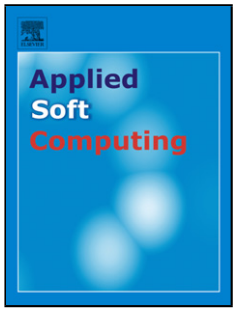

Title: A Novel Particle Swarm Optimization Based on Prey–Predator Relationship

Authors: Haoran Zhang, Meng Yuan, Yongtu Liang, Qi Liao

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A Novel Particle Swarm Optimization Based on Prey–Predator Relationship

Haoran Zhang, Meng Yuan, Yongtu Liang*, Qi Liao

National Engineering Laboratory for Pipeline Safety/Beijing Key Laboratory of Urban oil and Gas Distribution Technology, China University of Petroleum-Beijing, Fuxue Road No.18, Changping District, Beijing, P.R.CHINA 102249

*Corresponding author: Tel.:+86 10 89733990 (O/FAX); E-mail address:liangyt21st@163.com

Highlights

- We propose a novel bio-inspired improved PSO (PP-PSO) based on prey–predator relationship.
- PP-PSO employs three strategies of catch, escape and breeding.
- We conduct comparison experiment for 10 basic benchmark functions and 30 advanced benchmark functions derived from CEC 2017.
- PP-PSO achieves better performance with respect to other ten PSO variants.

Abstract

Particle swarm optimization (PSO) is a widely used nature-inspired optimization algorithm based on population and has strong robustness and good global astringency. In the mid–late iterations in the latest PSOs, there are plenty of dense gathering "slothful particles" with low velocities, which not only contribute little to the optimization but also impact the computation speed. Inspired by the prey–predator relationship in nature, we propose a novel prey–predator PSO (PP-PSO) that employs the three strategies of catch, escape, and breeding. In PP-PSO, slothful particles can be deleted or transformed, and while the former helps to speed up convergence and computation speed, the latter improves optimization results. In addition, a proportional-integral (PI) control is introduced for population control, where the population fluctuates but within a relative stability over iteration, thus enhancing population diversity. The experimental study on 10 basic benchmark functions and 30 advanced benchmark functions from CEC 2017 with different dimensions shows that our PP-PSO has a superior performance in comparison with ten other peer algorithms. In this study, a novel relationship between species behavior and swarm intelligence algorithm is found and the mechanism of particle motion in the convergence process of PSO is further revealed.

Keywords: Particle swarm optimization; Slothful particles; Prey–predator relationship; Optimization method

1. Introduction

As one of the population-based intelligent optimization algorithms, particle swarm optimization (PSO), attributed to Kennedy and Eberhart in 1995[1], has gained great popularity and improvements owing to the characteristics of strong robustness, high searching efficiency and avoiding immature convergence[2-5]. PSO is originally intended for simulating social behaviour, as a representation of the foraging behavior in a bird flock or fish school [6, 7]. While each member of the population is named as particle representing a potential feasible solution, the location of the food represents the global optimal solution[8]. Despite the success of PSO in a variety of applications, traditional version still has room for improvements, and several researchers have focused on it [9-11]. In recent years, most studies can be distributed into three classes as follows.