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New Merged Fuzzy Cognitive Relational Maps (MFCRMs) Model Definition and Description

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Abstract

In this paper for the first time a new Merged Fuzzy Cognitive Relational Maps (MFCRMs) model is defined using the technique of merging a FCMs model and a FRMs model is described.

Key words: Fuzzy Cognitive Maps (FCMs) model, Fuzzy Relational Maps (FRMs) model, New Merged Fuzzy Cognitive Relational Maps (MFCRMs) model, Hidden Pattern, Fixed point, Directed Graph and Connection Matrix.

1. Introduction

In this paper for the first time a new type of fuzzy merged model by using the notion of merged graphs is introduced. However merged graphs of FCMs have been defined and studied by researchers in [3,4]. Here the directed graphs of a FCMs model and FRMs model are merged and the resulting model is termed as MFCRMs model and this model functions only like a FCMs model. The basic properties of FCMs and FRMs models can be had from [1,2]. The paper has three sections, first section is introductory in nature. Second section defines and describes the new MFCRMs models. The final section gives the conclusions of this study.

2. Definition and description of the MFCRMs model :

The definition, description and the illustration of the Merged Fuzzy Cognitive Relational Maps (MFCRMs) model is given is this section.

Definition 2.1: Let an expert work with a problem P using some set of n-attributes using Fuzzy Cognitive Maps model. Let another expert work on the same problem using a FRMs model taking some attributes from the n attributes as well as some new attributes as domain space of attributes and some attributes from these n-attributes as well as some new attributes as the range space of attributes.

Let G be the directed graph associated

with the FCMs model and H be the directed graph associated with the FRMs model. Let K be the merged graph got by merging the graphs G and H. Now the model associated with the graph K is defined as the Merged Fuzzy Cognitive Relational Maps (MFCRMs) model.

This will be illustrated by two examples in the following:

Example 2.1: Let C ={C_1, C_2, …, C_7} be the set of nine attributes related with the problem *P*. Let the first expert work with all the nine attributes given in *C* using the FCMs model. Let *G* be the directed graph related with the FCMs. Let *M* be the connection matrix of the directed graph *G*. Let the second expert work with the same problem *P* using the FRMs model using the set attributes from *C*. Let *H* be the bipartite graph associated with the FRMs model given by the expert. Let *N* be the connection matrix of the graph *H*. Now the directed graph *G* of the FCM given by the first expert is as follows. The direct graph *G* is as follows:

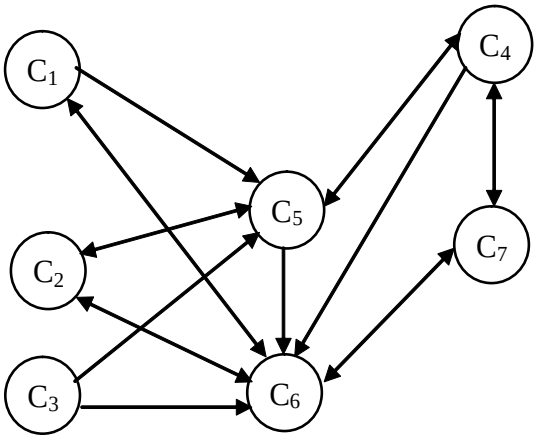

Figure 2.1: Graph *G*

Let *M* be the connection matrix associated with the directed graph *G* of the FCMs model.

$$M = \begin{array}{c} \\ C_1 \\ C_2 \\ C_3 \\ C_4 \\ C_5 \\ C_6 \\ C_7 \end{array} \begin{array}{c} \begin{array}{ccccccc} C_1 & C_2 & C_3 & C_4 & C_5 & C_6 & C_7 \end{array} \\ \begin{bmatrix} 0 & 0 & 0 & 0 & 1 & 1 & 0 \\ 0 & 0 & 0 & 0 & 1 & 1 & 0 \\ 0 & 0 & 0 & 0 & 1 & 1 & 0 \\ 0 & 0 & 0 & 0 & 1 & 1 & 1 \\ 0 & 1 & 0 & 1 & 0 & 1 & 0 \\ 1 & 1 & 0 & 0 & 0 & 0 & 1 \\ 0 & 0 & 0 & 1 & 0 & 1 & 0 \end{bmatrix} \end{array}.$$

Now taking $D = \{C_1, C_2, C_4\}$ as the domain space and $R = \{C_3, C_5, C_6, C_7\}$ as the range space of the FRMs model the second expert gives the following bipartite graph *H*.

