Fuzzy Cognitive Map Learning Based on Multi-Objective Particle Swarm Optimization

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ABSTRACT

In order to eliminate the excessive subjective elements involved in construction of FCMs, this paper proposes a new FCM learning algorithm which is based on the application of multi-objective particle swarm optimization. The simulation results show that the novel method not only implements inference process and FCM learning in parallel, and improves the efficiency and robustness of FCMs.

Categories and Subject Descriptors

I.2 [**Computing Methodologies**]: Artificial Intelligence; I.2.6 [**Artificial Intelligence**]: Learning

General Terms

Algorithms, Experimentation, Performance.

Keywords

Fuzzy Cognitive Maps, Multi-Objectives, Particle Swarm Optimization.

1. INTRODUCTION

FCM was proposed by Kosko to represent the causal relationships between concepts and to analyze inference patterns [1]. By describing behaviors of a collection of concepts, FCMs are able to emulate the cognitive process of human experts. However, the construction of FCMs relies heavily on subjective reasoning and the experts' knowledge. It is thus necessary to develop some algorithms for automated or semi-automated FCM learning in order to eliminate excessive subjective elements. Currently, several FCM learning approaches have been proposed [2] [3]. They can be categorized into the two approaches based on neural networks and evolution strategies respectively. These approaches require experts to predetermine the steady state of the given causal system. The assumption is unrealistic and impractical for complicated causal systems, such as social behavior systems and virtual world systems, because a wealth of nonlinear causalities and uncertainties involved in the real causal systems make it impossible to anticipate the steady states of the system in advance. To eliminate the deficiencies of existing FCM learning, we propose novel FCM learning based on the application of multi-objective PSO.

2. Main Algorithm

The Figure 1 outlines the concept model of the proposed approach.

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The leftmost side of Figure 1 shows that the states of a causal system at $(t+1)^{th}$ step are completely determined by the states and the weights matrix of the system at t^{th} step. This process is consistent with the inference mechanism of FCMs.

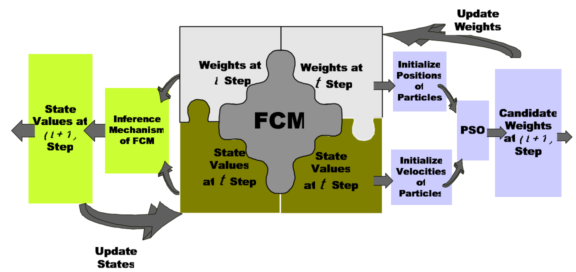

Figure 1. Flowchart of the proposed learning

The rightmost side of Figure 1 shows the FCM learning based on the application of multi-objective PSO. For the k^{th} objective function, the FCM learning generates candidate weight matrix $W^{(k)}(t+1)$ according to $W^{(k)}(t)$ and the $\mathbb{C}(t)$. In this way, the proposed approach implements the FCM inference and FCM learning in parallel.

3. CONCLUSION

By integrating the inference process of FCM and FCM learning based on multi-objective PSO, the proposed approach effectively eliminates the excessive subjective interventions in construction and inference process of FCMs. To demonstrate the effectiveness of FCM learning based on multi-objective PSO, we explored the method to model the mental and physical behavior of an emotional agent in a virtual world. The promising simulation results suggest that the novel method overcomes some deficiencies of existing FCM learning algorithms, therefore, improves the efficiency and robustness of FCMs.

4. REFERENCES

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