

Chapter 26

Performances of Adaptive Cuckoo Search Algorithm in Engineering Optimization

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ABSTRACT

A new optimization algorithm, specifically, the cuckoo search algorithm (CSA), which inspired by the unique breeding strategy of cuckoos, has been developed recently. Preliminary studies demonstrated the comparative performances of the CSA as opposed to genetic algorithm and particle swarm optimization, however, with the competitive advantage of employing fewer control parameters. Given enough computation, the CSA is guaranteed to converge to the optimal solutions, albeit the search process associated to the random-walk behavior might be time-consuming. Moreover, the drawback from the fixed step size searching strategy in the inner computation of CSA still remain unsolved. The adaptive cuckoo search algorithm (ACSA), with the effort in the aspect of integrating an adaptive search strategy, was attached in this study. Its beneficial potential are analyzed in the benchmark test function optimization, as well as engineering optimization problem. Results showed that the proposed ACSA improved over the classical CSA.

INTRODUCTION

Nature inspired metaheuristic algorithms such as genetic algorithms, particle swarm optimization and artificial bee colony algorithm are widely used for solving optimization problems (Holland, 1975; Karaboga & Basturk, 2008; Kennedy & Eberhart, 1995). A metaheuristic algorithm is an iterative generation process which combines different concepts for exploring the search space and finding near-optimal solutions (Gomathi & Sharmila, 2014). In short, metaheuristic algorithms attend to find an optimal solution and obtain a good solution in a specific period of time. Two crucial characteristics of metaheuristic algorithms

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are: intensification and diversification, or in other words, exploitation and exploration. Intensification or exploitation means to search around the current best solution in the local region and select the best solution which will eventually converge to the optimality. Meanwhile, diversification or exploration means to explore the search space on the global scale in order to avoid the solution from getting trapped at local optimal, and at the same time, increase the diversity of the solution. It is important to balance up between these two characteristics to ensure that the metaheuristic algorithms achieve the global optimal successfully. Metaheuristic algorithms are usually developed to deal with complex optimization problems where other optimization methods have failed to be either effective or efficient (Senvar, Turanoglu & Kahraman, 2013). These methods are known as one of the most practical approaches for solving many complex problems, which is especially true for real-world problems. Consequently, the field of metaheuristic in engineering optimization problems is a rapidly growing field of research. This is due to the importance of solving the mentioned optimization problems for the scientific as well as the industrial world. The practical advantage of metaheuristic lies in both their effectiveness and general applicability (Senvar, Turanoglu & Kahraman, 2013; Mukherjee & Ray, 2008).

Cuckoo search algorithm (CSA) is one of the nature inspired metaheuristic algorithms which is based on the brood parasitism of some cuckoo species (X.-S. Yang & Deb, 2010; X. S. Yang & Deb, 2009). CSA is a simple and effective algorithm that has been applied to solve a range of real-world optimization problem (Bhandari, Singh, Kumar, & Singh, 2014; Durgun & Yildiz, 2012; Malik, Ahsan, & Mohsin, 2014; Yildiz, 2013). CSA is enhanced by using Lévy flights, rather than simple isotropic random walk which has an infinite variance with an infinite mean (Ong, 2014; Ouaraab, Ahiod, & Yang, 2014; X.-S. Yang & Deb, 2010; X. S. Yang & Deb, 2009). The purpose of utilization of Lévy flight is to speed up the local search whereby CSA can achieve global optimal solutions rapidly. Nevertheless, due to the behavior of random walk in the standard CSA, it is difficult to achieve the optimal solution in a specified given time (Walton, Hassan, Morgan, & Brown, 2011). In addition, it is important for CSA to achieve the optimal solution more efficiently without getting trapped in a local optimum.

To serve for this intention, this chapter has proposed adaptive cuckoo search algorithm (ACSA) by integrating CSA with an accelerated searching strategy in its computation. The main thrust of this study is thus to improve the performance of the current CSA in achieving the optimal solution faster at a specific given time. The objectives of this study can be summarized as follows:

- To improve the optimization capability of the standard CSA
- To develop and apply a novel technique, i.e., the ACSA in function optimization for the purpose of accelerating its convergence characteristic
- To assess the potential benefits of the proposed ACSA in the context of function optimization, through empirical approaches with simulated as well as real world engineering problem, i.e., optimization of pulp and paper properties.

In the next section, the related works in CSA are provided. A detail description of the CSA and ACSA also are presented. The benchmark optimization functions used are discussed briefly. Meanwhile, the performances of CSA and ACSA in optimizing the benchmark functions and real world engineering problem are evaluated. Finally, some conclusions are drawn.

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