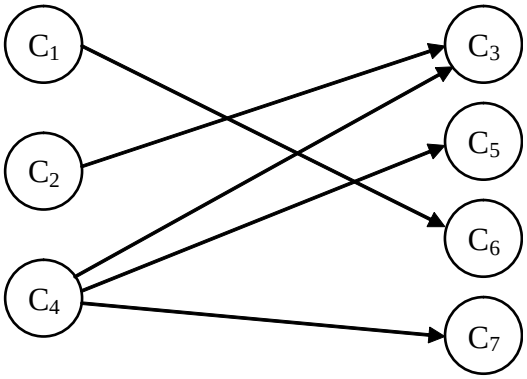

Figure 2.2: Graph *H*

The connection matrix *N* related with the FRMs is as follows:

$$N = \begin{array}{c} \\ C_1 \\ C_2 \\ C_4 \end{array} \begin{array}{c} \begin{array}{cccc} C_3 & C_5 & C_6 & C_7 \end{array} \\ \begin{bmatrix} 0 & 0 & 1 & 0 \\ 1 & 0 & 0 & 0 \\ 1 & 1 & 0 & 1 \end{bmatrix} \end{array}.$$

Now let L denote the merged graph of the graphs G and H which is as follows:

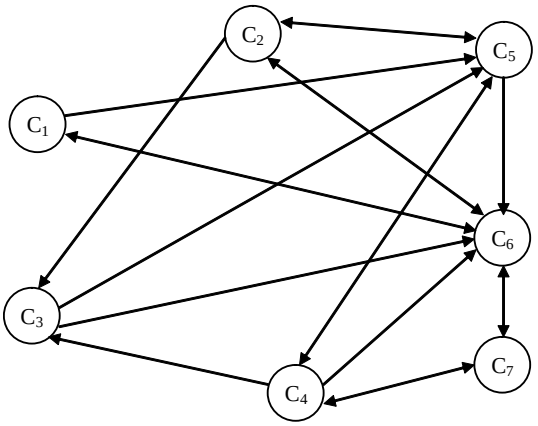

Figure 2.3: Graph L

The connection matrix L associated with the merged graph K is as follows:

$$L = \begin{array}{c} \\ C_1 \\ C_2 \\ C_3 \\ C_4 \\ C_5 \\ C_6 \\ C_7 \end{array} \begin{array}{c} \begin{array}{ccccccc} C_1 & C_2 & C_3 & C_4 & C_5 & C_6 & C_7 \end{array} \\ \begin{bmatrix} 0 & 0 & 0 & 0 & 1 & 1 & 0 \\ 0 & 0 & 1 & 0 & 1 & 1 & 0 \\ 0 & 0 & 0 & 0 & 1 & 1 & 0 \\ 0 & 0 & 1 & 0 & 1 & 1 & 1 \\ 0 & 1 & 0 & 1 & 0 & 1 & 0 \\ 1 & 1 & 0 & 0 & 0 & 0 & 1 \\ 0 & 0 & 0 & 1 & 0 & 1 & 0 \end{bmatrix} \end{array}.$$

Clearly L is the merged directed graph's connection matrix. L serves as the dynamical system of the Merged Fuzzy Cognitive Relational Maps (MFRCMs) model.

It is pertinent to record this is just an example and not any result using a real world problem. It is to be noted that in this example all the seven nodes associated with the problem P is used by both the experts. However there can be cases in which only a subset from the set of attributes will be used by both experts but the sets of attributes of both the experts will have a non empty intersection.

Example 2.2: Let $C = \{C_1, C_2, C_3, \ldots, C_{12}\}$ be the 12 attributes associated with the problem P. The first expert works with the set of attributes $\{C_1, C_3, C_4, C_6, C_{10}, C_9, C_{12}\}$ and uses the FCMs model. Let G be the direct graph associated with the FCMs which is as follows:

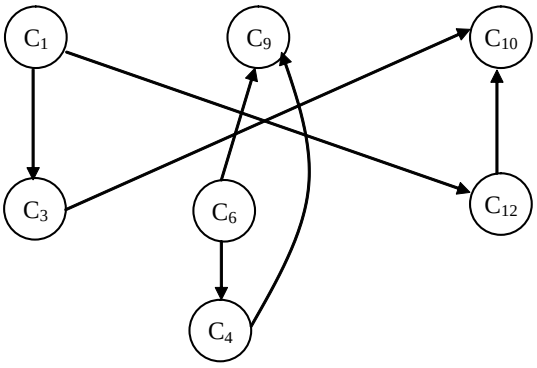

Figure 2.4: Graph G

Let M be the connection matrix associated with the directed graph G of the FCMs which serves as the dynamical system of the FCMs model.

$$M = \begin{array}{c} \\ C_1 \\ C_3 \\ C_4 \\ C_6 \\ C_9 \\ C_{10} \\ C_{12} \end{array} \begin{array}{c} \begin{array}{ccccccc} C_1 & C_3 & C_4 & C_6 & C_9 & C_{10} & C_{12} \end{array} \\ \begin{bmatrix} 0 & 1 & 0 & 0 & 0 & 0 & 1 \\ 0 & 0 & 0 & 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 0 & 1 & 0 & 0 \\ 0 & 0 & 1 & 0 & 1 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 1 & 0 \end{bmatrix} \end{array}.$$

