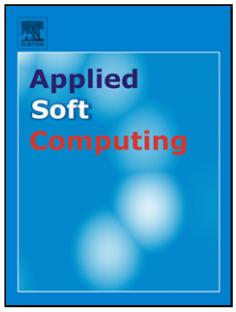

Title: Associative Cellular Learning Automata and its Applications

Author: Meysam Ahangaran Nasrin Taghizadeh Hamid Beigy

PII: S1568-4946(16)30624-X
DOI: http://dx.doi.org/doi:10.1016/j.asoc.2016.12.006
Reference: ASOC 3945

To appear in: *Applied Soft Computing*

Received date: 6-6-2015
Revised date: 16-12-2015
Accepted date: 3-12-2016

Please cite this article as: Meysam Ahangaran, Nasrin Taghizadeh, Hamid Beigy, Associative Cellular Learning Automata and its Applications, *<![CDATA[Applied Soft Computing Journal]]>* (2016), http://dx.doi.org/10.1016/j.asoc.2016.12.006

Associative Cellular Learning Automata and its Applications

Meysam Ahangaran and Nasrin Taghizadeh and Hamid Beigy

Department of Computer Engineering,
Sharif University of Technology, Tehran, Iran
ahangaran@iust.ac.ir, {taghizadeh, beigy}@ce.sharif.edu

Abstract

Cellular learning automata (CLA) is a distributed computational model which was introduced in the last decade. This model combines the computational power of the cellular automata with the learning power of the learning automata. Cellular learning automata is composed from a lattice of cells working together to accomplish their computational task; in which each cell is equipped with some learning automata. Wide range of applications utilizes CLA such as image processing, wireless networks, evolutionary computation and cellular networks. However, the only input to this model is a reinforcement signal and so it cannot receive another input such as the state of the environment. In this paper, we introduce a new model of CLA such that each cell receives extra information from the environment in addition to the reinforcement signal. The ability of getting an extra input from the environment results in an increase in the computational power and flexibility of the model. We designed some new algorithms for solving famous problems in pattern recognition and machine learning such as classification, clustering and image segmentation. All of them are based on the proposed CLA. We investigated performance of these algorithms through several computer simulations. Results of the new clustering algorithm shows acceptable performance on various data sets. CLA-based classification algorithm gets average precision 84% on eight data sets in comparison with SVM, KNN and Naive Bayes with average precision 88%, 84% and 75%, respectively. Similar results are obtained for semi-supervised classification based on the proposed CLA.

Keywords: Cellular learning automata, cellular automata, learning automata, external input, clustering, classification, self-organizing map, image segmentation.

1 Introduction

Since the introduction of the cellular learning automata (CLA) [1], various types of this computational model have been invented and each of them has been used for solving different problems. The main idea of the CLA is to combine the learning power of the learning automata (LA) with the computational power of the cellular automata (CA) to produce a distributed computational model. Variation of this model have been used in several applications. In the rest of this section, the motivation behind the idea given in the paper is explained and then the contribution of this paper is presented.

1.1 Motivation

Cellular learning automata is a distributed model for learning behaviour of complicated systems. CLA consists of a large number of simple identical units, which make a global complex behaviour through the interaction with each other. One can assume these units, which called cells, are placed nearby in a lattice structure and communicate with their neighbours. Each cell in the CLA consists of one or more LAs. These LAs change state of the cell based on the local rule and the reinforcement signal. CLA works as follows: at the first step each LA in each cell chooses an action based on its action probability vector. At the second step, the environment passes a reinforcement signal to the LAs residing in each cell on the basis of the CLA local rule. In CLA, neighbouring LAs of any cell constitute its local environment. At the third step each LA of each cell updates its internal state based on its current state and the received reinforcement signal. This process continues until the desired behaviour is obtained.

There are several applications that use the CLA as a basic computational element. Image segmentation [2, 3], resource allocation in mobile networks [4, 5], multi-agent systems [6], wireless sensor networks [7, 8] and numerical optimization [9, 10] are examples of such applications. However, none of the previous models can receive extra information from the environment. Indeed, the only input to each cell is a reinforcement signal; while some tasks in pattern recognition need to such ability that