Chapter 18
An Overview of the Last Advances and Applications of Artificial Bee Colony Algorithm

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ABSTRACT

Swarm Intelligence is defined as collective behavior of decentralized and self-organized systems of a natural or artificial nature. In the last years and today, Swarm Intelligence has proven to be a branch of Artificial Intelligence that is able to solving efficiently complex optimization problems. Some of well-known examples of Swarm Intelligence in natural systems reported in the literature are colony of social insects such as bees and ants, bird flocks, fish schools, etc. In this respect, Artificial Bee Colony Algorithm is a nature inspired metaheuristic, which imitates the honey bee foraging behaviour that produces an intelligent social behaviour. ABC has been used successfully to solve a wide variety of discrete and continuous optimization problems. In order to further enhance the structure of Artificial Bee Colony, there are a variety of works that have modified and hybridized to other techniques the standard version of ABC. This work presents a review paper with a survey of the modifications, variants and applications of the Artificial Bee Colony Algorithm.

INTRODUCTION

Nature is a constant source of inspiration in the development of new approximate algorithms for solving optimization problems. Specifically, nature intelligent entities that are able to work efficiently and autonomously in unknown and changing environments. Nature-inspired algorithms have high relevance when solving hard and complex optimization problems by mimicking the behaviour arisen in nature in various forms and these algorithms are always hot research topics in the area of Artificial Intelligence (AI). Some general categories grouping nature-inspired algorithms are evolutionary algorithms, swarm

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intelligence algorithms, and natural ecosystems algorithms. This chapter aims to focus on specific case of swarm intelligence algorithm.

Swarm Intelligence (SI) concept was first introduced in the context of cellular robotics systems (Beni & Wang, 1989). This field of study focuses on the collective behaviour those results from the local interactions of the people with each other and with their surrounding conditions. The main aim of SI is to increase the performance and robustness (Fleischer, 2003). Nowadays, SI is also strongly correlated with a new branch of AI that is used as collective behaviour of swarms in nature, such as colonies of ants, flocking of birds, honey bees. In (Bonabeau & Theraulaz, 1999), SI is defined as any attempt to design algorithms or distributed problem-solving devices inspired by the collective behaviour of social insect colonies and other animal societies. Overall, the term swarm is used for a large number of insects or other small organisms, especially when they are in motion. Roughly speaking, SI systems consist of a population of simple agents exchanging information locally with another simple agents and with their environment. The agent capabilities are simple and limited by interacting direct and indirect with other agents, they follow simple rules. An example of direct communication between agents is e.g. birds where they interact with each other through sound. Birds have very high immense vision power they go in search of food source. Some birds smell the best quality of food source and spread the information to all other birds. Hence they have good communication and cooperation between them. Indirect iterations are defined as interaction with the environment, i.e., one agent changes the environment and other agents respond to the change. An example, the pheromone trail lay by the ants during the search of food. Ants are able to search their food in shortest path and they communicate through environment by chemical substances called pheromone. They cannot communicate directly with each other. Generally speaking, the swarm system is characterized in terms of individuals, interactions and environment. There is no centralized control systems, individual agents of these swarms behave without supervision and each of these agents has a stochastic behaviour due to their perception of the neighborhood. The swarm can be seen as a decentralized and self-organized system. Through this simple and local behaviour, an intelligent and global behaviour of the swarm is generated.

Over the last decades, numerous research efforts have been devoted to the development and study of SI meta-heuristics. In the literature there are many of these meta-heuristics. Some relevant examples are Ant Colony Optimization (ACO) (Dorigo, 1992), Artificial Bee Colony (ABC) (Karaboga, 2005), Bat Algorithm (BA) (Yang, 2010), Particle Swarm Optimization (PSO) (Kennedy & Eberhart, 1995), and many others are some of the natural examples of swarm which are a smart and efficient problem solving techniques. The good reception of these meta-heuristics relies on its ability to obtain high-quality solutions in reasonable times in highly complex optimization problems. This is the reason that encompasses a wide range of practical applications covering areas such as computer networks, engineering, bio-medical applications, control systems, parallel processing, data mining, security, robotics, general optimization and many other application areas. SI is becoming increasingly important research area for computer scientists, engineers, economists, bioinformaticians, operational researchers, and many other disciplines. This is because the problems that the natural intelligent swarms can solve (finding food, building nests, dividing labor among nest mates, etc.) have important counterparts in several engineering areas of real world.

ABC is an interesting and practical algorithm to the scientific community used in a wide range of applications. Its advantage of being easily hybridized with other techniques makes it a robust and viable alternative to the search solutions in many years to come. That is the reason behind the interest of this chapter to organize the most important works around of this technique and identify future lines of