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A Neutrosophic Cognitive Maps Approach For TheSymptoms-Disease Model In Maternal Healthcare

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ABSTRACT
This study presents the Symptoms-Disease model for maternal health conditions using neutrosphic cognitive maps (NCM). This approach develops a NCM model to analyze the nine symptoms associated with the six disorders that affect expectant mothers. A numerical example of the diagnosis model is also provided to demonstrate the applicability of the proposed NCM approach
Keywords: Fuzzy Cognitive Map(FCM), Neutrosophic sets, Neutrosophic Cognitve Maps(NCM), Symptoms-Disease Model.

I. INTRODUCTION

Florentin Smarandache [1,2] introduced the concept of neutrosophic sets (NS) in 1998. Among the different classes of sets, the neutrosophic set is the extension of the classic set, fuzzy set, interval-valued fuzzy set, and intuitionistic fuzzy set.Fuzzy Cognitive Maps (FCMs) are an effective computational modeling technique to represent and examine the behavior of complex systems. FCM is a combination of cognitive maps and fuzzy logic components to simulate the causal relationships between various components in a system. An FCM can be especially useful when the relationships between components are uncertain, imprecise, or fuzzy. In 1986, Bart Kosko[3] presented the concept of Fuzzy Cognitive Maps (FCMs).WB Vasantha, and Florentin Smarandache[4] introduced the idea of the neutrosophic cognitive map(NCM), which is an extension of the fuzzy cognitive maps.The NCM model was created by WB Vasantha et al.[5] to analyze the social aspects of migrant laborers who are living with HIV/AIDS.

Recently, a disease symptoms model that uses FCM was developed by R. Sophia Porchelvi and R. Vanitha [6]. A neutrosophic cognitive map-based method was developed by Shakil et al.[7] to examine the elements contributing to health deterioration. Fuzzy and neuromorphic cognitive maps were used in the model established by Ramalingam and Said Broumi et al.[8] to analyze the factors of COVID-19.The Neutrosophic Cognitive Maps Model for the Diagnosis of Autism was proposed by Reyes Salgado and Lester Noel, et al.[9]. Deepak, F. X., et al. [10]proposed the concept of Pythagorean fuzzy cognitive maps and applied it in Making Optimal Decisions on Feasible Strategies for Inhibiting Electronic Waste. The neutrosophic cognitive maps model was created by Obbineni et al[11] and colleagues for Clinical Decision Making in Mental Healthcare: A Federated Learning Approach.

The novel symptoms-disease cognitive model is analyzed in this paper using a neutrosophic cognitive map approach. This study is aimed at determining exactly which combination of symptoms leads to diseases. The final results are determined by getting the fixed point. This paper consists the following sections: Section 2 contains basic definitions related to Neutrosophiccognitive map. The proposed method is presented in section 3. The numerical example for symptoms-disease cognitive model is discussed in section 4. Conclusion appear in section 5.

II. PRELIMINARIES

Definition2.1

An FCM is said to be simple if the edge weights are taken from the set $\{-1,0,1\}$ and for simple NCM it is $\{-1,0,1,I\}$. Let $\{C_1, C_2, \ldots, C_n\}$ be the concepts of the FCMs.Using this concept the directed graph is drawn with edge weight $a_{ij} = \{-1,0,1,I\}$. Here, $a_{ij} = 1$ means positive causality between the concepts.If the concepts has no relation indicates $a_{ij}=0$. If $a_{ij} = I$ means the relation

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between the concepts is indeterminate and its denoted by dotted line in the directed graph. define the adjacency matrix $A = a_{ij}$ where a_{ij} is the weights of the corresponding edge C_iC_j . The connection matrix is called the neutrosophic adjacency matrix of the NCMs.

III. METHODOLOGY

3.1 Neutrosophic Cognitive Map Approach

This section includes the steps of the suggested Neutrosophic FCM model. Let us consider the fuzzy cognitive map approach modified from WB Vasantha, and Smarandache [4].

Step 1: Construct the symptoms-disease model using neutrosophic cognitive maps. Here we analyzed nine symptoms associated with the six disorders. i.e.,$\{C_1, C_2, \ldots, C_n\}$.

Step 2: Construct the neutrosophic directed graph and the corresponding adjacency matrix. $A = a_{ij}$ for $i = 1,2,\ldots,n$ and $j = 1,2,\ldots,m$

Step 3: Consider the initial vector of the form $\mathcal{F}_1$=(10000...0) and multiply with A, in this initial vector the value 1 represents that the first vector kept ON positions and other vectors in OFF position, threshold the resultant vector by assigning the value 1 to the factor ON position and the greatest value, assign the value 0 to the remaining. the new vector is $\mathcal{F}_2$.

Step 4: Repeat the same procedure to reach the fixed point. Similarly, we follow the same procedure to find the hidden pattern and indeterminacy for all the parameters of the model.

IV. SYMPTOMS-DISEASE MODEL USING NCM

The different concepts that were taken into consideration for this analysis are specified below.Data were gathered from medical experts in order to analyze the parameters of the symptoms-disease model. The following factors were identified and gathered based on their suggestions. This work concentrates on the symptoms and disease model for maternal health conditions during pregnancy. Let us consider the following nodes in Table 1.

