# Artificial Bee Colony Algorithm with High Robustness for Time-Variable Solutions


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Recently, optimization problems have drawn attention. Optimization is to search for an optimal solution under condition. The advantage of optimization is to design or plan high efficiently. These problems are very difficult to solve because many problems have nonlinearity and are solved much time generally. Thus, optimization problem is often solved by efficient optimization algorithms.

Metaheuristic optimization algorithms are provided good-quality solutions which are close to the optimal solution with less computational effort in these problems. These algorithms are developed to solve more efficiency and larger problems. Metaheuristic optimization algorithms have characteristics that are easy to improve in order to solve many problems. Metaheuristic optimization algorithms have Evolutionary Algorithm (EA), Swarm Intelligence (SI) algorithm, local search, etc.

SI is one of the artificial intelligence techniques. SI aims to design algorithms with inspiration in the collective and intelligent behavior of insects and other animals. SI algorithms have Ant Colony Optimization (ACO), Particle Swarm Optimization (PSO), Artificial Bee Colony (ABC) algorithm, etc [1]. Karaboga has proposed an Artificial Bee Colony (ABC) algorithm in 2005. The ABC algorithm is based on real bee behavior and consist of 3 kinds of honeybee, employed bee, onlooker bee and scout bee. It is suitable when the object function is high dimension [2]. The procedure for solving an optimization problem in the ABC algorithm is shown below.

**Step 0.** Initialize each total number of employed bees $n_e$ and onlooker bee $n_o$, the colony size $N = n_e + n_o$ and the total number of iterations $t_{max}$.

**Step 1.** (1) Set the locations of the $x_i$. $i$ is the number of the employed bee.
(2) Calculate the fitness $f_i$ in the initial arrangement by Eq. (1). The best $f_i$ and initial arrangement are stored.

**Step 2.** (1) New locations $v_i$ is generated by Eq. (2) and calculated the fitness function value.
(2) Based on the fitness, the best location and fitness update.

**Step 3.** (1) Based on the fitness, the probability $p_i$ is calculated by Eq. (3).
(2) Select the number of employed bee $i$ based on $p_i$, and Step1 is applied. This procedure has been repeated $n_o$ times.

**Step 4.** If function value of each $i$ is better than function value of all bees, the solution and the function best value are updated.

**Step 5.** The employed bee which has not been generate the new location.

**Step 6.** Repeat steps 1 to 4 and output the solution.

Fitness function $f_i$, new location $v_i$ and evaluations value $a$ are given by following equations:

$$f_i = \begin{cases} \dfrac{1}{1+g(x_i)} & if\ g(x_i) \geq 0 \\ 1+|g(x_i)| & otherwise \end{cases} \tag{1}$$

$$v_{id}(t+1) = x_{id}(t) + \phi_{id}(x_{id}(t) - x_{kd}(t)) \tag{2}$$

$$p_i = f_i / \sum_{i=1}^{n_e} f_n\ , \tag{3}$$

where, $g(x_i)$ expresses the objective function.

The most of algorithms exclude time-varying solution. However, when we implement SI algorithm in the system, we need to apply the both solutions (time-varying and not time-varying) for high robustness of the system. It is important to search optimal solution under various conditions. Thus, Nishida improves the artificial bee colony for time-varying solution (ABCTV) [3]. The ABCTV can not search locally. We propose the ABCTV modified employed bee. We calculate optimal solution by the predictive value. The predictive value is calculated by difference between best solutions by assumeing that the optimal solution is constant motion. Therefore, $v$ is calculated by Eq. (4).

$$\begin{aligned} v_{id}(t+1) = x_{id}(t) + \phi_{id}(x_{id}(t) - x_{kd}(t)) \\ +\psi_{id}(x_{predict}(t) - x_{kd}(t)). \end{aligned} \tag{4}$$

According to this modification, we expect that the propose method obtains better performance. We compare the optimal solution with ABC, the previous method and the propose method.

# References


[1] X. S. Yang, "Nature-Inspired Metaheuristic Algorithms Second Edition," Luniver Press, 2010.

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[3] Takeshi Nishida, "Modification of ABC Algorithm for Adaptation to Time-Varying Functions," IEEJ Transactions on Electronics, Information and Systems, pp.584-591, 2011.