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Bollinger bands approach on boosting ABC algorithm and its variants

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ABSTRACT

In this study, a new algorithm that will improve the performance and the solution quality of the ABC (artificial bee colony) algorithm, a swarm intelligence based optimization algorithm is proposed. ABC updates one parameter of the individuals before the fitness evaluation. Bollinger bands is a powerful statistical indicator which is used to predict future stock price trends. By the proposed method an additional update equation for all ABC-based optimization algorithms is developed to speed up the convergence utilizing the statistical power of the Bollinger bands. The proposed algorithm was tested against classical ABC algorithm and recent ABC variants. The results of the proposed method show better performance in comparison with ABC-based algorithm with one parameter update in convergence speed and solution quality.

1. Introduction

Bollinger band (BB) is a technical analysis tool which is invented to predict the future stock prices. BB is used to predict maximum and minimum future prices referring from the past prices. BB indicator consists of three lines: an upper band, a lower band, and middle band which represents the moving average of the past prices. If the stock price catches up on the upper band, then the stock is considered as overbought; if price catches up on the lower band, then it is considered as oversold. In this study, working principles of the BB is applied to improve employed bee performance of the ABC algorithm and its variants by adding a second parameter update rule to ABC based algorithms based on BB. In this work, best fitness valued employed bees are used as data series to calculate the BB.

In nature, most of the animals live in a group which requires collaboration across group members. Each individual exhibits an intelligent behavior according to the role assigned to it inside the group. This kind of social behavior ensures the animal groups to get more food or have a better defense with less energy consumption. Swarm Intelligence is an Artificial Intelligence technique inspired by the social behaviors of insect or animal groups.

Optimization is selecting the best parameters among the all available to maximize or minimize a function. For example, the traveling salesman problem, irregular object allocation problem, vehicle routing problem are some of the best known engineering optimization problems. These problems may have very large search space according to parameter counts, and brute force approaches may take years to find the optimum parameters. So, people looked at the nature to see how nature solves its own optimization problems. One naturally inspired optimization method is genetic algorithms [1]. Genetic algorithm is inspired by natural selection and the theory of evaluation. Another naturally inspired optimization is artificial immune systems by Castro and Zuben [2]. In years following the discovery of genetic algorithms, researchers discovered another method of nature in optimization which is called swarm intelligence. One of the popular swarm intelligence based algorithms is particle swarm optimization algorithm by Elbart and Kennedy [3]. The algorithm is inspired by social behavior of birds flocking, and it is a population based stochastic optimization algorithm that is similar to the other swarm intelligence based algorithms. Ant colony algorithm developed by Dorigo et al. [4] which is a popular intelligence based optimization algorithm simulates the food carrying mechanism in the ant colonies.

Bees are also good example for swarms. Bee system by Lucic and Teodorovic [5], The Bees Algorithm by Pham et al. [6] and the recent method developed by Diwold et al. [7] are the examples for bee inspired optimization algorithms. This study focused on Artificial Bee Colony (ABC) algorithm which is inspired by the foraging behavior of bees. In the algorithm, global search process is realized by three types of the bees. First one is employed bees. Each employee bee represents a possible solution or food source. The second kind of the bees is onlooker bees. The task of that type of bees is to search better solutions around the current solutions. Better food sources or solutions attract more onlooker bees, so they are searching condenses around the better solutions. The last type of bees is scout bees. The task of the scout bees is to find untouched food sources. They search the search space randomly to find a bet-

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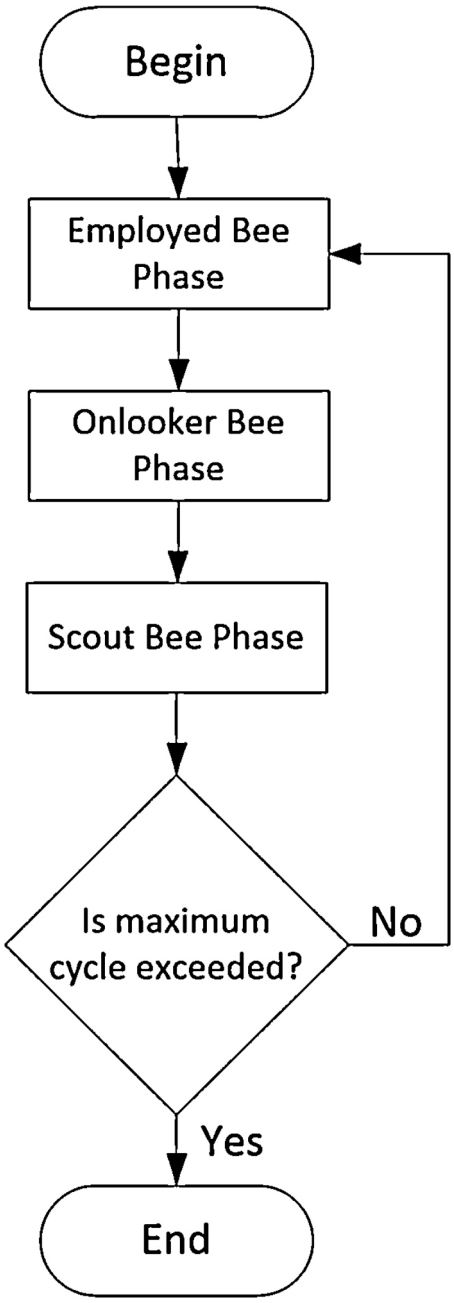

