Chapter 1

An Innovative Multi-Stage Multi-Dimensional Multiple-Inhomogeneous Melody Search Algorithm:

Symphony Orchestra Search Algorithm (SOSA)

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ABSTRACT

In this book chapter, the authors present an innovative strategy to enhance performance of the music-inspired algorithms. In this strategy, by using multiple-inhomogeneous music players and three different well-organized stages for improvisation, an innovative symphony orchestra search algorithm (SOSA) is proposed to solve large-scale non-linear non-convex optimization problems. Using multiple-inhomogeneous music players with different tastes, ideas, experiences can conduct players to choose better pitches, and increase the probability of playing a better melody. The strength of the newly proposed algorithm can enhance its superiority in comparison with other music-inspired algorithms, when feasible area of the solution space, and or dimensions of the optimization problem increases. Network expansion planning (NEP) problem has been employed to evaluate the performance of the newly proposed SOSA, compared with other existing optimization algorithms. The NEP problem is a large-scale non-convex optimization problem having a non-linear, mixed-integer nature.

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INTRODUCTION

Background and Motivation

The most recently, many meta-heuristic optimization techniques that are conceptually different from the traditional mathematical programming techniques have been developed in order to solve the large-scale, mixed-integer, non-linear and non-convex optimization problems (Lee & El-Sharkawi, 2008). This is because of the superiority of the non-traditional meta-heuristic optimization techniques in comparison with traditional mathematical programming techniques, when feasible area of the solution space and or dimensions of the optimization problem increases (Lee & El-Sharkawi, 2008). The non-traditional meta-heuristic optimization techniques have been inspired by certain attributes and behavior of biological, swarm of fauna, and neurobiological systems. The most popular meta-heuristic algorithms can be classified into genetic algorithm (GA) (Holland, 1975), particle swarm optimization (PSO) (Kennedy & Eberhart), simulated annealing (SA) (Kirkpatrick, Gelatt & Vecchi, 1983), Tabu search (TS) (Glover, 1977), ant colony optimization (ACO) (Dorigo, Maniezzo & Colorni, 1996), artificial bee colony (ABC) (Karaboga, 2005), artificial fish-swarm (AFS) (Li, Shao & Qian, 2002), bacterial foraging optimization (BFO) (Passino, 2002), bat algorithm (BA) (Yang, 2010), cuckoo search (CS) (Yang & Deb, 2009), firefly algorithm (FA) (Yang, 2009), etc. As further elucidation, the details of these algorithms are tabulated in Table 1. These studies into the meta-heuristic optimization techniques show that most of aforementioned algorithms are employed only for solving a specific class of convex and non-convex optimization problems. This is because of the fact that the performance of these meta-heuristic algorithms depend on a confined solution space. In other word, in every new generation, a new set of vectors is produced by using randomized selection and improved operators from the limited set of vectors. Therefore, these meta-heuristic algorithms cannot maintain their proper performance by increasing the irregular dimensions of real-world large-scale optimization problems.

As a result, researchers and engineers in different area of sciences are enthusiastic to use innovative alternatives in the optimization techniques, to improve the performance and efficiency of solving the real-word large-scale optimization problems.

Literature Review and Contributions

In the evolutionary computation literature, in the broadest sense, the optimization techniques can be classified into traditional (i.e., direct methods, gradient methods, linear programming methods, interior point methods), and non-traditional (i.e., swarm intelligence based algorithms, bio-inspired algorithms, physics and chemistry based

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