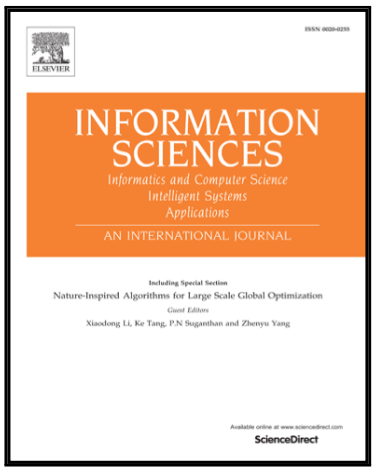

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Enhancing comprehensive learning particle swarm optimization with local optima topology

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Abstract

Recently, particle swarm optimization (PSO) has been employed in many studies for solving numerous real-world problems. However, PSO may suffer from premature convergence when dealing with multimodal problems. Thus, we propose a local optima topology (LOT) structure based on the comprehensive learning particle swarm optimizer (CLPSO) called CLPSO-LOT. The local optima are found in the iterative process and a new topology space is composed. A random element from the space can serve as the next exemplar that the particle uses for learning. This topology structure comprises the local optima that enlarge the particle's search space and increase the convergence speed with a certain probability. We conducted numerical experiments based on various functions from CEC2005 and CEC2014, where the results demonstrated good performance of this algorithm. Furthermore, we applied the algorithm to the optimization of four-bar linkages, where the results indicated that the CLPSO-LOT performed better than other algorithms, and that the performance of the CLPSO was improved.

Keywords: `CLPSO`, `CLPSO-LOT`, `Evolutionary algorithm`, `Local optima topology, Particle swarm optimization (PSO)`

1. Introduction

In 1995, inspired by the foraging behavior of birds, Kennedy and Elberhart proposed the particle swarm optimization (PSO) algorithm [11], which subsequently attracted much attention from researchers and has been employed for solving many real-world problems. PSO starts with a set of random solutions before searching for the optimal solution in an iterative manner, and then evaluates the quality of the solution based on its fitness. It follows the current optimal value to obtain the global optimum. Previously, PSO was applied successfully to many fields, such as the feedback controller[22], sliding mode controller[24], cognitive radio network[19], hypersonic weapons[49], and travelling plan [38].

Although PSO is simple and easy to program, it suffers two problems, namely premature and slow convergence in the late stage. In the last two decades, these problems have been addressed by enhancing the swarm distribution in PSO and further improving its global search ability. To prevent the premature convergence problem related to PSO, Liang [16] proposed the comprehensive learning particle swarm optimizer (CLPSO). The CLPSO learns from each particle's historical optimal solution (*pbest*) instead of the global best solution (*gbest*). This search behavior improves the global search ability related to

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