

## Chapter 2

# Coupling of Optimization Algorithms Based on Swarm Intelligence: An Application for Control of Heroin Addiction Epidemic

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### ABSTRACT

*Swarm intelligence is a branch of computational intelligence where algorithms are developed based on the biological examples of swarming and flocking phenomena of social organisms such as a flock of birds. Such algorithms have been widely utilized for solving computationally complex problems in fields of biomedical engineering and sociology. In this chapter, two different swarm intelligence algorithms, namely the jumping frogs optimization (JFO) and bacterial foraging optimization (BFO), are explained in detail. Further, a synergetic algorithm, namely the coupled bacterial foraging/jumping frogs optimization algorithm (BFJFO), is described and utilized as a tool for control of the heroin epidemic problem.*

### INTRODUCTION

Computational artificial intelligence can be described as the computational techniques built using the foundations of the intelligent behavior exhibited in nature. The central aim of computational intelligence is to design, build, and experiment with systems that perform tasks commonly viewed as requiring intelligence (Poole & Mackworth, 2010). Such computational techniques based on the intelligent behavior exhibited in nature are highly useful for solving certain computationally demanding problems and is highly useful for decision making. The field of artificial intelligence has developed rapidly as the power of computers has increased (Rossini, 2000).

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The task of finding the global optimum in a multi parameter and multiple state problems is extremely difficult since the search space increases. In such cases, it is necessary to adopt highly efficient algorithms for scanning the entire search space for the elite solution. Further, there is a need for avoiding the premature convergence to local minima. Such problems can be overcome using novel optimization strategies known as swarm intelligence algorithms. Swarm intelligence algorithms are versatile population-based optimization techniques based on random search principles, similar to evolutionary algorithms (Kamberaj, 2014). Heuristic and random search algorithms are useful in obtaining approximations to the optimal solutions in a bounded time (Rebollo-Ruiz & Graña, 2014).

Swarm Intelligence is an innovative distributed intelligent paradigm for solving optimization problems that originally took its inspiration from the biological examples of swarming and flocking phenomena. This discipline is inspired by the behavior of social creatures and organisms such as frogs, a flock of birds, swarm of bacteria etc. In general, this is done by mimicking the behavior of the biological creatures within their swarms and colonies (Nedjah & Mourelle, 2006).

Swarm intelligence is a novel and innovative branch of meta-heuristics developed by mimicking or imitating the behavioral pattern of natural insects or organisms (Zhang, Lee, Chan, Choy & Wu, 2015). In other words, swarm Intelligence is the property of a system in which the collective behavior of simple quasi-independent agents which locally interact with their environment will lead to global intelligent behavior. Swarm intelligence techniques have been widely used for solving hard estimation problems since they are robust, flexible, fault tolerant, scalable, and highly parallelizable (Da San Martino et al. 2006; Kennedy & Eberhart, 2001; Consoli et al. 2008). Swarm Intelligence techniques provide powerful tools to help doctors to analyze biomedical datasets and medical images (Min, Liu, He, Gong, Fong, Xu, & Wong, 2016; Podgorelec & Kokol, 2001; Garlapati, Vundavilli & Banerjee, 2010; Jalali-Heravi & Ebrahimi-Najafabadi, 2011; Bursa, Lhotska, Chudacek, Spilka, Janku, & Hruban, 2015).

Some of the common algorithms based on swarm intelligence are:

1. **Particle Swarm Optimization:** A stochastic optimization technique that draws inspiration from the behavior of a flock of birds or the collective intelligence of a group of social insects for finding the optimal solution (Biswas, Dasgupta, Das & Abraham, 2007; Kamalanand & Mannar Jawahar, 2014; Kamalanand & Mannar Jawahar, 2015; Kamalanand & Mannar Jawahar, 2016)
2. **Bacterial Foraging Optimization:** The algorithm mimics the foraging strategies of the E. Coli bacteria for finding the optimal solution (Biswas, Dasgupta, Das & Abraham, 2007; Rajinikanth & Latha, 2011; Rajinikanth & Latha, 2012; Kamalanand & Mannar Jawahar, 2014; Kamalanand & Mannar Jawahar, 2015; Kamalanand & Mannar Jawahar, 2016)
3. **Bee Colony Optimization:** This algorithm utilizes the individual cognitive abilities and self-organization of a colony of honey bees for problem solving (Ari, Yenke, Labraoui, Damakoa, & Gueroui 2016)
4. **Ant Colony Optimization:** The behavior of real ants which find the shortest path to arrive at the food sources is mimicked. This process is performed through a chemical known as pheromone which is secreted by the ants on to the ground which increases the probability that other ants will follow the same path (Zheng, Yin, Fu, Fu, & Liu 2014).
5. **Firefly Algorithm:** This algorithm mimics the behavior of the Fire flies for searching the optima in a search space (Min, Liu, He, Gong, Fong, Xu, & Wong 2016; Yang 2010; Raja, Manic & Rajinikanth, 2013; Rajinikanth & Couceiro, 2015; Zahedi, Akbari, Shokouhifar, Safaei & Jalali, 2016; Yang, 2009).

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