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A Hybrid Firefly and Particle Swarm Optimization Algorithm for Computationally Expensive Numerical Problems

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Highlights

- A hybrid optimization algorithm is proposed that combines strongpoints of both algorithms and keeps balance between exploration and exploitation abilities of particle swarm and firefly optimization algorithms.
- A local search strategy is proposed by controlling previous global best fitness value.
- Proposed HFPSO are compared with standard particle swarm, firefly and other recent and successful hybrid and memetic algorithms in the limited function evaluations.
- In experiments, CEC 2015 and CEC 2017 benchmark, realistic engineering and mechanical design problems are employed. The Holm–Bonferroni statistical test procedure is adopted.

Abstract

Optimization in computationally expensive numerical problems with limited function evaluations provides computational advantages over constraints based on runtime requirements and hardware resources. Convergence success of an optimization algorithm depends on directing and balancing of its exploration and exploitation abilities. Firefly and particle swarm optimization are successful swarm intelligence algorithms inspired by nature. In this paper, a hybrid algorithm combining firefly and particle swarm optimization (HFPSO) is proposed. The proposed algorithm is able to exploit the strongpoints of both particle swarm and firefly algorithm mechanisms. HFPSO try to determine the start of the local search process properly by checking the previous global best fitness values. In experiments, several dimensional CEC 2015 and CEC 2017 computationally expensive sets of numerical and engineering, mechanical design benchmark problems are used. The proposed HFPSO is compared with standard particle swarm, firefly and other recent hybrid and successful algorithms in limited function evaluations. Runtimes and convergence accuracies are statistically measured and evaluated. The solution results quality of this study show that the proposed HFPSO algorithm provides fast and reliable optimization solutions and outperforms others in unimodal, simple multimodal, hybrid, and composition categories of computationally expensive numerical functions.

Keywords: hybrid optimization, firefly algorithm, particle swarm optimization

1. Introduction

Finding optima in many real-world optimization problems requires expensive evaluations in terms of computation. Because of some limitations in studies like project time requirements and computation resource constraints, the optimization process should be conducted quickly and it should not be too complex [1]. Many standard optimization algorithms require a large number of function evaluations. These algorithms usually give satisfactory results by use of their special information transfer mechanisms with a number of first candidate solutions in a number of fitness evaluations. Due to the evaluation of each candidate resolution,