Chapter 1
Recent Developments of Fireworks Algorithms

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ABSTRACT

Fireworks Algorithm has been proposed for almost 10 years. Because of its basic but profound collaborative searching manner and advantages of universal effectiveness, hundreds of scholars have conducted and published a wide range of work on it. This chapter serves as a background description of fireworks algorithms' developments by introducing its detailed status of researches and applications. Specifically, it gives a brief summarization and analysis of published researches on Fireworks Algorithms since 2010 to clarify characteristics of its historical progress and future trend in detailed fields like algorithms improvements, theoretical analysis, and practical applications.

INTRODUCTION

Optimization is an everlasting topic in science and engineering. However, traditional mathematic tools for optimization have failed on many situations due to the significant complexity in modern optimization problems. As an example, the most commonly applied method, gradient-decent or the Newton's method, seems always inevitably trapped in local optimal for complex multi-modal problems, let alone it can be scarcely possible to be implemented in gradient-free or discontinuous objective functions. New mathematical tools have been invented but they are still too fragile for high dimensional, sophisticated constrains or other requirements. Decades ago, evolutionary computation was proposed and developed, which is flexible and robust for all kinds of optimization problems. Nowadays, evolutionary computation has become one of the most active subfield of artificial intelligence.

Swarm Intelligence Optimization Algorithms (SIOAs) is a new class of algorithms that is available and effective for general optimization problems. Like many evolutionary algorithms, SIOAs subtly controls a group of individuals moving or evolving in the search space, each represents a solution of the objective problem. However, SIOAs focus on the collaborative behaviors between individuals to improve the whole population instead of simply eliminating bad ones. Classic algorithms like Particle

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Swarm Optimization (PSO) (Eberhart & Kennedy,1995) and Ant Colony Optimization (ACO) (Dorigo & Di Caro, 1999) have been used in a large number of engineering problems.

Fireworks Algorithm (FWA) is a new type of swarm intelligence optimization algorithms proposed since 2010 (Tan & Zhu, 2010). Different from other SIOAs, FWA maintains multiple groups of individuals which independently searching their local area and the global optimization is enhanced by the collaboration of strategies. Fireworks algorithm have received extensive attention because of its simplicity and effectiveness. In recent years, there are hundreds of work on fireworks algorithms published in international journals or conferences. Here, we are going to summarize and introduce some important results on fireworks algorithms since it is proposed, and try to expose its development trends and promising research directions.

FIREWORKS ALGORITHMS

Motivation and Principle

Fireworks and firecrackers are one of the traditional events for Chinese festivals, especially for New Year's Eve. In the night, fireworks rise and explode, bursting with plenty of sparks to light up the sky. Plenty of fireworks explode in different ways which form a distribution of sparks over the night sky. Such a process has much in common with the optimization process. And this is how fireworks algorithm been inspired and proposed at 2010 by Prof. Tan and Zhu (Tan & Zhu, 2010).

Figure 1. Fireworks in the night sky

Most meta-heuristic algorithms designed delicate local optimization mechanisms to accelerate population convergence. However, the behavior of fireworks illustrates a different perspective for global optimization, that is, to manage several simple local search process conducted by sub-groups of individuals and enhance global optimization by collaboration between each group.

So the population of fireworks algorithms are composed of several individual called fireworks and each firework corresponds to plenty of individuals called sparks. In each iteration of the optimization, each firework simply generates certain number of sparks around itself. However, the distribution and