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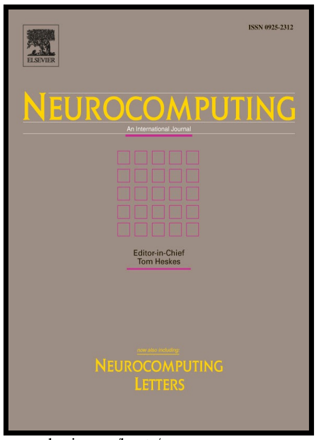

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Collective Decision Optimization Algorithm: a new heuristic optimization method

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Abstract

Recently, inspired by nature, diversiform successful and effective optimization methods have been proposed for solving many complex and challenging applications in different domains. This paper proposes a new meta-heuristic technique, collective decision optimization algorithm (CDOA), for training artificial neural networks. It simulates the social behavior of human based on their decision-making characteristics including experience-based phase, others'-based phase, group thinking-based phase, leader-based phase and innovation-based phase. Different corresponding operators are designed in the methodology. Experimental results carried out on a comprehensive set of benchmark functions and two nonlinear function approximation examples demonstrate that CDOA is competitive with respect to other state-of-art optimization algorithms.

Keywords: Collective decision optimization algorithm, artificial neural networks, meta-heuristic, decision-making

1. Introduction

Global optimization refers to the process of obtaining optimal values for a given system or mathematical model from all the possible solutions to maximize or minimize objective function. Increasing complexity of optimization tasks involved in different fields of real world make the development of optimization techniques more significant and interesting than before. Therefore, over the past two decades, various optimization methods have been proposed on diverse inspirations. According to the number of candidate solutions, they can be grouped in two categories: individual-based and population-based methods. In the former case, optimization process tends to start with single random solution, which is improved over the course iterations. Thus, individual-based techniques need less computation cost and function evaluation but suffer from great drawbacks: derivation-based mechanism and premature convergence. In contrary, in the latter case, a set of solutions is generated randomly and improved from generation to generation. In this way, population-based methods have high ability to avoid local optima, since the exchange of information occurs between the solutions and assists them to conquer different difficulties of search spaces. Meanwhile, they also encounter high computational cost and more function evaluation.

The important feature of population-based stochastic search techniques is the division of the solution domain to two main milestones: diversification and intensification [1]. The former refers to the phase where candidate solutions tend to be changed more frequently and explore promising regions as broad as possible. Contradictory, the latter promotes convergence toward the best values obtained in exploration process. In other words, favoring diversification turns out higher local optima avoidance, whereas emphasizing intensification yields to faster convergence rate. Recently, heuristic optimization techniques have exhibited remarkable performance in a wide variety of problems from diverse fields due to the following advantages: simplicity, flexibility, derivation-free mechanism and local optima avoidance. For this reason, it has expanded tremendously. Inspired by different nature phenomena, scholars have proposed many successful and effective optimization methods. According to inspiration, these existing paradigms can be classified into three main categories: evolution-based, physics-based and swarm-based methods.

Evolution-based methodologies are inspired from the laws of biological evolution. The most popular evolution approach in this category is Genetic Algorithm (GA) [2], which imitates the theory of Darwinian evolution. Biogeography-Based Optimizer (BBO) on natural biogeography [3] and Bird Mating Optimizer (BMO) on natural evolution [4].

Physics-based algorithms are those who mimic the physical regulations of the universe, such as Simulated Annealing (SA) on the metallurgic annealing process [5], Ray Optimization (RO) on the Snell's light refraction law [6], Gravitational Search Algorithm (GSA) on the law of gravity and mass interactions [7], and Black hole (BH) on black hole phenomenon [8].

Swarm-based techniques simulate all kind of animal or human behaviors. For instance, Particle Swarm Optimization (PSO) [9] on the foraging behavior of bird flocking, Flower Pollination algorithm (FPA) on the pollination process of flowers [10], Cuckoo Search (CS) on the brood parasitism of cuckoo

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