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Fuzzy Cognitive Map – A Survey

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Abstract: ***The survey gives the overall review and study of the relevant information of literature materials related to a topic - Fuzzy Cognitive Map that have been referred. Fuzzy cognitive map (FCM) is a soft computing concept for modeling methodology for complex systems, which originate from a combination of fuzzy logic and neural networks. Fuzzy cognitive maps (FCMs) are reasoning networks described by directed graphs. FCM is described by a directed graph with dependence and feedback, which comprises a collection of nodes and directed weighted arcs connecting nodes. In FCMs, the nodes designate the concepts and the signed weights associated with the directed arcs illustrate the types as well as magnitudes of the causalities between concepts. FCMs are more applicable when the data in its initial state and it works on the opinion of experts. FCM is a simple and impressive tool which is used in various applications such as management, banking, education, medical field, politics, decision making, sports, prediction, businesses, robotics, engineering, expert systems, environment, information technology, Agriculture, etc. In this paper, we present a survey of different work about this topic.***

Key words: Fuzzy Cognitive Maps; Soft Computing; Modeling; Fuzzy Sets; Fuzzy Logic.

I. INTRODUCTION

Fuzzy Cognitive Map is an expansion of cognitive maps for modeling complex causal relationships easily, both qualitatively and quantitatively. They are a suitable modeling tool, usually characterized as a neuro-fuzzy method, for modeling and simulation of complex dynamic systems. One of their main advantages is ability to inserting and adapts human knowledge. During the past decade, FCMs played a important role in the applications of different scientific areas. FCMs incorporate fuzzy logic and neural networks obtaining their main advantages. From an Artificial Intelligence viewpoint, FCMs are dynamic networks with learning capabilities, whereas more data is easily available to model the problem, the system becomes better to accept itself and reaching a solution. They gained momentum due to their dynamic features and learning capabilities. These abilities make them essential for modeling and decision making tasks as they increase the performance of these tasks.

II. EXISTING METHODOLOGY

In the current scenario, lot of research papers are there that used FCMs in different application areas. The analyses show that the FCMs are a suitable modeling tool, for modeling and simulation of dynamic systems.

Fuzzy cognitive map is a graphical method of illustrating arbitrary complex models of interrelations between concepts. In [1] is described a dynamic or adaptive fuzzy cognitive map which is mainly based on the random neural network (RNN) model. The adaptive fuzzy cognitive map adjusted its fuzzy causal web as causal patterns change and experts update their causal knowledge. Instead of symbolic deduction, the model carries out inferences via numerical calculation and shows how the adaptive/dynamic random fuzzy cognitive map can show implications of models consist of dynamic processes. The new concept introduce by the DRFCM is the dynamic causal relationships. To accommodate dynamic causal relationships to the new environment conditions there is modification of values of the arcs during the runtime of the FCM. In order to update the arcs the quantitative concepts is used to develop a feedback mechanism, which is included in the causal model. So with the help of

DRFCM we can assume on-line adaptive procedures of the model like real situations and show fusing the RFCM with a traditional learning algorithm, which can yield better results. Changes in the modeled behavior are rapidly adapted by the DRFCM.

Fuzzy Cognitive Maps have proved to be a one of the efficient modeling methodology, which includes many successful applications in different areas for simulating system design and control. In order to model a decision related support system for Precision Agriculture (PA) FCMs are introduced [2]. This model developed mainly consists of different nodes, which is used to describe soil properties, yield of cotton, and the weighted relationships between the nodes. The nodes of the FCM model represent the important factors that influence cotton crop production i.e. OM, K, soil properties such as texture, pH and P. The proposed and related FCM model shows the problem of crop development and variability of cotton yield, thus taking into consideration the spatial distribution of all the main factors that affects crop yield. The results of the study are very effective; this Fuzzy Cognitive Maps model achieves a 70% success rate on yield class prediction between two categories (low and high) for consecutive three different years. This soft computing technique is a knowledge representation and processing method that can handle the main characteristics and site-specific management behavior of the cotton crop, which provides an interpretable and transparent model. The type of cognitive maps proposed here for developing the medical decision support systems are Fuzzy Cognitive Maps here the values of the nodes themselves and the weightings of the connections are expressed using a fuzzy (linguistic value). It is a suitable modeling technique for the medical decision support system (MDSS) since the weighting in a human reasoning decision process almost never carries an exact numerical value.

In [3] described three novel types of Fuzzy Cognitive Map (FCM) structures appropriate for Medical Decision Support Systems. The three structures are: a) the Competitive FCM, suitable when a single out of different possible diagnoses must be reached, b) a distributed m-FCM as complex medical decision support system which involve a large number of interacting factors, and c) a hierarchical structure where the m-FCM receives information from all the subsystems in order to accomplish the task of making decisions. For each structure a corresponding example of the FCM is described performing medical decision support. The real examples presented here, are successful applications of the proposed methodologies and structures in the fields of speech pathology, language pathology, and obstetrics.

MDSS are complex systems that can be decomposed to subsystems and elements, where complementary, competitive, and contradictory factors needs to be considered. These influencing factors are used to determine the overall clinical decision with varying degrees. The proposed and developed Medical Decision Support System (MDSS) is based on an appropriate FCM architecture, as well as a corresponding paradigm from obstetrics is described. The area of Medical Decision Support Systems (MDSS) is characterized by complexity by considering the medical practitioners needs that requires investigation of newly advanced methodologies for modeling and developing sophisticated systems. In [4] described a dynamic decision support tool minimizes fatal distress and maternal complications safety for the mother, assisting in better, and timelier, decisions.

