Chapter 31
An Efficient Adaptive Strategy for Melody Search Algorithm

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ABSTRACT

An efficient adaptive version of Melody Search algorithm (EAMS) is introduced in this study, which is a powerful tool to solve optimization problems in continuous domains. Melody search (MS) algorithm is a recent newly improved version of harmony search (HS), while the algorithm performance strongly depends on fine-tuning of its parameters. Although MS is more efficient for solving continuous optimization problems than most of other HS-based algorithms, the large number of algorithm parameters makes it difficult to use. Hence, the main objective in this study is to reduce the number of algorithm parameters and improving its efficiency. To achieve this, a novel improvisation scheme is introduced to generate new solutions, a useful procedure is developed to determine the possible variable ranges in different iterations and an adaptive strategy is employed to calculate proper parameters' values and choose suitable memory consideration rules during the evolution process. Extensive computational comparisons are carried out by employing a set of eighteen well-known benchmark optimization problems with various characteristics from the literature. The obtained results reveal that EAMS algorithm can achieve better solutions compared to some other HS variants, basic MS algorithms and certain cases of well-known robust optimization algorithms.

1. INTRODUCTION

In the case of large-scale optimization problems, meta-heuristic algorithms seem to be the most efficient alternatives to find near-optimal solutions. However, one of the major challenges of meta-heuristic techniques' design is how intel-ligent stochastically driven operators could be adopted by an algorithm to explore the whole search space effectively and to avoid getting trapped in local optimums (Manjarres *et al.*, 2013). Nowadays, bio-inspired computing is preferred by several researchers for solving computational and real-world optimization problems (Wong *et al.*,

2009), while meta-heuristic methods have been widely applied in recent decades to solve practical problems (Barharnsakun *et al*., 2012). Generally, algorithms applied in the field of optimization, are usually classified as either derivative-free or derivative-based methods. Although the later methods are more efficient, they can only be adopted for differentiable functions (Hussain & Al-Sultan, 1997). These algorithms usually attempt to improve the solution in the neighborhood of a starting point, and therefore require substantial gradient information of the problem objective function (Lee & Geem, 2005).

Among different heuristic search methods, genetic algorithm, particle swarm optimization, ant colony optimization, tabu search, simulated annealing, bee's algorithm and artificial immune system are very popular. These algorithms are extensively applied for various science and engineering problems because of their advantages over derivative-based methods, including not requiring gradient derivative information, global and local search capabilities, and efficiency of handling discrete variables (Geem & Sim, 2010). Although relatively good results in a reasonable computation time are achieved, these algorithms do not ensure the global optimum solution to be achieved for sure (Mahdavi *et al*., 2007). Therefore, to improve the accuracy of the obtained results, researchers have been eager to develop newer techniques and improve existing methods.

The relatively new Harmony Search (HS) algorithm was proposed by Geem *et al*. (Geem *et al*., 2001). HS algorithm simulates the improvisation process of musicians to find better harmonies. The main characteristics of HS algorithm have made it as one of the most important meta-heuristic methods (Geem, 2010). HS has been able to attract many researches to develop HS-based solutions for their different engineering and optimization problems, such as structural design, Sudoku puzzles, musical composition, medical imaging, heat exchanger design, course timetabling, web page clustering, robotics, water network design,

dam scheduling, vehicle routing, energy system dispatch, cell phone network, satellite heat pipe design, and medical physics (Alia & Mandava, 2011).

Although the algorithm is computationally effective and easy to implement for solving various kinds of engineering optimization problems, it is not quite successful in performing local search in continuous numerical optimization applications (Omran & Mahdavi, 2008), especially for problems with high dimensions. Consequently, advantages of this algorithm led the researchers to improve the performance and develop further applications with different ideas. Ingram and Zhang (Ingram & Zhang, 2009) classified and explained various modifications of HS in seven categories. Among several attempts that have been made to improve the performance of basic-HS algorithm some of more popular ones are: Improved Harmony Search algorithm (IHS) by Mahdavi *et al.* (Mahdavi *et al*., 2007), Global-best Harmony Search algorithm (GHS) by Omran and Mahdavi (Omran & Mahdavi, 2008), Improved Harmony Search (IHS) by Coelho and Mariani (Coelho & Mariani, 2009), Improved Harmony Search with Differential mutation operator (DHS) by Chakraborty *et al*. (Chakraborty *et al*. 2009), Self-adaptive Global-best Harmony Search algorithm (SGHS) by Pan *et al.* (Pan *et al*., 2010), Novel Global Harmony Search (NGHS) by Zou *et al.* (Zou *et al*., 2010), and Parameter-setting-free harmony search algorithm by Geem and Sim (Geem & Sim, 2010). For more consideration, an extensive explanation of HS variants applications in various kinds of engineering, real-world and numerical optimization problems are reported by Manjarres *et al.* (Manjarres *et al*., 2013).

Most recently, Ashrafi and Dariane (Ashrafi & Dariane, 2011) introduced an innovative improved version of HS, named Melody Search (MS) which is an efficient algorithm to solve continuous optimization problems. The algorithm imitates performance processes that occurred in a group of musicians to improvise a melody, while

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