Chapter 21
Analysis and Implementation of Artificial Bee Colony Optimization in Constrained Optimization Problems

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ABSTRACT

The growing complexity of real-world problems has motivated computer scientists to search for efficient problem-solving methods. Evolutionary computation and swarm intelligence meta-heuristics are outstanding examples that nature has been an unending source of inspiration. The behaviour of bees, bacteria, glow-worms, fireflies, slime moulds, cockroaches, mosquitoes and other organisms have inspired swarm intelligence researchers to devise new optimisation algorithms. Swarm Intelligence appears in biological swarms of certain insect species. It gives rise to complex and often intelligent behavior through complex interaction of thousands of autonomous swarm members. In this chapter, the ABC algorithm has been extended for solving constrained optimization problems and applied to a set of constrained problems.

DOI: 10.4018/978-1-5225-2857-9.ch021

1. INTRODUCTION

The computer revolution has changed the human societies. Some problems are there which cannot be tackled through traditional hardware and software. So, new computing techniques are needed. Swarm intelligence is an important concept in artificial intelligence and computer science with emergent properties (Blum, 2008). A swarm is a large number of homogenous, simple agents interacting locally among themselves, and their environment, with no central control to allow a global interesting behavior to emerge. Swarm-based algorithms have recently emerged as a family of nature-inspired, population-based algorithms that are capable of producing low cost, fast, and robust solutions to several complex problems. Swarm Intelligence can therefore be defined as a relatively new branch of Artificial Intelligence that is used to model the collective behavior of social swarms in nature, such as ant colonies, honey bees, and bird flocks. Although these agents (insects or swarm individuals) are relatively unsophisticated with limited capabilities on their own, they are interacting together with certain behavioral patterns to cooperatively achieve tasks necessary for their survival. The social interactions among swarm individuals can be either direct or indirect. Examples of direct interaction are through visual or audio contact, such as the waggle dance of honey bees. Indirect interaction occurs when one individual changes the environment and the other individuals respond to the new environment, such as the pheromone trails of ants that they deposit on their way to search for food sources. In 1989, the expression "Swarm Intelligence" was first introduced by G. Beni and J. Wang in the global optimization framework as a set of algorithms for controlling robotic swarm. Swarm intelligence is used in various fields like robotics for controlling robots, automobiles for designing unmanned cars, in NASA for planet or satellite mapping, in medical fraternity for locating and killing tumors or blockages, in genetics, in data mining etc. Various principles of swarm intelligence are:

1. **Proximity Principle:** The basic units of a swarm should be capable of simple computation related to its surrounding environment. Here computation is regarded as a direct behavioral response to environmental variance, such as those triggered by interactions among agents;
2. **Quality Principle:** Apart from basic computation ability, a swarm should be able to response to quality factors, such as food and safety;
3. **Principle of Diverse Response:** Resources should not be concentrated in narrow region. The distribution should be designed so that each agent will be maximally protected facing environmental fluctuations;
4. **Principle of Stability and Adaptability:** Swarms are expected to adapt environmental fluctuations without rapidly changing modes since mode changing costs energy.

Nature is inspiring researchers to develop models for solving their problems. Optimization is an instance field in which these models are frequently developed and applied. Optimization is the science of allocating scarce resources to the best possible effect. The nature-inspired algorithms (Das, 2009) are motivated by a variety of biological and natural processes. Evolutionary computation, neural networks, ant colony optimization, particle swarm optimization, artificial immune systems, and bacteria foraging algorithm are among the algorithms and concepts that were motivated by nature. Swarm behavior is one of the main features of different colonies of social insects (bees, wasps, ants, termites). This type of behavior is principally characterized by autonomy, distributed functioning, and self-organizing. The researchers have been studying the behavior of social insects in an attempt to utilize the swarm intelli-