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Social mimic optimization algorithm and engineering applications

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ABSTRACT

Increase in complexity of real world problems has provided an area to explore efficient methods to solve computer science problems. Meta-heuristic methods based on evolutionary computations and swarm intelligence are instances of techniques inspired by nature. This paper presents a novel social mimic optimization (SMO) algorithm inspired by mimicking behavior to solve optimization problems. The proposed algorithm is evaluated using 23 test functions. Obtained results are compared with 14 known optimization algorithms including Whale optimization algorithm (WOA), Grasshopper optimization algorithm (GOA), Particle Swarm Optimization (PSO), Stochastic fractal search (SFS), Grey Wolf Optimizer (GWO), Optics Inspired Optimization (OIO), League Championship Algorithm (LCA), Wind Driven Optimization (WDO), Harmony search (HS), Firefly Algorithm (FA), Artificial Bee Colony (ABC), Biogeography Based Optimization (BBO), Bat Algorithm (BA), and Teaching Learning Based Optimization (TLBO). Obtained results indicate higher capability of the SMO algorithm in solving high-dimensional decision variables. Furthermore, SMO is used to solve two classic engineering design problems. Three important features of SMO are simple implementation, solving optimization problems with minimum population size and not requiring control parameters. Results of various evaluations show superiority of the proposed method in finding the optimal solution with minimum function evaluations. This superiority is achieved based on reducing number of initial population. The proposed method can be applied to applications like automatic evolution of robotics, automatic control of machines and innovation of machines in finding better solutions with less cost.

1. Introduction

Optimization is a procedure used to obtain optimal parameters of a problem with all possible values to increase or decrease the output. Complicated problems like scheduling, data clustering, image processing and adjusting neural networks are examples of optimization problems. In order to solve such problems, several classic and meta-heuristic optimization approaches have been proposed. There are lots of controversy about incapability of classic methods to obtain an optimal solution in an acceptable time. On the other hand, meta-heuristic methods have become increasingly popular in solving optimization problems due to their simplicity, flexibility, no-derivative mechanism and avoiding local optima (Mirjalili, Mirjalili, & Lewis, 2014).

Meta-heuristic methods can be divided into two single-solution and multiple-solution approaches. In the first category, search procedure is started with one solution. This unique candidate solution is enhanced in the subsequent iterations. On the contrary, multiple-solution meta-heuristic methods perform optimization using a set of random initial solutions. Population is enhanced in the subsequent iterations. According to the studies, methods based on multiple solutions are more popular than single-solution methods (Mirjalili & Lewis, 2013).

Multiple-solution methods avoid local optima due to high number of initial random solutions. These methods investigate a wider span of the search space, hence probability of finding a desired optimal solution is higher. Information of the search space can be exchanged among multiple solutions as a result of which it converges towards the optimum faster. Multiple-solution based methods require investigating more fitness functions compared to single-solution based methods. Single-solution based methods like hill-climbing (Davis, 1991) and simulated annealing (Kirkpatrick, Gelatt, & Vecchi, 1983) follow a similar idea. But simulated annealing outperforms hill-climbing in terms of avoiding local optima. A class of multiple-solution meta-heuristic methods are methods inspired by social behavior and swarm intelligence of human, animals, herds, teams or any class of creatures. Movement of organisms as a group like bird flocks, group hunting or fish school are the motivation of particle swarm. Group is represented with particle swarm and particle swarm employs position of particles in

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