Dynamic Swarm Artificial Bee Colony Algorithm

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ABSTRACT

Artificial Bee Colony (ABC) optimization algorithm is relatively a simple and recent population based probabilistic approach for global optimization. ABC has been outperformed over some Nature Inspired Algorithms (NIAs) when tested over test problems as well as real world optimization problems. This paper presents an attempt to modify ABC to make it less susceptible to stick at local optima and computationally efficient. In the case of local convergence, addition of some external potential solutions may help the swarm to get out of the local valley and if the algorithm is taking too much time to converge then deletion of some swarm members may help to speed up the convergence. Therefore, in this paper a dynamic swarm size strategy in ABC is proposed. The proposed strategy is named as Dynamic Swarm Artificial Bee Colony algorithm (DSABC). To show the performance of DSABC, it is tested over 16 global optimization problems of different complexities and a popular real world optimization problem namely Lennard-Jones potential energy minimization problem. The simulation results show that the proposed strategies outperformed than the basic ABC and three recent variants of ABC, namely, the Gbest-Guided ABC, Best-So-Far ABC and Modified ABC.

Keywords: Artificial Bee Colony (ABC), Dynamic Swarm, Self Adaptive Swarm, Swarm Intelligence, Variable Swarm

1. INTRODUCTION

Swarm Intelligence has become an emerging and interesting area in the field of nature inspired techniques that is used to solve optimization problems during the past decade. It is based on the collective behaviour of social creatures. Swarm based optimization algorithms find solution by collaborative trial and error process. Social creatures use their ability of social learning to solve complex tasks. Peer to peer learning behaviour of social colonies is the main driving force behind the development of many efficient swarm based optimization algorithms. Researchers have analyzed such behaviors and designed algorithms that can be used to solve nonlinear, non convex or combinatorial optimization problems. Previous research (Dorigo...
& Di Caro, 1999; Kennedy & Eberhart, 1995; Price, Storn, & Lampinen, 2005) have shown that algorithms based on swarm intelligence have great potential to find solutions of real world optimization problems. Artificial bee colony (ABC) optimization algorithm introduced by Karaboga (2005) is a recent addition in this category. This algorithm is inspired by the behaviour of honey bees when seeking a quality food source. Like any other population based optimization algorithm, ABC consists of a population of potential solutions. The potential solutions are food sources of honey bees. The fitness is determined in terms of the quality (nectar amount) of the food source. It is relatively a simple, fast and population based stochastic search technique in the field of nature inspired algorithms.

Since its inception, the ABC algorithm has become very popular because of its robustness and ease to apply. Many researchers have successfully applied it on the problems from different application areas. The ABC algorithm was first applied to numerical optimization problems (Karaboga, 2005). The ABC algorithm was extended for constrained optimization problems in Karaboga and Basturk (2007) and was applied to train neural networks (Karaboga, Akay, & Ozturk, 2007), to medical pattern classification and clustering problems (Akay, Karaboga, & Ozturk, 2008). Recently, Hsu, Chen, Huang, and Huang (2012) used ABC and proposed a personalized auxiliary material recommendation system on Facebook to recommend appropriate auxiliary materials for a learner according to learning style, interests, and difficulty. The object of the proposed method was to search for suitable learning materials effectively. Xing, Fenglei, and Haijun (2007) also studied the control mechanism of local optimal solution in order to improve the global search ability of the ABC algorithm and apply it to solve TSP problems. Singh (2009) used the Artificial Bee Colony algorithm for the leaf-constrained minimum spanning tree (LCMST) problem called ABC-LCMST and compared the approach against GA, ACO and tabu search (TS) (Singh, 2009). Rao, Narasimham, and Ramalingaraju (2008) applied the ABC algorithm to network reconfiguration problem in a radial distribution system in order to minimize the real power loss, improve voltage profile and balance feeder load subject to the radial network structure in which all loads must be energized. The results obtained by the ABC algorithm were better than the other methods compared in the study, in terms of quality of the solution and computation as efficiency. Karaboga (2009) used the ABC algorithm in the signal processing area for designing digital IIR filters. Pawar, Rao, and Shankar (2008) applied the ABC algorithm to some problems in mechanical engineering including multi-objective optimization of electrochemical machining process parameters, optimization of process parameters of the abrasive flow machining process and the milling process. Recently, machine intelligence and cybernetics are most well-liked field in which ABC algorithm has become a popular strategy. Bansal et al. solved the model order reduction optimization problem of single input single output systems (Bansal, Sharma, & Arya, 2012).

It has been shown that the ABC may occasionally stop proceeding towards the global optimum even though the population has not converged to a local optimum (Karaboga & Akay, 2009). In order to overcome this problem and to speed up the convergence of ABC, a dynamic swarm artificial bee colony (DSABC) is proposed. In the proposed strategy, a dynamic swarm mechanism is integrated with the ABC. The proposed mechanism is influenced by the variable swarm strategy applied in Differential Evolution algorithm (DEVP). In the proposed strategy, the swarm size is adaptively changing through iterations based on the fitness of best-fit solution. The proposed strategy is tested over 16 well known benchmark test functions and one real world engineering optimization problem named Lennard-Jones potential energy minimization problem. To show the perfor-
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