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High Performance Artificial Bee Colony Algorithm for Time-Varying Solutions

Ken KAMIYOTSUMOTO†, Thomas OTT‡, Yoko UWATE† and Yoshifumi NISHIO†
(Tokushima University†, Zurich University of Applied Sciences‡)

1. Introduction

Recently, nature-inspired metaheuristic optimization algorithms such as Artificial Bee Colony (ABC) algorithm is developed. ABC is based on a particular intelligent foraging behavior of honeybee.

In this study, we propose ABC applied time-varying solution. We compare the optimal solution with ABC and the proposed method.

2. Artificial Bee Colony algorithm

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. The procedure for solving an optimization problem in the ABC algorithm is shown below.

Step0. 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}.

Step1. (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.

Step2. (1) New locations v_i is generated and calculated the fitness function value.
(2) Based on the fitness, the best location and fitness update.

step3. (1) Based on the fitness, the probability p_i is calculated by Eq. (2).
(2) Select the number of employed bee i based on p_i, and Step1 is applied. When this procedure has been repeated n_o times.

step4. If function value of each i is better than function value of all bees, the solution and the function best value are updated.

step5. The employed bee which has not been generate the new location.

Step6. Repeat steps 1 to 4 and output the solution.

Fitness function f_i and evaluations value a are given by following equations:

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

$$p_i = f_i / \sum_{i=1}^{n_e} f_n , \quad (2)$$

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

3. Propose method

The most of algorithms exclude time-varying solution. However, when we search optimal solution, we need to apply the both solutions (time-varying and not time-varying). We improve the artificial bee colony for time-varying solution (ABCTV) [1]. The ABCTV can not search locally. We propose the ABCTV modified fitness function(ABCTVD). We calculate p_i for the difference between evaluate value of present location and previous location. Therefore p_i is calculated Eq. (3).

$$p_i = (f_{i+1} - f_i) / \sum_{i=1}^{n_e} (f_{n+1} - f_n) \quad (3)$$

According to this modification, we expect that ABCTVD obtains better performance.

4. Simulation result

We compare the result of Eq. (4).

$$g(x_1, x_2, t) = 1 - exp[-\frac{(x_1 - 250 - 125sin\alpha k)^2}{2 \cdot 40^2} - \frac{(x_2 - 250 + 125sin\alpha k)^2}{2 \cdot 40^2}]. \quad (4)$$

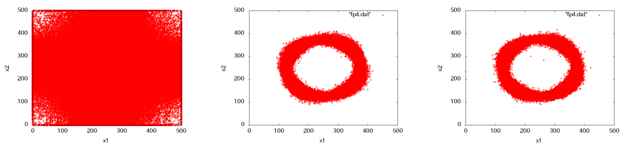
Equation (4) simulates a visual tracking problem. The optimal function value is 0, and position along a circle of radius 125 centered at $(x_1, x_2) = (250, 250)$, then return its original position in $(2\pi/\alpha)$ steps. We express the constant value to use for simulation in Eq. (5).

$$n_e = n_o = 100,\ t_{max} = 500000, \quad (5)$$

We compare the best value for 3 kinds α. Table 1 shows that the best value of each method.

Table 1: Simulation results

α	0.01	0.05	0.1
ABC	2.76e-05	6.59e-06	1.23e-06
ABCTV	5.12e-04	1.58e-02	7.96e-03
ABCTVD	3.58e-05	1.55e-03	9.73e-03



(a) ABC. (b) ABCTV. (c) ABCTVD.

Figure 1: shape of solutions when α is 0.01.

From Table 1, the best value of TBCTVD is better than the best value of ABCTV. Furthermore, Fig. 1 expresses that ABCTVD can search time-varying solution.

5. Conclusion

This study introduced the ABC modified fitness function. We tried improvement of ABC, where fitness function modified the difference of 2 locations. We compared the best values of ABCTVD ABCTV and ABC. As a result, ABCTVD performed better than other algorithms.

Reference

[1] Takeshi Nishida, “ Modification of ABC Algorithm for Adaptation to Time-Varying Functions,” Electronics and Communications in Japan, 2012.