Table 1. Concepts for the Symptoms-Disease Model

Nodes	Symtomps Factors	Disease
$\mathcal{S}_1$	Fatigue	
$\mathcal{S}_2$	Blurred Vision	
$\mathcal{S}_3$	Headache	
$\mathcal{S}_4$	Fever	
$\mathcal{S}_5$	Frequent Urination	
$\mathcal{S}_6$	Stomach Pain	
$\mathcal{S}_7$	Trouble Breathing	
$\mathcal{S}_8$	Swelling	
$\mathcal{S}_9$	Nausea and Vomiting	
$\mathcal{S}_{10}$	Gestational Diabetes	
$\mathcal{S}_{11}$	Morning Sickness	
$\mathcal{S}_{12}$	Iron Deficiency	
$\mathcal{S}_{13}$	Placental Disorders	
$\mathcal{S}_{14}$	Infectious Disease	
$\mathcal{S}_{15}$	High Blood Pressure	

%3CmxGraphModel%3E%3Croot%3E%3CmxCell%20id%3D%220%22%2F%3E%3CmxCell%20id%3D%221%22%20parent%3D%220%22%2F%3E%3CmxCell%20id%3D%222%22%20value%3D%22%26lt%3Bfont%20face%3D%26quot%3BTimes%20New%20Roman%26quot%3B%20style%3D%26quot%3Bfont-size%3A%2018px%3B%26quot%3B%26gt%3BS%26lt%3Bsub%20style%3D%26quot%3B%26quot%3B%26gt%3B1%26lt%3B%2Fsub%26gt%3B%26lt%3B%2Ffont%26gt%3B%22%20style%3D%22ellipse%3BwhiteSpace%3Dwrap%3Bhtml%3D1%3Brounded%3D0%3Bshadow%3D1%3Bcomic%3D0%3BlabelBackgroundColor%3Dnone%3BstrokeWidth%3D1%3BfontFamily%3DVerdana%3BfontSize%3D12%3Balign%3Dcenter%3BfillColor%3D%23D4E1F5%3B%22%20vertex%3D%221%22%20parent%3D%221%22%3E%3CmxGeometry%20x%3D%22450%22%20y%3D%2270%22%20width%3D%2290%22%20height%3D%2260%22%20as%3D%22geometry%22%2F%3E%3C%2FmxCell%3E%3CmxCell%20id%3D%223%22%20value%3D%22%26lt%3Bspan%20style%3D%26quot%3Bfont-

