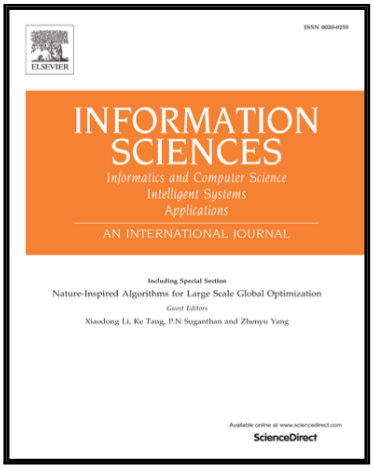

Cellular Artificial Bee Colony Algorithm with Gaussian Distribution

Ming Zhang, Na Tian, Vasile Palade, Zhicheng Ji, Yan Wang

PII: S0020-0255(18)30472-9
DOI: 10.1016/j.ins.2018.06.032
Reference: INS 13725

To appear in: *Information Sciences*

Received date: 9 May 2017
Revised date: 9 June 2018
Accepted date: 12 June 2018

Please cite this article as: Ming Zhang, Na Tian, Vasile Palade, Zhicheng Ji, Yan Wang, Cellular Artificial Bee Colony Algorithm with Gaussian Distribution, *Information Sciences* (2018), doi: 10.1016/j.ins.2018.06.032

Cellular Artificial Bee Colony Algorithm with Gaussian Distribution

Ming Zhang[a], Na Tian[b], Vasile Palade[c,*], Zhicheng Ji[a], Yan Wang[a,**]

[a]*Engineering Research Center of Internet of Things Technology Applications Ministry of Education, Jiangnan University, Wuxi City, 214122, PR China*
[b]*School of Humanities, Jiangnan University, Wuxi City, 214122, China*
[c]*School of Computing, Electronics and Mathematics, Coventry University, Coventry, CV1 5FB, UK*

Abstract

The Artificial bee colony (ABC) algorithm has shown competitive performance for handling various optimization problems. However, despite its strong global search ability, it suffers from a poor convergence rate and it loses the balance between exploitation and exploration. To compensate for this weakness, our paper proposes a cellular structured neighborhood, with Gaussian-based search equation and local attractor, and a redefined probability calculation for the ABC algorithm after an empirical analysis. The proposed algorithm is named as CGABC-Cellular neighborhood with Gaussian distribution ABC. The cellular automata (CA) model can keep individuals interact with specific neighbors while maintaining the population diversity. The Gaussian-based search equation combined with the local attractor can help exploit locally the search space, and the modified probability calculation based on rank sorting can make the selection of onlooker bees more robust and appropriate. Theoretical analysis are made to prove the global convergence of the CGABC algorithm based on the theory of probability metric spaces, and the results show that CGABC will converge to the global optimum. The proposed algorithm is tested on a set of benchmark functions and three real-world problems (the "Lennard Jones potential problem", the "frequency-modulated sound wave synthesis problem" and the "feature selection problem"), and the results demonstrate that our proposed strategies help ABC achieve higher accuracy and faster convergence when compared with other ABC variants and swarm-based evolutionary algorithms (EAs).

Keywords: Artificial bee colony, Cellular automata, Gaussian distribution, Probability calculation

1. Introduction

Evolutionary Algorithms (EAs) [13], as an important branch of derivative-free techniques, have been demonstrated to be efficient tools for solving difficult optimization problems characterized as multi-modal, non-differentiable, non-convex, nonlinear as well as other challenging problems. As a class of stochastic optimization and adaptive techniques, EAs draw inspirations from natural evolution and the collective behavior of social insect colonies or animal groups in nature. They provide a framework that mainly includes Genetic Algorithms (GA) [6], Differential Evolution (DE) [43] algorithm, Particle Swarm Optimization (PSO) [27], etc.

Artificial bee colony (ABC) algorithm was initially proposed by Karaboga [23] in 2005, inspired from the intelligent foraging behavior of honeybees. In this algorithm, there are three kinds of bees to perform different tasks. Employed bees take the responsibility for searching food sources in a given multidimensional continuous search space and propagating food information to onlooker bees. After receiving the information,

*corresponding author
**corresponding author
Email addresses: zmjiangnan@126.com (Ming Zhang), tianna@jiangnan.edu.cn (Na Tian), vasile.palade@coventry.ac.uk (Vasile Palade), zcji@jiangnan.edu.cn (Zhicheng Ji), wangyan@jiangnan.edu.cn (Yan Wang)