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ORIGINAL PAPER

CLA-DE: a hybrid model based on cellular learning automata for numerical optimization

R. Vafashoar, M. R. Meybodi and A. H. Momeni Azandaryani

Abstract

This paper presents a hybrid model named: CLA-DE for global numerical optimization. This model is based on cellular learning automata (CLA) and differential evolution algorithm. The main idea is to learn the most promising regions of the search space using cellular learning automata. Learning automata in the CLA iteratively partition the search dimensions of a problem and learn the most admissible partitions. In order to facilitate incorporation among the CLA cells and improve their impact on each other, differential evolution algorithm is incorporated, by which communication and information exchange among neighboring cells are speeded up. The proposed model is compared with some evolutionary algorithms to demonstrate its effectiveness. Experiments are conducted on a group of benchmark functions which are commonly used in the literature. The results show that the proposed algorithm can achieve near optimal solutions in all cases which are highly competitive with the ones from the compared algorithms.

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1 Introduction

Global optimization problems are one of the major challenging tasks in almost every field of science. Analytical methods are not applicable in most cases; therefore, various numerical methods such as evolutionary algorithms [1] and learning automata based methods [2, 3] have been proposed to solve these problems by estimating global optima. Most of these methods suffer from convergence to local optima and slow convergence rate.

Learning automata (LA) follows the general schemes of reinforcement learning (RL) algorithms. RL algorithms are used to enable agents to learn from the experiences gained by their interaction with an environment. For more theoretical information and applications of reinforcement learning see [4–6]. Learning automata are used to model learning systems. They operate in a random unknown environment by selecting and applying actions via a stochastic process. They can learn the optimal action by iteratively acting and receiving stochastic reinforcement signals from the environment. These stochastic signals or responses from the environment exhibit the favorability of the selected actions, and according to them the learning automata modify their action selecting mechanism in favor of the most promising actions [7–10]. Learning automata have been applied to a vast variety of science and engineering applications [10, 11], including various optimization problems [12, 13]. A learning automata approach has been used for a special optimization problem, which can be formulated as a special knapsack problem [13]. In this work a new on-line Learning Automata System is presented for solving the problem. Sastry et al. used a stochastic optimization method based on continuous-action-set learning automata for learning a hyperplane classifier which is robust to noise [12]. In spite of its effectiveness in various domains, learning automata have been criticized for having a slow convergence rate.