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2%20parent%3D%221%22%3E%3CmxGeometry%20width%3D%22160%22%20relative%3D%221%22%20as%3D%22geometry%22%3E%3CmxPoint%20x%3D%22400%22%20y%3D%22290%22%20as%3D%22sourcePoint%22%2F%3E%3CmxPoint%20x%3D%22560%22%20y%3D%22290%22%20as%3D%22targetPoint%22%2F%3E%3C%2FmxGeometry%3E%3C%2FmxCell%3E%3CmxCell%20id%3D%2239%22%20value%3D%22%22%20style%3D%22endArrow%3Dblock%3Bdashed%3D1%3BendFill%3D0%3BendSize%3D12%3Bhtml%3D1%3Brounded%3D0%3Belbow%3Dvertical%3BexitX%3D0.067%3BexitY%3D0.2%3BexitDx%3D0%3BexitDy%3D0%3BentryX%3D0.5%3BentryY%3D1%3BentryDx%3D0%3BentryDy%3D0%3BexitPerimeter%3D0%3B%22%20edge%3D%221%22%20source%3D%2214%22%20target%3D%228%22%20parent%3D%221%22%3E%3CmxGeometry%20width%3D%22160%22%20relative%3D%221%22%20as%3D%22geometry%22%3E%3CmxPoint%20x%3D%22473.75%22%20y%3D%22340%22%20as%3D%22sourcePoint%22%2F%3E%3CmxPoint%20x%3D%22531.25%22%20y%3D%22270%22%20as%3D%22targetPoint%22%2F%3E%3C%2FmxGeometry%3E%3C%2FmxCell%3E%3CmxCell%20id%3D%2240%22%20value%3D%22%22%20style%3D%22endArrow%3Dblock%3Bdashed%3D1%3BendFill%3D0%3BendSize%3D12%3Bhtml%3D1%3Brounded%3D0%3Belbow%3Dvertical%3BexitX%3D0.404%3BexitY%3D-0.027%3BexitDx%3D0%3BexitDy%3D0%3BexitPerimeter%3D0%3BentryX%3D0.222%3BentryY%3D0.889%3BentryDx%3D0%3BentryDy%3D0%3BentryPerimeter%3D0%3B%22%20edge%3D%221%22%20source%3D%2214%22%20target%3D%222%22%20parent%3D%221%22%3E%3CmxGeometry%20width%3D%22160%22%20relative%3D%221%22%20as%3D%22geometry%22%3E%3CmxPoint%20x%3D%22495%22%20y%3D%22350%22%20as%3D%22sourcePoint%22%2F%3E%3CmxPoint%20x%3D%22470%22%20y%3D%22132%22%20as%3D%22targetPoint%22%2F%3E%3CArray%20as%3D%22points%22%3E%3CmxPoint%20x%3D%22430%22%20y%3D%22230%22%2F%3E%3C%2FArray%3E%3C%2FmxGeometry%3E%3C%2FmxCell%3E%3CmxCell%20id%3D%2241%22%20value%3D%22%22%20style%3D%22endArrow%3Dclassic%3Bhtml%3D1%3Brounded%3D0%3Belbow%3Dvertical%3BexitX%3D0.741%3BexitY%3D0.978%3BexitDx%3D0%3BexitDy%3D0%3BexitPerimeter%3D0%3BentryX%3D0.5%3BentryY%3D0%3BentryDx%3D0%3BentryDy%3D0%3B%22%20edge%3D%221%22%20source%3D%222%22%20target%3D%2214%22%20parent%3D%221%22%3E%3CmxGeometry%20width%3D%2250%22%20height%3D%2250%22%20relative%3D%221%22%20as%3D%22geometry%22%3E%3CmxPoint%20x%3D%22450%22%20y%3D%22300%22%20as%3D%22sourcePoint%22%2F%3E%3CmxPoint%20x%3D%22520%22%20y%3D%22360%22%20as%3D%22targetPoint%22%2F%3E%3CArray%20as%3D%22points%22%3E%3CmxPoint%20x%3D%22550%22%20y%3D%22230%22%2F%3E%3C%2FArray%3E%3C%2FmxGeometry%3E%3C%2FmxCell%3E%3CmxCell%20id%3D%2242%22%20value%3D%22%22%20style%3D%22endArrow%3Dclassic%3Bhtml%3D1%3Brounded%3D0%3Belbow%3Dvertical%3BentryX%3D0.347%3BentryY%3D-0.04%3BentryDx%3D0%3BentryDy%3D0%3BexitX%3D0%3BexitY%3D1%3BexitDx%3D0%3BexitDy%3D0%3BentryPerimeter%3D0%3B%22%20edge%3D%221%22%20source%3D%223%22%20target%3D%229%22%20parent%3D%221%22%3E%3CmxGeometry%20width%3D%2250%22%20height%3D%2250%22%20relative%3D%221%22%20as%3D%22geometry%22%3E%3CmxPoint%20x%3D%22450%22%20y%3D%22300%22%20as%3D%22sourcePoint%22%2F%3E%3CmxPoint%20x%3D%22500%22%20y%3D%22250%22%20as%3D%22targetPoint%22%2F%3E%3CArray%20as%3D%22points%22%3E%3CmxPoint%20x%3D%22430%22%20y%3D%22370%22%2F%3E%3C%2FArray%3E%3C%2FmxGeometry%3E%3C%2FmxCell%3E%3CmxCell%20id%3D%2243%22%20value%3D%22%22%20style%3D%22endArrow%3Dblock%3Bdashed%3D1%3BendFill%3D0%3BendSize%3D12%3Bhtml%3D1%3Brounded%3D0%3Belbow%3Dvertical%3BentryX%3D0.636%3BentryY%3D0.96%3BentryDx%3D0%3BentryDy%3D0%3BentryPerimeter%3D0%3BexitX%3D0%3BexitY%3D1%3BexitDx%3D0%3BexitDy%3D0%3B%22%20edge%3D%221%22%20source%3D%2214%22%20target%3D%2213%22%20parent%3D%221%22%3E%3CmxGeometry%20width%3D%22160%22%20relative%3D%221%22%20as%3D%22geometry%22%3E%3CmxPoint%20x%3D%22460%22%20y%3D%22400%22%20as%3D%22sourcePoint%22%2F%3E%3CmxPoint%20x%3D%22560%22%20y%3D%22280%22%20as%3D%22targetPoint%22%2F%3E%3C%2FmxGeometry%3E%3C%2FmxCell%3E%3CmxCell%20id%3D%2244%22%20value%3D%22%22%20style%3D%22endArrow%3Dblock%3Bdashed%3D1%3BendFill%3D0%3BendSize%3D12%3Bhtml%3D1%3Brounded%3D0%3Belbow%3Dvertical%3BentryX%3D0.5%3BentryY%3D1%3BentryDx%3D0%3BentryDy%3D0%3BexitX%3D0.027%3BexitY%3D0.253%3BexitDx%3D0%3BexitDy%3D0%3BexitPerimeter%3D0%3B%22%20edge%3D%221%22%20source%3D%2212%22%20target%3D%2211

