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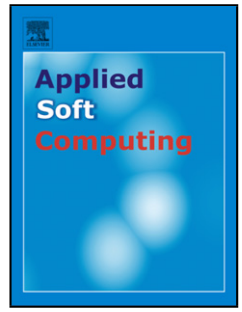

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A novel improved particle swarm optimization algorithm based on individual difference evolution

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Abstract

As a well-known stochastic optimization algorithm, the particle swarm optimization (PSO) algorithm has attracted the attention of many researchers all over the world, which has resulted in many variants of the basic algorithm, in addition to a vast number of parameter selection/control strategies. However, most of these algorithms evolve their population using a single fixed pattern, thereby reducing the intelligence of the entire swarm. Some PSO-variants adopt a multimode evolutionary strategy, but lack dynamic adaptability. Furthermore, competition among particles is ignored, with no consideration of individual thinking or decision-making ability. This paper introduces an evolution mechanism based on individual difference, and proposes a novel improved PSO algorithm based on individual difference evolution (IDE-PSO). This algorithm allocates a competition coefficient called the emotional status to each particle for quantifying individual differences, separates the entire swarm into three subgroups, and selects the specific evolutionary method for each particle according to its emotional status and current fitness. The value of the coefficient is adjusted dynamically according to the evolutionary performance of each particle. A modified restarting strategy is employed to regenerate corresponding particles and enhance the diversity of the population. For a series of benchmark functions, simulation results show the effectiveness of the proposed IDE-PSO, which outperforms many state-of-the-art evolutionary algorithms in terms of convergence, robustness, and scalability.

Keywords: Particle swarm optimization, Individual difference, Dynamic adjustment, Subgroup, Emotional PSO, psychology model

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1. Introduction

Inspired by social behavior observed in nature, such as schools of fish, flocks of birds, swarms of bees, colonies of ants, and even human social behavior (1), particle swarm optimization (PSO), since its advent in 1995, has demonstrated good performance on many optimization problems (2; 3). PSO belongs to the broad class of swarm intelligence methods.

As a population-based meta-heuristic search algorithm, PSO uses a pool of individuals to perform a search of the solution space (4). It regards each individual as a particle without mass and volume that represents the potential solution of the optimization problem (5). The set of particles, also known as a swarm, fly through the multidimensional search space following typical dynamics in search of a global optimum. At any particular instance, each particle has a position and velocity (2). The trajectory of each individual in the search space is adjusted by dynamically altering the velocity of each particle according to its flying experience and that of other particles in the search space (2; 6; 7); that is, unlike most existing meta-heuristic search algorithms, PSO sets the current swarm to roam through the search space, simultaneously memorizing the personal best positions of particles in the memory swarm and allowing particles to share information with each other, thereby enabling them to move toward the global optima (8; 9).

PSO has the advantage of simple implementation, fewer control parameters, and better convergence performance, among others (10). Hence, it has attracted a great deal of attention from researchers across the globe, and many

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