Fig. 1. The ABC algorithm.

ter solution. In this study, the employed bees of ABC algorithm have been investigated to get better solutions with the same fitness evaluation count.

Employed bees and onlooker bees use the same position update procedure. The biggest issue about the update procedure is that it causes slow convergence speed. That because in each phase, one parameter of the solution is updated and then the new solutions are evaluated. In this study, a second parameter update rule is added to employed bee phase to improve the searching ability of the ABC algorithm. The proposed method is applied to the original ABC and four different variants. First of them is G-best guided ABC algorithm (GABC) [8]. This algorithm adds the global best solution information to search equation to let the algorithm search better in the solution space. The second and third algorithms are ABC/Best/1 and ABC/Best/2 algorithms proposed by Gao et al. [9]. These algorithms use the update rule of differential evaluation algorithm and guide the agents to search around the best solution that found in the previous iteration. The last compared algorithm is ABC with variable search strategy (ABCVSS) [10]. The method proposes the integration of multiple solution update rules with ABC to solve optimization problems having different characteristics.

ABC is one of the swarm intelligence based optimization techniques. Its performance is better than most of the swarm based methods. The main problem of the algorithm is its slow convergence speed because it updates only one parameter before every fitness evaluation process. There are many modified versions of the ABC algorithm and similarly all of them apply one update rule before fitness evaluation. In this work an additional update equation has been proposed to speed up the convergence rate and improve the solution quality that uses Bollinger bands indicator (BB) [11] which is originally used to predict the future stock prices.

2. Related works

ABC algorithm was first introduced by Karaboğa in 2005 [12]. The algorithm was first used to solve numerical benchmark functions [13,14]. After ABC appeared in optimization field, some methods which modify ABC have also appeared. One of these studies, named GABC, was developed by Zhu and Kwnong [8]. They changed the neighborhood equation of the algorithm by adding the global best solution. Banharnsakun et al. [15] modified ABC by considering the best-so-far solution of the onlooker bees. Gao and Lui [16] also modified the ABC algorithm and they excluded the probabilistic selection and scout bee from the algorithm. They named the method modified ABC (MABC) and tested against two different ABC based methods on a set of 28 benchmark functions. In [17] authors proposed an improved ABC algorithm based on rank selection and utilized the best-so-far solution. Genetic operators are also used to produce new candidate solutions in ABC [18]. Another improved ABC algorithm combines personal best solution with global best solution [19]. To improve convergence characteristics of ABC, Kıran and Fındık proposed a directed ABC algorithm [20]. Kıran and Fındık also proposed a new method to improve search capabilities of ABC and PSO [21]. Babaoğlu [22] proposed a distribution based update rule to overcome stagnation behavior of the ABC algorithm.

Beyond the numerical benchmark functions, ABC algorithm is also used to solve binary optimization problems [23,24] and discrete optimization problems [25], some complex real problems like automatic voltage regulator [26], vehicle routing problem [27], allocation problem [28], design of filter bank transmultiplexer [29], synthetic radar aperture radar images segmentation [30] and parametric optimization of non-traditional machining process [31]. ABC is used to design digital infinite impulse to solve leaf-constrained minimum spanning tree problem [32] and response filters [33] design. Another application of the ABC is data collection path planning in sparse wireless sensor networks [34].

Thakkar and Kotecha [35] proposed that a Bollinger Bands based proposed a new decentralized cluster head election method for designing of scalable routing protocol with prolonged network lifetime for a wireless sensor network. Ngan and Pang [36] developed a BB based method to detect of defection on patterned fabric and tested the method on both three different patterned fabrics which defect free and defected. They obtained 98.59% accuracy. In [37] Torrisi deal with deadband sampling algorithm for unbounded variables and investigates how cab BB can be used on calculating.

3. The ABC algorithm

Like other swarm based algorithms, ABC algorithm is also an iterative algorithm. Every potential solution is represented by employed bees with D parameters. In each iteration, employed bees