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%22%20parent%3D%221%22%3E%3CmxGeometry%20width%3D%22160%22%20relative%3D%221%22%20as%3D%22geometry%22%3E%3CmxPoint%20x%3D%22400%22%20y%3D%22280%22%20as%3D%22sourcePoint%22%2F%3E%3CmxPoint%20x%3D%22260%22%20y%3D%22380%22%20as%3D%22targetPoint%22%2F%3E%3C%2FmxGeometry%3E%3C%2FmxCell%3E%3CmxCell%20id%3D%2245%22%20value%3D%22%22%20style%3D%22endArrow%3Dclassic%3Bhtml%3D1%3Brounded%3D0%3Belbow%3Dvertical%3B%22%20edge%3D%221%22%20target%3D%224%22%20parent%3D%221%22%3E%3CmxGeometry%20width%3D%2250%22%20height%3D%2250%22%20relative%3D%221%22%20as%3D%22geometry%22%3E%3CmxPoint%20x%3D%2375%22%20y%3D%22440%22%20as%3D%22sourcePoint%22%2F%3E%3CmxPoint%20x%3D%22425%22%20y%3D%22390%22%20as%3D%22targetPoint%22%2F%3E%3C%2FmxGeometry%3E%3C%2FmxCell%3E%3CmxCell%20id%3D%2246%22%20value%3D%22%22%20style%3D%22endArrow%3Dclassic%3BstartArrow%3Dclassic%3Bhtml%3D1%3Brounded%3D0%3Belbow%3Dvertical%3BexitX%3D1%3BexitY%3D1%3BexitDx%3D0%3BexitDy%3D0%3BentryX%3D0%3BentryY%3D0%3BentryDx%3D0%3BentryDy%3D0%3B%22%20edge%3D%221%22%20source%3D%227%22%20target%3D%226%22%20parent%3D%221%22%3E%3CmxGeometry%20width%3D%2250%22%20height%3D%2250%22%20relative%3D%221%22%20as%3D%22geometry%22%3E%3CmxPoint%20x%3D%22625%22%20y%3D%22390%22%20as%3D%22sourcePoint%22%2F%3E%3CmxPoint%20x%3D%22675%22%20y%3D%22340%22%20as%3D%22targetPoint%22%2F%3E%3C%2FmxGeometry%3E%3C%2FmxCell%3E%3CmxCell%20id%3D%2247%22%20value%3D%22%22%20style%3D%22endArrow%3Dblock%3Bdashed%3D1%3BendFill%3D0%3BendSize%3D12%3Bhtml%3D1%3Brounded%3D0%3Belbow%3Dvertical%3BexitX%3D0.987%3BexitY%3D0.347%3BexitDx%3D0%3BexitDy%3D0%3BexitPerimeter%3D0%3BentryX%3D0.667%3BentryY%3D1%3BentryDx%3D0%3BentryDy%3D0%3BentryPerimeter%3D0%3B%22%20edge%3D%221%22%20source%3D%226%22%20target%3D%225%22%20parent%3D%221%22%3E%3CmxGeometry%20width%3D%22160%22%20relative%3D%221%22%20as%3D%22geometry%22%3E%3CmxPoint%20x%3D%22710%22%20y%3D%22370%22%20as%3D%22sourcePoint%22%2F%3E%3CmxPoint%20x%3D%22870%22%20y%3D%22370%22%20as%3D%22targetPoint%22%2F%3E%3C%2FmxGeometry%3E%3C%2FmxCell%3E%3CmxCell%20id%3D%2248%22%20value%3D%22%22%20style%3D%22endArrow%3Dblock%3Bdashed%3D1%3BendFill%3D0%3BendSize%3D12%3Bhtml%3D1%3Brounded%3D0%3Belbow%3Dvertical%3BexitX%3D0.267%3BexitY%3D0%3BexitDx%3D0%3BexitDy%3D0%3BexitPerimeter%3D0%3BentryX%3D0.5%3BentryY%3D1%3BentryDx%3D0%3BentryDy%3D0%3B%22%20edge%3D%221%22%20source%3D%226%22%20target%3D%224%22%20parent%3D%221%22%3E%3CmxGeometry%20width%3D%22160%22%20relative%3D%221%22%20as%3D%22geometry%22%3E%3CmxPoint%20x%3D%22530%22%20y%3D%22310%22%20as%3D%22sourcePoint%22%2F%3E%3CmxPoint%20x%3D%22690%22%20y%3D%22310%22%20as%3D%22targetPoint%22%2F%3E%3C%2FmxGeometry%3E%3C%2FmxCell%3E%3CmxCell%20id%3D%2249%22%20value%3D%22%22%20style%3D%22endArrow%3Dblock%3Bdashed%3D1%3BendFill%3D0%3BendSize%3D12%3Bhtml%3D1%3Brounded%3D0%3Belbow%3Dvertical%3BentryX%3D0%3BentryY%3D0%3BentryDx%3D0%3BentryDy%3D0%3BexitX%3D0.996%3BexitY%3D0.667%3BexitDx%3D0%3BexitDy%3D0%3BexitPerimeter%3D0%3B%22%20edge%3D%221%22%20source%3D%2210%22%20target%3D%223%22%20parent%3D%221%22%3E%3CmxGeometry%20width%3D%22160%22%20relative%3D%221%22%20as%3D%22geometry%22%3E%3CmxPoint%20x%3D%22370%22%20y%3D%22160%22%20as%3D%22sourcePoint%22%2F%3E%3CmxPoint%20x%3D%22525%22%20y%3D%22169%22%20as%3D%22targetPoint%22%2F%3E%3C%2FmxGeometry%3E%3C%2FmxCell%3E%3CmxCell%20id%3D%2250%22%20value%3D%22%22%20style%3D%22endArrow%3Dclassic%3BstartArrow%3Dclassic%3Bhtml%3D1%3Brounded%3D0%3Belbow%3Dvertical%3BentryX%3D0%3BentryY%3D0%3BentryDx%3D0%3BentryDy%3D0%3BexitX%3D0.5%3BexitY%3D1%3BexitDx%3D0%3BexitDy%3D0%3B%22%20edge%3D%221%22%20source%3D%2210%22%20target%3D%229%22%20parent%3D%221%22%3E%3CmxGeometry%20width%3D%2250%22%20height%3D%2250%22%20relative%3D%221%22%20as%3D%22geometry%22%3E%3CmxPoint%20x%3D%22328%22%20y%3D%22190%22%20as%3D%22sourcePoint%22%2F%3E%3CmxPoint%20x%3D%22500%22%20y%3D%22250%22%20as%3D%22targetPoint%22%2F%3E%3CArray%20as%3D%22points%22%3E%3CmxPoint%20x%3D%22350%22%20y%3D%22360%22%2F%3E%3C%2FArray%3E%3C%2FmxGeometry%3E%3C%2FmxCell%3E%3C%2Froot%3E%3C%2FmxGraphModel%3E

