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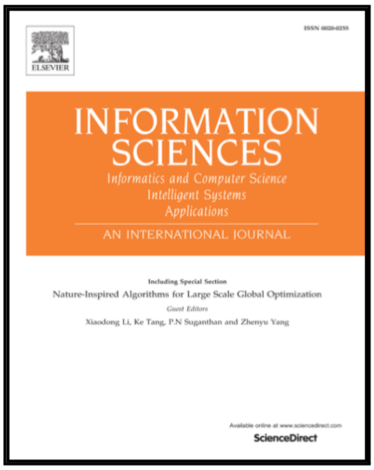

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Vector Coevolving Particle Swarm Optimization Algorithm

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Abstract

In this paper, we propose a novel vector coevolving particle swarm optimization algorithm (VCPSO). In VCPSO, the full dimension of each particle is first randomly partitioned into several sub-dimensions. Then, we randomly assign either one of our newly designed scalar operators or learning operators to update the values in each sub-dimension. The scalar operators are designed to enhance the population diversity and avoid premature convergence. In addition, the learning operators are designed to enhance the global and local search ability. The proposed algorithm is compared with several other classical swarm optimizers on thirty-three benchmark functions. Comprehensive experimental results show that VCPSO displays a better or comparable performance compared to the other algorithms in terms of solution accuracy and statistical results.

Keywords: Particle swarm optimization, Coevolving evolution, Vector partition, Scalar Operators, Learning Operators, Centralized learning, Decentralized learning

1. Introduction

Optimization is an important area in scientific research. As many real-world optimization problems such as non-linear optimal control, text clustering, DNA sequence compression, distribution network design are becoming increasingly more complex, there is high demand for more efficient optimization algorithms. Optimization problems can generally be classified into two categories: unconstrained problems and constrained problems. The constrained problems can be formulated as follows:

$$min\ \sigma = f(X), X \in S,\ S = \{X|g_i(X) \leq 0, i = 1, ..., m\}$$

where $\sigma = f(X)$ is the objective function, and $g_i(X)$ is the constraints function. m is the number of constraint functions, and X is a D-dimensional vector. The constrained problems can be formulated as D-dimensional minimization problems in Euclidean n-space without any constrained function as follows:

$$min\ \sigma = f(X), X \in S, X = \{x_1, x_2, ..., x_D\}, S \subset R^n$$

where $\sigma = f(X)$ is the objective function, and X is a D-dimensional vector. Algorithms for solving these two optimization categories can be divided into deterministic and random optimization algorithms. Traditional deterministic algorithms, such as gradient-based algorithms use specific rules to move from one solution to the other. These methods have been proven to be inefficient and have poor solution quality when solving optimization problems with nonlinear, high dimensional, and discontinuous features. The stochastic optimization search methods are used to tackle complex problems that are non differentiable, multi-modal and have multiple objectives while lacking smoothness. Nature inspired meta-heuristics are currently the most powerful tools for optimization among stochastic algorithms. Examples

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