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Dynamic Irregular Cellular Learning Automata

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Research Highlights:

- Introduction of DICLA, as en extension to the recently proposed ICLA model, with a dynamic structure
- Introduction of the expediency notion for DICLA
- Providing sufficient conditions, under which DICLA becomes expedient

Abstract: Irregular Cellular learning automaton (*ICLA*), which is recently introduced, is a cellular learning automaton (*CLA*) with irregular structure. ICLA is suitable for modeling problems which are not regular in nature, such as problems in the area of sensor networks, web mining, and grid computing. In some areas such as mobile ad hoc and sensor networks, where the structure of the environment changes over the time, an ICLA with a dynamic structure is required. For this reason, in this paper, we have extended ICLA in such a way that the structure of the extended model, called dynamic ICLA (*DICLA*), can change over time. For the newly introduced model, we have proposed the concept of expediency and then, discussed sufficient conditions under which a DICLA becomes expedient.

Keywords: learning automata, cellular learning automata, irregular cellular learning automata, dynamic irregular cellular learning automata, expediency

1. Introduction

Cellular learning automaton (*CLA*) [1][4][5][6][7] is a combination of cellular automaton (*CA*) [2] and learning automaton (*LA*) [3]. The basic idea of CLA is to use LA to adjust the state transition probability of stochastic CA. This model, which opens a new learning paradigm, is superior to CA because of its ability to learn and also is superior to single LA because it consists of a collection of LAs interacting with each other [4]. In [4], authors have introduced a mathematical framework for studying the behavior of the CLA. They have shown that, for a class of rules called commutative rules, different models of CLA converge to a globally stable state [4][5][6][7].

Irregular Cellular learning automaton (*ICLA*), which is recently introduced, is a cellular learning automaton (*CLA*) with irregular structure [8]. ICLA is suitable for modeling problems which are not regular in nature, such as problems in the area of sensor networks, web mining, and grid computing. ICLA has been used in many different applications including: clustering of sensor networks [9], sleep/wake scheduling of sensor nodes [10], graph coloring [11][12], finding the shortest path in stochastic graphs [13], and channel assignment in mobile ad hoc networks [14].

In many research domains, such as web mining, computer networks, social networks, and so on, problems can be modeled by graphs, and in some of such domains, the structure of the graph may change in time. For example, in a computer network, especially mobile networks, new links may become available between nodes or some existing links may be removed. In a social network, people may find new friends or lose their ex-friends. To be able to cope with such changes within the environment of the problem, the model must be able to change its structure. Therefore, in this paper, we introduce a new version of ICLA, called dynamic irregular cellular learning automaton (*DICLA*), in which, unlike ICLA, the structure may change over the course of time. Underlying an ICLA model, there is a graph which represents the neighborhood relationship between cells of the ICLA. The structure of this graph is fixed for the ICLA, but in the proposed DICLA model, the graph may change in time, resulting in dynamicity in the neighbors of each cell; that is, during the passage of time, two cells may become neighbors or two neighboring cells may not be further neighbors. We have successfully applied the DICLA to the deployment problem in mobile wireless sensor networks [15].