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4.1 Figure Representation of NCM

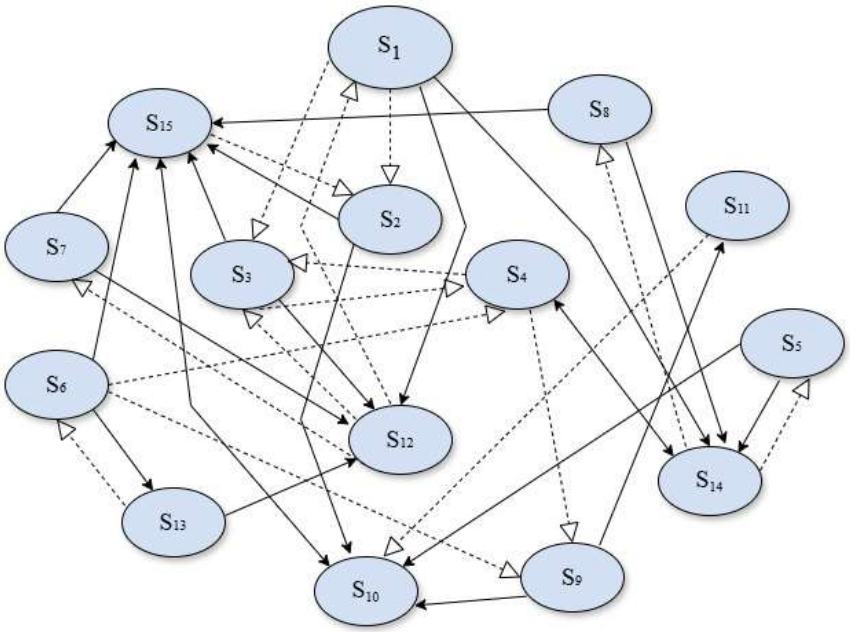

Figure 1. Directed graph for the analysis of disease factors

4.2 Matrix Representation of PNCM

Aneutrosophiccognitive map is represented by a matrix calculated from the connectivity among nodes. In this matrix, The experts gives their suggestions in neutrosophic fuzzy sense,

The connection matrix is given below,

$$A = \begin{array}{c} \\ S_1 \\ S_2 \\ S_3 \\ S_4 \\ S_5 \\ S_6 \\ S_7 \\ S_8 \\ S_9 \\ S_{10} \\ S_{11} \\ S_{12} \\ S_{13} \\ S_{14} \\ S_{15} \end{array} \begin{array}{c} \begin{array}{ccccccccccccccc} S_1 & S_2 & S_3 & S_4 & S_5 & S_6 & S_7 & S_8 & S_9 & S_{10} & S_{11} & S_{12} & S_{13} & S_{14} & S_{15} \end{array} \\ \begin{bmatrix} 0 & I & I & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 1 & 0 & 1 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 1 & 0 & 0 & 0 & 0 & 1 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 1 & 0 & 0 & 1 \\ 0 & 0 & I & 0 & 0 & 0 & 0 & 0 & I & 0 & 0 & 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 1 & 0 & 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & I & 0 & 0 & 0 & 0 & I & 0 & 0 & 0 & 1 & 0 & 1 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 1 & 0 & 0 & 1 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 1 & 1 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 1 & 1 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 1 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & I & 0 & 0 & 0 & 0 & 0 \\ I & 0 & I & 0 & 0 & 0 & I & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & I & 0 & 0 & 0 & 0 & 0 & 1 & 0 & 0 & 0 \\ 0 & 0 & 0 & 1 & I & 0 & 0 & I & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & I & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 1 & 0 & 0 & 0 & 0 & 0 \end{bmatrix} \end{array}$$

4.3 Iteration Process of NCM

Case 1: Gestational Diabetes - ON State

Let us consider the parameter $\mathcal{S}_{10}$ as ON state. The initial matrix needed for the iteration process is described below, with 0 representing the OFF state and 1 representing the ON state.