The [5] report on participatory processes that focusing on the development of a bio-based economy that involve local companies and organizations from the Humber region. The cognitive map includes factors by considering key for the development of the regional bio-based economy and causal, directional, weighted interconnections between them. Participants allowed describing two alternate potential causal structures by updating to the original map. The two standard methodologies used for the analysis of all map structures: linear and sigmoidal FCMs, which demonstrates some different results significantly. The development of FCM methodology involves a sensitivity analysis with different mappings. It also develops the extended FCM methodology, which includes multiple functional mappings within one participant-constructed graph. This illuminated that different functional mappings used to construct FCM output may give rise to large differences in the output and change the interpretation of different scenarios.

This study describes at different levels of reasons for miracles, which includes incidents included in the holy bible using the Fuzzy cognitive Maps. This technique is the mainly based on the fusion of the simulation of the fuzzy logic and theories related

to cognitive maps. Using FCMs, the content gives preliminaries FCMs with a descriptive account of the issue and the various miracles witnessed in the Bible. The data acquired is examined to conclude on the most required component in various instances that results in the discharge of miracles. [6]

This describes the suitability of using Fuzzy Cognitive Mapping (FCM) technique for the diagnosis of human disease along with Fuzzy inference system (FIS). The diagnosis is mainly based on the biochemical analysis and the symptoms of blood. To determine the diagnosis when illness is present, the Health care professionals use symptoms and signs. Biochemistry based on the disease diagnosis and disease monitoring by measuring the concentration of chemicals in urine, blood etc. The substances present in blood are maintained within defined limits in health diagnosis but the process of disease disturbs the normal balance of these blood chemicals and they are the symptoms of the disease. The proposed FCM will enable the diagnosis of disease, from various symptoms. Medical decision support system is presented here. It works in two phases. The first phase deals with the physiological symptoms, which is linguistic in nature. Fuzzy cognitive map is well suited for modeling and decision. A Fuzzy cognitive map is realized using mental modeller tool. Once the FCM gives initial diagnosis as per the available symptoms, further diagnosis is carried out with the blood analysis. Since the blood analysis gives numerical data, a fuzzy inference system with the use of membership functions will provide proper inference. Hence it can be noticed that, a combination of various tools in soft computing yield more reliable results in applications like medical diagnosis. [7]

In this model, behaviors and nonlinear relationships are used to describe an unsupervised dynamic fuzzy cognitive map. In [8] introduced dynamic trend-effects and weights to make the reasonable model. To establish a machine-learning model the data credibility is also considered. For weight learning, an optimized Estimation of Distribution Algorithm (EDA) is developed. The practicability of the dynamic FCM model described using experimental results. This algorithm gives better performance in terms of convergence and stability. This focus on three clear defects of FCMs, and propose improvement approaches accordingly. An unsupervised dynamic fuzzy cognitive map is proposed as an extension of classical FCMs, which can not only describe the nonlinear relationships but also the trend-effects between concepts. It can be a reliable alternative to FCM when experts or decision makers try to get a better understanding of the causal relationships embedded in a complex system.

FCM can be used as an environmental planning and learning tool, finite progress has been made with regard to the relationship of method to existing resilience frameworks and how the use of FCM compares with available participatory modeling or approaches. The usefulness of FCM is examined for promoting resilience analysis with stakeholders in terms of determining key state variables that comprise an SES, evaluating optional SES equilibrium states, and describing desirable/undesirable state outcomes through scenario analysis by using data developed from case study of community-driven models of the bushmeat trade in Tanzania. The FCM approach described [9] has resulted in management decision making between shared participation. FCMs helps stakeholders participate in management decisions and they can facilitate the discourse with nonstakeholders seeking to understand the case, governing agencies and players in the management outcomes.

Stakeholder analysis methodology used to assist business leaders with their strategic management functions. And it can be expanded beyond the corporate arena. The employees, suppliers, regulators, clients, customers, users, and team members of a system are stakeholders and they are most important elements in all complex systems problems. The system can be funded, designed, built, operated, maintained, and disposed by stakeholder. On the basis of description by the systems principle known as complementarity, each stakeholder contributes his or her own value-added perspective. There are many approaches existing for classifying and determining their attitudes, as well as these approaches stop short of evaluating stakeholders in a dynamic and holistic manner. An approach allows for qualitative and quantitative evaluation of stakeholders on a given problem to managing stakeholders using fuzzy cognitive mapping, has closed this research gap. Fuzzy cognitive mapping-based approach has been developed [10] for “what-if” analysis to be conducted in a manner, which supports stakeholder analysis for problem solution efforts.

III. Conclusion

The chapter represents some of the existing papers and the characteristics of it are discussed here. Also describes types of Fuzzy Cognitive Map (FCM) structures suitable for many applications. The real examples presented, are successful applications of the FCM methodologies and structures in a variety of areas. This study examines the number of desirable properties of FCM that make it attractive and different Fuzzy Cognitive Map structures that researchers have proposed for developing various systems. Fuzzy Cognitive Map techniques have increased a good reputation and importance in the recent years and have been used successfully in a variety of area.

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