

A Comprehensive Review of the Fireworks Algorithm

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The fireworks algorithm, which is inspired from the phenomenon of fireworks explosion, is a special kind of swarm intelligence algorithm proposed in 2010. Since then, it has been attracting more and more research interest and has been widely employed in many real-world problems due to its unique search manner and high efficiency. In this article, we present a comprehensive review of its advances and applications. We begin with an introduction to the original fireworks algorithm. Then we review its algorithmic research work for single objective and multi-objective optimization problems. After that, we present the theoretical analyses of the fireworks algorithm. Finally, we give a brief overview of its applications and implementations. Hopefully, this article could provide a useful road map for researchers and practitioners who are interested in this algorithm and inspire new ideas for its further development.

CCS Concepts: • **Theory of computation** → **Evolutionary algorithms; Bio-inspired optimization;**

Additional Key Words and Phrases: Fireworks algorithm, evolutionary computation, swarm intelligence

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1 INTRODUCTION

Optimization is one of the most fundamental and common problems in science and industry. Convex optimization with available derivatives can be solved efficiently by gradient-based algorithms like gradient descent or the Newton's method. However, there is no derivative information in black-box or discrete optimization problems, and gradient-based algorithms are often trapped in local optima when optimizing multi-modal objective functions even though there is derivative information. Therefore, a new branch of approaches, i.e., evolutionary computation was proposed and developed, which do not require derivative information and can keep a balance between exploitation and exploration in the global search process. Nowadays, evolutionary computation has become one of the most active subfield of artificial intelligence.

Evolutionary computation in a narrow sense refer to algorithms that are directly inspired by biological evolutionary phenomena, such as evolutionary strategy and the genetic algorithm. While evolutionary computation in a broad sense refer to all derivative-free iterative optimization algorithms, including metaphor-based algorithms (meta-heuristics) and direct methods such as the downhill simplex method and estimation of distribution algorithms. So far, more than one hundred

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