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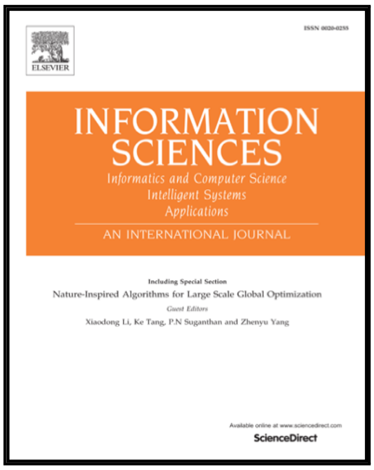

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All-dimension neighborhood based particle swarm optimization with randomly selected neighbors

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Abstract:

Particle swarm optimization (PSO) is widely used for solving various optimization problems, since it has few parameters and is easy to implement. However, canonical PSO generally suffers from premature convergence because it usually loses diversity too rapidly during the evolutionary process. To improve the performance of PSO on complex problems, an all-dimension-neighborhood-based PSO with randomly selected neighbors learning strategy (ADN-RSN-PSO) is proposed in this study. The randomly selected neighbors (RSN) learning strategy is adopted in the early stage of PSO to enhance the swarm diversity, while the all-dimension neighborhood (ADN) strategy is utilized in the later stage to accelerate the convergence rate. The ADN strategy enhances the local search capability around the global-best solution in a dimension by dimension manner, and the search distance is adapted by shrinking and random-expansion operators. Experimental results show that ADN-PSO can improve the exploitation capability of the global version of PSO. To test the performance of the proposed ADN-RSN-PSO, comparison tests on the CEC2013 test suite are carried out. The comparison results reveal that ADN-RSN-PSO outperforms other peer PSO variants. In the end, the proposed ADN-RSN-PSO is applied to the radar system design problem to demonstrate its potential in real-life applications.

Keywords: particle swarm optimization; all-dimension neighborhood search; randomly selected neighbors; local search

1 Introduction

Inspired by flocks of birds, James Kennedy and Russell Eberhart introduced particle swarm optimization (PSO) [10,19] in 1995. Since PSO has few parameters and converges fast in finding the optimal solution, it has attracted extensive investigation in the last two decades.

In the canonical PSO algorithm, each particle in the swarm is persistently attracted by its previous best position (*Pbest*) and the global best position (*Gbest*). This motion mechanism can obtain fast convergence rate, however, it is easy to become trapped in local optima. In the starting stage, the velocities of the particles are very high, causing the swarm diversity to decrease too rapidly to locate the global optimum. When the particles converge to a local optimum, reaching a consensus, PSO loses its search capabilities due to the lack of diversity. In addition to the premature convergence problem, most of the existing PSO variants are problem dependent, few PSO versions can perform well on different kinds of problems [16].

To improve the performance of PSO, a great deal of work has been done in the past two decades. Shi and Eberhart proposed a fuzzy adaptive PSO [35]. Suganthan presented a particle swarm optimizer with neighborhood operators [36]. Ratnaweera and Halgmuge introduced a self-organizing hierarchical particle

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