Let the second expert work with the following set of domain attributes D and that of the range attributes R. Here $D = \{C_2, C_3, C_4, C_9, C_{12}\}$ and $R = \{C_1, C_5, C_6, C_7\}$. Let H be the directed graph associated with the FRMs which is as follows:

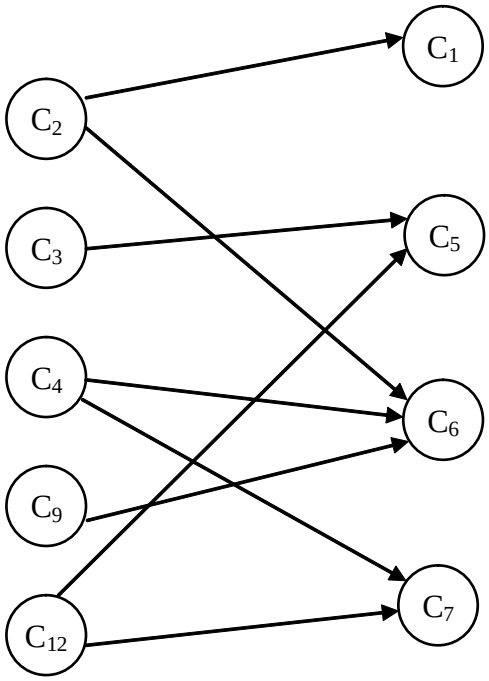

Figure 2.5: Graph H

Let N be the connection matrix of the FRMs model associated with bipartite graph H.

$$N = \begin{array}{c} \\ C_2 \\ C_3 \\ C_4 \\ C_9 \\ C_{12} \end{array} \begin{array}{c} \begin{array}{cccc} C_1 & C_5 & C_6 & C_7 \end{array} \\ \begin{bmatrix} 1 & 0 & 1 & 0 \\ 0 & 1 & 0 & 0 \\ 0 & 0 & 1 & 1 \\ 0 & 0 & 1 & 0 \\ 0 & 1 & 0 & 1 \end{bmatrix} \end{array}.$$

Let K denoted the merged graph of the graphs G and H which is as follows:

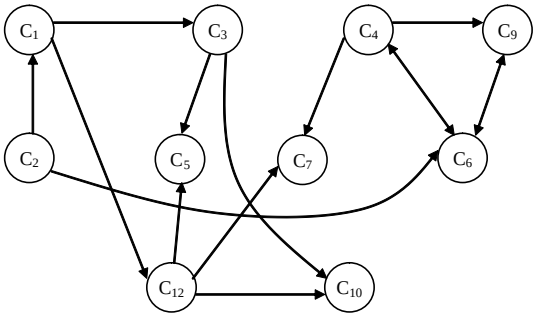

Figure 2.6: Graph K

Let L be the connection matrix associated with the direct graph K.

$$L = \begin{array}{c} \\ C_1 \\ C_2 \\ C_3 \\ C_4 \\ C_5 \\ C_6 \\ C_7 \\ C_9 \\ C_{10} \\ C_{12} \end{array} \begin{array}{c} \begin{array}{cccccccccc} C_1 & C_2 & C_3 & C_4 & C_5 & C_6 & C_7 & C_9 & C_{10} & C_{12} \end{array} \\ \begin{bmatrix} 0 & 0 & 1 & 0 & 0 & 0 & 0 & 0 & 0 & 1 \\ 1 & 0 & 0 & 0 & 0 & 1 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 1 & 0 & 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 0 & 0 & 1 & 1 & 1 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 1 & 0 & 0 & 0 & 1 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 1 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 1 & 0 & 1 & 0 & 1 & 0 \end{bmatrix} \end{array}.$$

Thus L acts as the dynamical system of the Merged Fuzzy Cognitive Relational Maps (MFCRMs) model. Here all the 12 attributes are not used even by combining both the experts. This is infact different from that of the earlier example.

3. Conclusions

The conditions under which this model can be built and the merits of the model are given in this section. However there is a non trivial intersection of the attributes used by both

the experts. Unless there is a non empty intersection of the attributes used by the two experts the Merged Fuzzy Cognitive Relational Maps model does not exist.

The advantages of using this new model is

i. When two experts work with the same problem using subsets from the same set of attributes then one may not be in a position to compare them. This model helps in integrating their views.

ii. Use of this model saves time and economy.

iii. By using this new model both the experts are given equal importance.

One can include more than two experts and construct the MFCRMs model. The only demand or condition is that atleast one of the experts must work with the FCMs model. So using several experts opinion working on the same problem and from subsets of the same set of attributes the New Merged Fuzzy Cognitive Relational Maps model can be constructed which gives the integrated opinion of all experts without any bias and saves time and economy.

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