Tournament Selection Based Artificial Bee Colony Algorithm with Elitist Strategy*

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Abstract. Artificial bee colony (ABC) algorithm is a novel heuristic algorithm inspired from the intelligent behavior of honey bee swarm. ABC algorithm has a good performance on solving optimization problems of multivariable functions and has been applied in many fields. However, traditional ABC algorithm chooses solutions on the onlooker stage with roulette wheel selection (RWS) strategy which has several disadvantages. Firstly, RWS is suitable for maximization optimization problem. The fitness value has to be converted when solving minimization optimization problem. This makes RWS difficult to be generally used in real-world applications. Secondly, RWS has no any parameter that can control the selection pressure. Therefore, RWS is not easy to adapt to various optimization problems. This paper proposes a tournament selection based ABC (TSABC) algorithm to avoid these disadvantages of RWS based ABC. Moreover, this paper proposes an elitist strategy that can be applied to traditional ABC, TSABC, and any other ABC variants, so as to avoid the phenomenon that ABC algorithm may abandon the globally best solution in the scout stage. We compare the performance of traditional ABC and TSABC on a set of benchmark functions. The experiment results show that TSABC is more flexible and can be efficiently adapted to solve various optimization problems by controlling the selection pressure.

Keywords: Artificial bee colony (ABC) algorithm, roulette wheel selection, tournament selection, selection strategy, elitist strategy.

1 Introduction

With the development of optimization techniques, many heuristic algorithms play important roles in solving numeric and combinatorial optimization problems [1]-[3].

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Artificial Bee Colony (ABC) Algorithm is a novel swarm intelligence based algorithm introduced by Karaboga and Basturk to solve the optimization problem of multivariable functions [4]. Compared with Genetic Algorithm (GA) [5], Particle Swarm Optimization (PSO) [6] or some other population based algorithms, ABC algorithm has the faster convergence speed and the better ability to get out of a local optimal solution [4]. As a consequence, ABC algorithm attracts extensive attention and obtains rapid development in various fields.

Although ABC algorithm has good performances on optimization, there are still some insufficiencies in the selection strategy. In the onlooker bee stage of traditional ABC algorithm, an onlooker randomly chooses a food source with the probability value calculated from roulette wheel selection (RWS) strategy. However, compared with other selection strategies, RWS has two key disadvantages. Firstly, although RWS is a well-known random selection strategy according to the proportion of different components of a system, it is inconvenient when solving minimization problems because the fitness values have to be converted to make the smaller value has more probability to be chosen. Secondly, RWS has no adjustable parameters to adapt its selection pressure to different optimization problems. In order to improve the optimization ability of ABC algorithm, these two disadvantages should be avoided. In this paper, we propose to adopt tournament selection (TS) strategy in ABC to avoid the above two disadvantages. In the literatures, TS has been used in some optimization algorithms, such as Genetic Algorithm (GA), that shows good performance in population selection [7]. TS strategy can be applied easily in both minimization and maximization problems because it compares the fitness values to select better solutions. Moreover, TS strategy has a parameter λ (the proportion of solutions to be chosen) that can adjust selection pressure for various optimization problems. Therefore, the proposed TS based ABC (TSABC) algorithm can extend the generality of ABC algorithm. Another contribution of this paper is to design the elitist strategy to the standard ABC framework. Although ABC has been widely studied, it is strange that no literatures specifically claim that the ABC algorithm should not abandon the historically best solution that has found so far. On scout stage of ABC, the food source (solution) that cannot be improved for a certain generations will be abandoned. However, if the solution is the globally best one of the population, such abandon can make the ABC algorithm deteriorated. In order to avoid such bad influence on optimization, we propose the elitist strategy to ABC. This strategy uses an extensive archive to keep the historically best solution during the running. This solution is not in the ABC population, but is updated in every generation if the globally best solution of the population is better than this solution. Therefore, even though the scout stage may abandon the globally best solution of the population (e.g., it has not improved for a long time), the historically best solution won't be abandoned. This is only a slight change to the ABC framework. It not only has no negative influences on the performance, but also can be applied to any ABC variants, which can be considered as a standard component in the ABC algorithmic framework.

This paper aims to improve ABC algorithm with TS strategy and compare its performance with that with RWS. Also, the optimization ability of TSABC algorithm is analyzed under the change of control parameter values. The rest of the paper is structured as follows. Section 2 introduces ABC algorithm and its current development. The TSABC algorithm and the experimental results are presented in Section 3 and Section 4, respectively. Finally, conclusions are given in Section 5.