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$$X_1 = [0\ 0\ 0\ 0\ 0\ 0\ 0\ 0\ 0\ 1\ 0\ 0\ 0\ 0\ 0\ ]$$
$$X_1 * A \rightarrow [0\ 0\ 0\ 0\ 0\ 0\ 0\ 0\ 0\ 1\ 0\ 0\ 0\ 0\ 1] = X_2$$
$$X_2 * A \rightarrow [0\ I\ 0\ 0\ 0\ 0\ 0\ 0\ 0\ 1\ 0\ 0\ 0\ 0\ 1] = X_3$$
$$X_3 * A = [0\ I\ 0\ 0\ 0\ 0\ 0\ 0\ 0\ 1 + I\ 0\ 0\ 0\ 0\ 1 + I]$$
$$\rightarrow [0\ I\ 0\ 0\ 0\ 0\ 0\ 0\ 0\ 1\ 0\ 0\ 0\ 0\ 1] = X_4$$

Here, $X_3 = X_4$ the fixed point is obtained. The values obtained in the third and fourth iterations are the same, allowing the iteration process to end. The factor $\mathcal{S}_2, \mathcal{S}_{15}$ is obtained ON state when the factor $\mathcal{S}_{10}$ is taken ON state. It is concluded that a patient with gestational diabetes may be at an increased risk of high blood pressure and may have blurred vision.

Case 2: Morning Sickness - ON State

Let us consider the parameter $\mathcal{S}_{11}$ as ON state. The initial matrix needed for the iteration process is described below, with 0 representing the OFF state and 1 representing the ON state.

$$X_1 = [0\ 0\ 0\ 0\ 0\ 0\ 0\ 0\ 0\ 0\ 1\ 0\ 0\ 0\ 0\ ]$$
$$X_1 * A \rightarrow [0\ 0\ 0\ 0\ 0\ 0\ 0\ 0\ 0\ I\ 1\ 0\ 0\ 0\ 0] = X_2$$
$$X_2 * A \rightarrow [0\ 0\ 0\ 0\ 0\ 0\ 0\ 0\ 0\ I\ 1\ 0\ 0\ 0\ I] = X_3$$
$$X_3 * A = [0\ I^2\ 0\ 0\ 0\ 0\ 0\ 0\ 0\ 2I\ 0\ 0\ 0\ 0\ I]$$
$$\rightarrow [0\ I\ 0\ 0\ 0\ 0\ 0\ 0\ 0\ I\ 1\ 0\ 0\ 0\ I] = X_4$$
$$X_4 * A = [0\ I^2\ 0\ 0\ 0\ 0\ 0\ 0\ 0\ 3I\ 0\ 0\ 0\ 0\ 2I]$$
$$\rightarrow [0\ I\ 0\ 0\ 0\ 0\ 0\ 0\ 0\ I\ 1\ 0\ 0\ 0\ I] = X_5$$

Here, $X_4 = X_5$ the fixed point is obtained. The values obtained in the fourth and fifth iterations are the same, allowing the iteration process to end. The factors $\mathcal{S}_2, \mathcal{S}_{10}, \mathcal{S}_{15}$ are obtained ON state when the factor $\mathcal{S}_{11}$ is taken ON state. It is concluded that a patient with Morning Sickness may be at an increased risk of gestational diabetes, high blood pressure and may have blurred vision.

Case 3: Iron Deficiency - ON State

Let us consider the parameter $\mathcal{S}_{12}$ as ON state. The initial matrix needed for the iteration process is described below, with 0 representing the OFF state and 1 representing the ON state.

$$X_1 = [0\ 0\ 0\ 0\ 0\ 0\ 0\ 0\ 0\ 0\ 0\ 1\ 0\ 0\ 0\ ]$$
$$X_1 * A \rightarrow [I\ 0\ I\ 0\ 0\ 0\ I\ 0\ 0\ 0\ 0\ 1\ 0\ 0\ 0] = X_2$$
$$X_2 * A = [I\ I^2 I^2 + I\ 0\ 0\ 0\ I\ 0\ 0\ 0\ 0\ 3I\ 0\ 1\ 2I]$$
$$\rightarrow [0\ I\ I\ 0\ 0\ 0\ 0\ 0\ 0\ 0\ 0\ 1\ 0\ 0\ I] = X_3$$
$$X_3 * A = [I\ I^2\ I\ 0\ 0\ 0\ I\ 0\ 0\ 2I\ 0\ 1\ 0\ 0\ I + 1]$$
$$\rightarrow [0\ I\ 0\ 0\ 0\ 0\ 0\ 0\ 0\ I\ 0\ 1\ 0\ 0\ 1] = X_4$$
$$X_4 * A = [I\ I\ I\ 0\ 0\ 0\ I\ 0\ 0\ I + 1\ 0\ 0\ 0\ 0\ 2I]$$
$$\rightarrow [0\ 0\ 0\ 0\ 0\ 0\ 0\ 0\ 0\ 1\ 0\ 1\ 0\ 0\ I] = X_5$$
$$X_5 * A = [I\ I^2\ I\ 0\ 0\ 0\ I\ 0\ 0\ I\ 0\ 0\ 0\ 0\ 1]$$
$$\rightarrow [0\ I\ 0\ 0\ 0\ 0\ 0\ 0\ 0\ 0\ 0\ 1\ 0\ 0\ 1] = X_6$$
$$X_6 * A = [I\ I\ I\ 0\ 0\ 0\ I\ 0\ 0\ I + 1\ 0\ 0\ 0\ 0\ I]$$
$$\rightarrow [0\ 0\ 0\ 0\ 0\ 0\ 0\ 0\ 0\ 1\ 0\ 1\ 0\ 0\ 0] = X_7$$
$$X_7 * A\ = [I\ 0\ I\ 0\ 0\ 0\ I\ 0\ 0\ 0\ 0\ 0\ 0\ 0\ 1]$$
$$\rightarrow [I\ 0\ I\ 0\ 0\ 0\ I\ 0\ 0\ 0\ 0\ 1\ 0\ 0\ 1] = X_8$$
$$X_8 * A = [I\ \ I^2 + I\ I^2 + I\ 0\ 0\ 0\ I\ 0\ 0\ 1\ 0\ 3I\ 0\ I\ 2I]$$
$$\rightarrow [0\ I\ I\ 0\ 0\ 0\ 0\ 0\ 0\ 1\ 0\ 1\ 0\ 0\ I] = X_9$$
$$X_9 * A = [I\ \ I^2\ I\ 0\ 0\ 0\ I\ 0\ 0\ 2I\ 0\ I\ 0\ 0\ 2I + 1]$$
$$\rightarrow [0\ I\ 0\ 0\ 0\ 0\ 0\ 0\ 0\ I\ 0\ 1\ 0\ 0\ 1] = X_{10}$$

