (0 \quad 0 \quad 1 \quad 0 \quad 0 \quad 0 \quad 0 \quad 0)$

$$A(1) = \mathrm{A}(0) \times TrF(M)$$

DOI: 10.5281/zenodo.4127202

$$A(2) = \mathrm{A}(1) \times TrF(M) = \mathrm{A}(1) \quad (17)$$

The limiting cycle arrives and is observe that influence of state N3 is triggered the state N8, its well-known that Maintaining social distance, wearing mask and continuous hand wash is also a part of preventive measures and a self-discipline to be followed by every individual.

In case of contradiction degree between the factors, Maintaining social distance, wearing mask and continuous hand wash is in ON state then the initial state vector $\mathrm{A}(0) = (0 \quad 0 \quad 1 \quad 0 \quad 0 \quad 0 \quad 0 \quad 0)$ and considering the connection matrix of expert 1,

$$\mathrm{A}(1) = \mathrm{A}(0) \times \mathrm{CM}(\mathrm{E}_1) = (1 \quad 0.875 \quad 0.75 \quad 0.625 \quad 0.5 \quad 0.606 \quad 0.588 \quad 0.729)$$

$$\downarrow (1 \quad 0 \quad 1 \quad 0 \quad 0 \quad 0 \quad 0 \quad 0) = A(1) \quad (18)$$

$$A(2) = \mathrm{A}(1) \times \mathrm{CM}(\mathrm{E}_1) = (1 \quad 0.875 \quad 0.75 \quad 0.625 \quad 0.5 \quad 0.606 \quad 0.588 \quad 0.729)$$

$$\downarrow (1 \quad 0 \quad 1 \quad 0 \quad 0 \quad 0 \quad 0 \quad 0) = A(2) = A(1) \quad (19)$$

Limiting cycle is attained and is observed that when the N3 is ON it triggers the state N1, which is not matched with the real time situation rather the proposed methodology is concurred with the real time situation and in addition in the proposed method the opinions can be obtained from more than one expert.

6.Conclusion

The research work proposes a plithogenic approach to fuzzy cognitive map. The interpretation of contradiction degree to a plithogenic operator is used to accumulate the expert's opinion. The accumulated connection matrix is then utilized for the simulation which is based on fuzzy cognitive map.In order to assess the accuracy, the proposed model isutilised for the analysis of current pandemic situation, a covid-19 outbreak. The factors influencing the considered system and linguistic scales representing a strength between them was obtained from three distinct expert members and the simulation was done by using proposed methodology to increase the accuracy of results. The results are well matched with real time situations. This work can be further extended to Plithogenic approach to Neutrosophic Cognitive Map in the future.

Funding: "This research received no external funding"

Conflicts of Interest: "The authors declare no conflict of interest."

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