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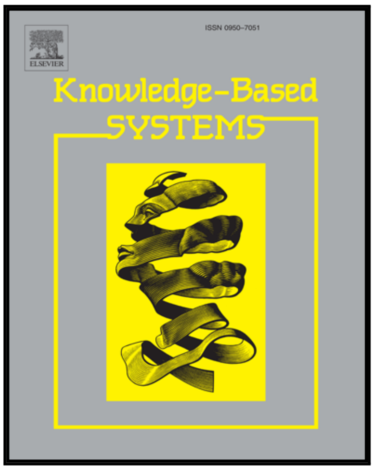

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Chaotic Dynamic Weight Particle Swarm Optimization for Numerical Function Optimization

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Abstract: Particle swarm optimization (PSO), which is inspired by social behaviors of individuals in bird swarms, is a nature-inspired and global optimization algorithm. The PSO method is easy to implement and has shown good performance for many real-world optimization tasks. However, PSO has problems with premature convergence and easy trapping into local optimum solutions. In order to overcome these deficiencies, a chaotic dynamic weight particle swarm optimization (CDW-PSO) is proposed. In the CDW-PSO algorithm, a chaotic map and dynamic weight are introduced to modify the search process. The dynamic weight is defined as a function of the fitness. The search accuracy and performance of the CDW-PSO algorithm are verified on seventeen well-known classical benchmark functions. The experimental results show that, for almost all functions, the CDW-PSO technique has superior performance compared with other nature-inspired optimizations and well-known PSO variants. Namely, the proposed algorithm of CDW-PSO has better search performance.

Keyword: Particle swarm optimization; Chaotic map; Dynamic weight; Optimization

1. Introduction

In recent years, optimization problems are frequently encountered in many real-world applications such as statistical physics [1], computer science [2], artificial intelligence [3], pattern recognition and information theory [4, 5], etc. It is widely believed that it takes too much time to solve actual optimization problems with traditional optimization techniques, and searching for optimal solutions is extremely hard. So, there has been a growing interest in developing and investigating different optimization methods [6, 7] in the past twenty years, especially meta-heuristic optimization methods such as particle swarm optimization (PSO) [8], sine cosine algorithm (SCA) [9], moth-flame optimization algorithm (MFO) [10], ant colony optimization (ACO) [11], firefly algorithm [12], and the artificial bee colony (ABC) method [13]. These optimization algorithms have been adopted by researchers and are well suited for optimizing tasks such as function optimization [14], feature selection [15, 16], logic circuit design [17, 18] and artificial neural networks [19, 20].

With the development of nonlinear dynamics, chaotic theory has been widely applied to various domains. In this case, one of the most famous applications is the introduction of the chaotic concept into optimization algorithms [21]. At present, the chaotic concept has been successfully combined with several nature-inspired methods such as biogeography-based optimization (BBO) [22], gravitational search algorithm (GSA) [23], harmony search (HS) [24], and krill herd algorithm (KH) [25]. To date, there is no clear theory to explain the use of the chaotic sequences to replace certain parameters that change the performance of meta-heuristic optimization algorithms. However, empirical studies indicate that the chaotic theory owns a high-level of mixing ability, and thus, a chaotic map replaced the algorithm parameter. The generated solutions may have higher diversity and mobility; therefore, the chaotic map should be adopted in many studies, especially in meta-heuristic approaches.

Particle swarm optimization (PSO) is a nature-inspired and global optimization algorithm originally developed by Kennedy et al. [26], which mimics the social behaviors of individuals in bird and fish swarms.