Here, $X_4 = X_{10}$ the fixed point is obtained. The values obtained in the fourth and tenth iterations are the same, allowing the iteration process to end. The factor $\mathcal{S}_{25}, \mathcal{S}_{10,}\mathcal{S}_{15}$ is obtained ON state when the factor $\mathcal{S}_{12}$ is taken ON state. It is concluded that a patient with Iron Deficiency may

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be at an gestational diabetes, high blood pressure and may have blurred vision.

Case 4. Placental Disorders - ON State

Let us consider the parameter $\mathcal{S}_{13}$as ON state. The initial matrix needed for the iteration process is described below, with 0 representing the OFF state and 1 representing the ON state.

$$X_1 = [0\ 0\ 0\ 0\ 0\ 0\ 0\ 0\ 0\ 0\ 0\ 0\ 1\ 0\ 0\ ]$$
$$X_1 * A \to [0\ 0\ 0\ 0\ 0\ I\ 0\ 0\ 0\ 0\ 0\ 1\ 1\ 0\ 0] = X_2$$
$$X_2 * A = [I\ 0\ I\ I^2\ 0\ I\ I\ 0\ I^2\ 0\ 0\ 1\ I\ 0\ I]$$
$$\to [0\ 0\ 0\ I\ 0\ 0\ 0\ 0\ I\ 0\ 0\ 1\ 1\ 0\ 0] = X_3$$
$$X_3 * A = [I\ 0\ I^2 + I\ 0\ 0\ I\ I\ 0\ I^2\ I\ I\ 1\ 0\ I\ 0]$$
$$\to [0\ 0\ I\ 0\ 0\ 0\ 0\ 0\ I\ 0\ 0\ 1\ 1\ 0\ 0] = X_4$$
$$X_4 * A = [I\ 0\ I\ 0\ 0\ I\ I\ 0\ 0\ I\ I\ I + 1\ 0\ 0\ I]$$
$$\to [0\ 0\ 0\ 0\ 0\ 0\ 0\ 0\ 0\ 0\ 0\ 1\ 1\ 0\ 0] = X_5$$
$$X_5 * A = [I\ 0\ I\ 0\ 0\ I\ I\ 0\ 0\ 0\ 0\ I\ 0\ 0\ 0]$$
$$\to [I\ 0\ I\ 0\ 0\ I\ I\ 0\ 0\ 0\ 0\ I\ 1\ 0\ 0] = X_6$$
$$X_6 * A = [I^2 I^2\ \ 2I^2 I^2\ \ 0\ \ I\ \ I^2\ \ 0\ \ I^2\ \ 0\ \ 0\ \ 3I + 1\ \ I\ \ I\ \ 3I]$$
$$\to [I\ I\ I\ I\ 0\ 0\ I\ 0\ I\ 0\ 0\ 1\ 1\ 0\ I] = X_7$$
$$X_7 * A\ = [I\ \ 2I^2\ \ 2I^2 + I\ \ 0\ \ 0\ \ I\ \ I\ \ 0\ \ I^2\ \ 3I\ \ I\ \ 3I + 1\ \ 0\ \ 2I\ \ 3I]$$
$$\to [0\ I\ I\ 0\ 0\ 0\ 0\ 0\ I\ I\ 0\ 1\ 1\ I\ I] = X_8$$
$$X_8 * A = [I\ \ I^2\ \ I\ \ I\ \ I^2\ \ I\ \ I\ \ I^2\ \ 0\ \ 3I\ \ I\ \ I + 1\ \ 0\ \ 0\ \ 3I]$$
$$\to [0\ I\ 0\ 0\ I\ 0\ 0\ I\ 0\ I\ 0\ 1\ 1\ 0\ I] = X_9$$
$$X_9 * A = [I\ \ I^2\ I\ \ 0\ \ 0\ \ I\ \ I\ \ 0\ \ 0\ \ 3I\ \ 0\ \ 1\ \ 0\ \ 2I\ \ 3I]$$
$$\to [0\ I\ 0\ 0\ 0\ 0\ 0\ 0\ 0\ I\ 0\ 1\ 1\ I\ I] = X_{10}$$
$$X_{10} * A = [I\ \ I^2\ I\ \ I\ \ I^2\ I\ \ I\ \ I^2\ \ 0\ \ 2I\ \ 0\ \ 1\ \ 0\ \ 0\ \ 2I]$$
$$\to [0\ I\ 0\ 0\ I\ 0\ 0\ I\ 0\ I\ 0\ 1\ 1\ 0\ I] = X_{11}$$

