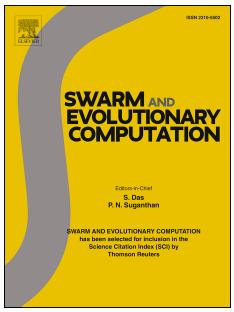
Accepted Manuscript



MPSO: Modified particle swarm optimization and its applications

Dongping Tian, Zhongzhi Shi

PII: S2210-6502(17)30713-7

DOI: 10.1016/j.swevo.2018.01.011

Reference: SWEVO 352

To appear in: *Swarm and Evolutionary Computation BASE DATA*

Received Date: 30 August 2017

Revised Date: 28 January 2018

Accepted Date: 28 January 2018

Please cite this article as: D. Tian, Z. Shi, MPSO: Modified particle swarm optimization and its applications, *Swarm and Evolutionary Computation BASE DATA* (2018), doi: 10.1016/j.swevo.2018.01.011.

MPSO: Modified Particle Swarm Optimization and Its Applications

Dongping Tian [a *], **Zhongzhi Shi** [b]

[a] *Institute of Computer Software, Baoji University of Arts and Sciences, Baoji, Shaanxi, 721007, P.R China*

[b] *Key Laboratory of Intelligent Information Processing, Institute of Computing Technology, Chinese Academy of Sciences, Beijing, 100190, P.R China*

Abstract: Particle swarm optimization (PSO) is a population based meta-heuristic search algorithm that has been widely applied to a variety of problems since its advent. In PSO, the inertial weight not only has a crucial effect on its convergence, but also plays an important role in balancing exploration and exploitation during the evolution. However, PSO is easily trapped into the local optima and premature convergence appears when applied to complex multimodal problems. To address these issues, we present a modified particle swarm optimization with chaos-based initialization and robust update mechanisms. On the one side, the Logistic map is utilized to generate uniformly distributed particles to improve the quality of the initial population. On the other side, the sigmoid-like inertia weight is formulated to make the PSO adaptively adopt the inertia weight between linearly decreasing and nonlinearly decreasing strategies in order to achieve better tradeoff between the exploration and exploitation. During this process, a maximal focus distance is formulated to measure the particle's aggregation degree. At the same time, the wavelet mutation is applied for the particles whose fitness value is less than that of the average so as to enhance the swarm diversity. In addition, an auxiliary velocity-position update mechanism is exclusively applied to the global best particle that can effectively guarantee the convergence of MPSO. Extensive experiments on CEC'13/15 test suites and in the task of standard image segmentation validate the effectiveness and efficiency of the MPSO algorithm proposed in this paper.

Keywords: particle swarm optimization, maximal focus distance, inertial weight, premature convergence, local optima, Logistic map, wavelet mutation

1 Introduction

Inspired by social behavior observed in nature, such as schools of fish, flocks of birds, swarms of bees, and even human social behavior, particle swarm optimization was first introduced in 1995 for the task of optimization of continuous nonlinear functions [31]. PSO is similar to other population based evolutionary algorithms (EAs) [78] in that it is initialized with a population of random solutions (here refers to the positions of each particle), such as genetic algorithm (GA) [29], ant colony optimization (ACO) [21], firefly algorithm (FA) [79,82,84,86] and cuckoo search (CS) [16,97], etc. It is unlike most of other population based evolutionary algorithms, however, in that PSO is motivated by the simulation of social behavior instead of survival of the fittest, and each candidate solution is associated with a velocity rather than the evolutionary

* Corresponding author: Dongping Tian. E-mail address: tdp211@163.com, tiandp@ics.ict.ac.cn.