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Recombinative CLA-EC

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Abstract

Cellular Learning Automata (CLA) which is obtained by combining cellular automata (CA) and learning automata (LA) models is a mathematical model for dynamical complex systems that consists of a large number of simple learning components. CLA-EC, introduced recently is an evolutionary algorithm which is obtained by combining CLA and evolutionary computation (EC). In this paper CLA-EC with recombination operator is introduced. Recombination increases explorative behavior of CLA-EC and also provides a mechanism for partial structure exchange between chromosomes of population individuals that standard CLA-EC is not capable of performing it. This modification greatly improves CLA-EC ability to effectively search solution space and leave local optima. Experimental results on five optimization test functions show the superiority of this new version of CLA-EC over the standard CLA-EC.

Keywords: CLA-EC, CLA, Genetic Algorithm, Recombination, Optimization

1. Introduction

Cellular Learning Automata (CLA) first introduced in [1]. This model is obtained combining Cellular Automata [8] and Learning Automata [10][12] models. It is a mathematical framework for dynamic complex systems that is consists of large number of learning components with local interactions. This model can solve problems with collective behavior of learning components, interacting with problem. This model have been applied to many problems such as channel assignment in cellular networks [2] , image processing [3], evolutionary computation [4], simulation of pesticide percolation [5], modeling rumor diffusion [6], VLSI placement [7]. As mentioned above an application of CLA is evolutionary computing. Cellular Learning Automata based Evolutionary Computing (CLA-EC) [4] is a newly proposed algorithm in this area. In this model every cell contains one chromosome. Each cell selects its chromosome according to its LA's actions. A reinforcement signal according to actions of the LA and the neighborhood topology is generated. This model is capable of performing search in complex, large and multimodal landscapes. This model suffers from lack of explorative behavior. This problem is solved with the use of recombination borrowed from genetic algorithm.

Genetic Algorithm [9] is a search algorithm based on the mechanics of natural selection and natural genetics. It has some operators that mimic natural genetic operators: Selection, Recombination and Mutation. Selection ensures survival of fittest solution in population. Recombination is a genetic operator used to generate children chromosomes from parent chromosomes. Crossover or recombination is inheriting genetic information of parents by children. A child has some of the Mother and some features of Father. Recombination is done with the hope that children inherit good features of parents and generating individuals that are better than parents are. It is an analogy to reproduction and biological recombination. Mutation is a genetic operator used to maintain genetic diversity from one generation of a population of chromosomes to the next generation and it is analogous to biological mutation.

The poor behaviors of evolutionary methods in some problems, in which the designed operators of crossover and mutation do not guarantee that the building block hypothesis is preserved, have led to the development Estimation of Distribution Algorithms (EDA) [15]. Toward the development of a more robust evolutionary algorithm some approaches have been taken to prevent building blocks disruption. [4], [15], [16], [17] to name a few. All of these methods do not use recombination because of its disruption in building blocks. In contrast some literatures discuss benefits of using recombination and that recombination can provide better diversification and wider exploration of search space [18][19].

In this paper we introduce a new version of CLA-EC that uses recombination operator. This modification does improve its ability in leaving local optima and effectively exploring the search space without adding much overhead on computation needs. The new version of CLA-EC combines adjacent chromosomes (called string genomes in