Here,$X_9 = X_{11}$the fixed point is obtained. The values obtained in the ninth and eleventh iterations are the same, allowing the iteration process to end. The factor $\mathcal{S}_2, \mathcal{S}_5, \mathcal{S}_8, \mathcal{S}_{10}, \mathcal{S}_{12}\mathcal{S}_{15}$ is obtained ON state when the factor $\mathcal{S}_{13}$ is taken ON state. It is concluded that a patient with placental disorders may be at an increased risk of Iron Deficiency, gestational diabetes and may have blurred vision, Frequent Urination, Swelling.

Case 5: Infectious Disease - ON State

Let us consider the parameter $\mathcal{S}_{14}$as ON state. The initial matrix needed for the iteration process is described below, with 0 representing the OFF state and 1 representing the ON state.

$$X_1 = [0\ 0\ 0\ 0\ 0\ 0\ 0\ 0\ 0\ 0\ 0\ 0\ 0\ 1\ 0\ ]$$
$$X_1 * A \to [0\ 0\ 0\ 1\ I\ 0\ 0\ I\ 0\ 0\ 0\ 0\ 0\ 1\ 0] = X_2$$
$$X_2 * A = [0\ 0\ I\ 1\ I\ 0\ 0\ I\ I\ I\ 0\ 0\ 0\ 1 + 2I\ \ 2I]$$
$$\to [0\ 0\ I\ 1\ I\ 0\ 0\ I\ I\ \mathrm{I}\ 0\ 0\ 0\ 1\ I] = X_3$$
$$X_3 * A = [0\ I^2\ I\ 1\ I\ 0\ 0\ I\ I\ 3I\ I\ I\ 0\ 1 + 2I\ \ 2I]$$
$$\to [0\ I\ 0\ 1\ 0\ 0\ 0\ 0\ 0\ I\ 0\ 0\ 0\ 1\ I] = X_4$$
$$X_4 * A = [0\ I^2\ I\ 1\ I\ 0\ 0\ I\ I\ 2I\ 0\ 0\ 0\ 1\ 2I]$$
$$\to [0\ I\ 0\ 1\ 0\ 0\ 0\ 0\ 0\ I\ 0\ 0\ 0\ 1\ I] = X_5$$

Here,$X_4 = X_5$the fixed point is obtained. The values obtained in the fourth and fifth iterations are the same, allowing the iteration process to end. The factor$\mathcal{S}_2$,$\mathcal{S}_4$,$\mathcal{S}_{10}$,$\mathcal{S}_{15}$ is obtained ON state when the factor $\mathcal{S}_{14}$ is taken ON state. It is concluded that a patient with Infectious Disease may be at an increased risk of Fever ,blurred vision, high blood pressure and gestational diabetes.

Case 6: High Blood Pressure - ON State

Let us consider the parameter $\mathcal{S}_{15}$as ON state. The initial matrix needed for the iteration process is described below, with 0 representing the OFF state and 1 representing the ON state.

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$$X_1 = [0\ 0\ 0\ 0\ 0\ 0\ 0\ 0\ 0\ 0\ 0\ 0\ 0\ 0\ 1\ ]$$
$$X_1 * A \rightarrow [0\ I\ 0\ 0\ 0\ 0\ 0\ 0\ 0\ 1\ 0\ 0\ 0\ 0\ 1] = X_2$$
$$X_2 * A = [0\ I\ 0\ 0\ 0\ 0\ 0\ 0\ 0\ I+1\ 0\ 0\ 0\ 0\ I+1]$$
$$\rightarrow [0\ I\ 0\ 0\ 0\ 0\ 0\ 0\ 0\ 1\ 0\ 0\ 0\ 0\ 1] = X_3$$

Here, $X_2 = X_3$ the fixed point is obtained. The values obtained in the second and third iterations are the same, allowing the iteration process to end. The factor $\mathcal{S}_2, \mathcal{S}_{10}$ is obtained ON state when the factor $\mathcal{S}_{15}$ is taken ON state. It is concluded that a patient with high blood pressure may be at an increased risk of gestational diabetes and may have blurred vision.

V. CONCLUSION

This paper presents a novel type of fuzzy cognitive map decision-making model that is combined with neutrosophic sets. The proposed NCM symptoms-disease model thoroughly analyzes the fifteen factors associated with symptoms-disease complications, which also gives the early diagnosis to maintain a decreased risk throughout the pregnancy.The suggested NCM model can be extended with several extended representations of neutrosophic sets.

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