Chapter 1
Some Words About Nature-Inspired Computing

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ABSTRACT

The use of artificial intelligence (AI) in various domains has drastically increased during the last decade. Nature-inspired computing is a strong computing approach that belongs to AI and covers a wide range of techniques. It has successfully tackled many complex problems and outperformed several classical techniques. This chapter provides the original ideas behind some nature-inspired computing techniques and their applications, such as the genetic algorithms, particle swarm optimization, grey wolf optimizer, ant colony optimization, plant propagation algorithm, cuckoo optimization algorithm, and artificial neural networks.

1. INTRODUCTION

Nowadays, artificial intelligence (AI) is largely used in almost all domains. It includes various approaches, notably nature-inspired algorithms. These algorithms involve mathematical models inspired by the principles of biology, such as human anatomy and evolution, animals and insects, and by the principles of natural phenomena, such as fractals, water cycle, and galaxy gravity. Stochastic models are used in this kind of algorithms to explore and exploit the search space for finding the optimal solutions in a reasonable number of iterations and time. Many mathematical and engineering benchmarks have been investigated to prove the effectiveness of these algorithms. Despite these algorithms having some limitations, the advantages are much more numerous and real-world applications are reaffirming this matter, notably in renewable energy systems, such as fuel cells, photovoltaic cells, wind turbines, biomass, geothermal, and hybrid systems.

A comprehensive illustration of nature-inspired algorithms may take the whole book; therefore, this chapter presents the basic principles and applications of some of them. It is organized as follows. Sec-

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tion 2 includes the definition of some algorithms. Section 3 highlights a listing of applications. Finally, the last section concludes the chapter.

2. PRINCIPLES OF SOME NATURE-INSPIRED ALGORITHMS

2.1. Genetic Algorithms

The genetic algorithms (GAs) are one of the most popular, oldest, and pioneer nature-inspired optimization algorithms. John Henry Holland developed the GAs in 1975 (Holland, 1975) based on genetic operators: chromosomes, parents, children, population, selection, crossover, and mutation. Many types of each operator can be used to solve a particular problem. The detailed principles can be found in Refs. (Holland, 1975; Sivanandam & Deepa, 2008; Sumathi & Paneerselvam, 2010).

2.2. Ant colony Optimization

The ant colony optimization (ACO) was developed by Marco Dorigo in 1992 (M. Dorigo, 1992). It is based on the ants' behavior for foraging. The ants left a pheromone on the ground and based on its intensity and evaporation process, the optimal path will be identified. It allows finding the shortest path. The detailed principles can be found in Refs. (M. Dorigo, 1992; Marco Dorigo, Maniezzo, & Colorni, 1996; M. A. Mellal & Williams, 2018).

2.3. Particle Swarm Optimization

The particle swarm optimization (PSO) is inspired by the principles of the moving style of some species, such as birds and fishes. It was developed by Kennedy and Eberhart in 1995 (Kennedy & Eberhart, 1995). Each element of the swarm, called a particle, has a position and a velocity. The particles move randomly and the best positions are computed and updated. Comprehensive details about the PSO can be found in Refs. (Clerc, 2006; Kennedy & Eberhart, 1995; M. A. Mellal & Williams, 2018).

2.4. Grey Wolf Optimizer

The grey wolf optimizer (GWO) was developed by Mirjalili et al. in 2014 (Mirjalili, Mirjalili, & Lewis, 2014) and is inspired by the grey wolves. This algorithm is reputed to be efficient and fast. In the GWO, the wolves are divided into four hierarchies, called alpha, beta, delta, and omega. These wolves follow some rules to hunt. Details can be found in Refs. (Mohamed Arezki Mellal, Frik, & Boutiche, 2021; Mirjalili et al., 2014; Panda & Das, 2019).

2.5. Plant Propagation Algorithm

The plant propagation algorithm (PPA), also called the strawberry algorithm, is inspired by the propagation mechanism of some plants, such as the strawberry plant. It was developed by Salhi and Fraga in 2011 (Salhi & Fraga, 2011), based on the runners of these plants. This algorithm is characterized by a