Artificial Bee Colony Algorithm based on Adaptive Local Information Sharing: Approach for several dynamic changes

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ABSTRACT

This paper focuses on Artificial Bee Colony (ABC) algorithm in dynamic optimization problems (DOPs), and proposes the improvements for ABC algorithm in DOPs as ABC algorithm based on adaptive local information sharing (ABC-alis). To investigate the tracking ability to dynamic change of ABC-alis, it is compared the improved algorithm to two cases of dynamic change. These two cases are "Case 1: Periodic Change" and "Case 2: Continuing Change". The experimental results revealed that the following implications: (1) ABC-alis can adapt with various dynamic changes; (2) ABC-alis has high tracking performance against continuous change.

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1 INTRODUCTION

An artificial bee colony (ABC) algorithm [1] has a good search ability in static optimization problems. However, it is difficult to apply ABC algorithm to the dynamic optimization problems (DOPs). There is the modification of the ABC algorithm for adaptation to DOPs by Nishida [2]. However, when the number of local optima increases in multimodal functions, there is the problem that it cannot track the transition of dynamic change and the search performance decreases [3]. In this way, although the ABC algorithm has high solution search performance, the development for dynamic changes is a little progress yet.

2 ABC ALGORITHM BASED ON ADAPTIVE LOCAL INFORMATION SHARING

In order to solve this problem, the authors propose Artificial Bee Colony Algorithm based on Adaptive Local Information Sharing (ABC-alis) which added the improvement of the following two points: (1) Information sharing of each individual is locally limited to the local range d_i to keep searching globally and capture local optima; (2) the local range d_i is adaptively changed according to gather of individuals to cope with various dynamic changes. The local range d_i are individually changed by the binary tree shown in Fig. 1. For this binary tree, the state "Clouding bees" is newly set based on the positional relationship between individuals. This indicates that one or more other individuals are gathering in the range of the radius cd_{I} which is set as a value much smaller than the shared range d_i.

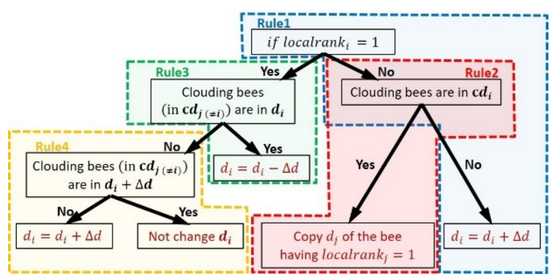

Figure 1: Binary tree of adaptation mechanism

3 EXPERIMENT

In order to verify comprehensively the tracking ability in dynamic change, ABC-alis is applied to several optimization problems with various types of dynamic changes. And also, it is compared with SPSO which is another swarm-based algorithm for dynamic change [4]. As the specific DOPs, it is employed as experiments on two cases using "moving peaks" problem of generalized dynamic benchmark generator (GDBG) [5]. In GDBD, six change types are prepared, which consist on small step change (T1), large

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[1]It is a datatype.

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Table 1: The comprehensive result of Case 1

		T1	T2	T3	T4	T5	T6
ABC-alis	Mean	4.96	5.51	3.95	0.40	2.37	1.95
	Std	8.09	8.89	6.75	1.57	4.53	3.25
SPSO	Mean	4.87	8.31	4.44	2.29	2.38	3.59
	Std	8.67	10.7	7.58	3.76	3.62	6.13

Table 2: The comprehensive result of Case 2

		T1	T2	T3	T4	T5	T6
ABC-alis	Mean	8.81	11.35	6.34	5.43	2.68	3.74
	Std	11.08	11.92	9.19	5.89	5.79	6.96
SPSO	Mean	12.19	16.62	7.83	9.34	11.04	11.23
	Std	12.78	14.09	8.20	10.09	11.73	12.49

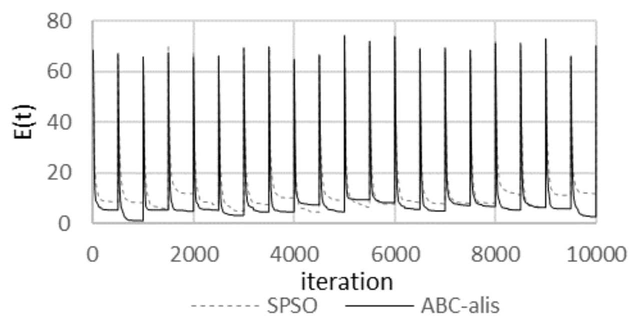

Figure 2: The result of change type T2 in Case 1

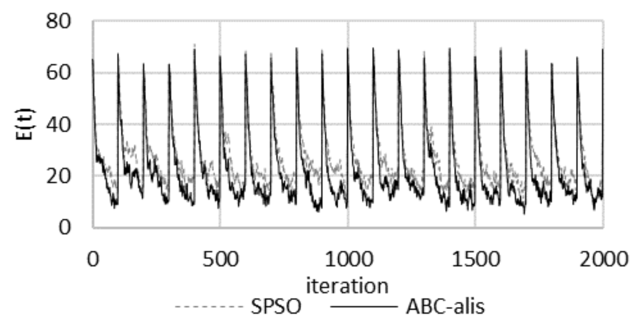

Figure 3: The result of change type T2 in Case 2

step change (T2), random change (T3), chaotic change (T4), recurrent change (T5), and recurrent change with noisy (T6), respectively. Two cases are "Case 1: Periodic Change" and "Case 2: Continuing Change". "Case 1: Periodic Change" is the problem in which the frequency of occurrence of dynamic change is small but the magnitude of change is large, "Case 2: Continuing Change" is the problem in which the dynamic change is always continued but the magnitude of change is small. In the two cases, it is evaluated the search performance of the algorithm using equation (1).

$$E(t) = \left| f\left(x_{best}(t)\right) - f(x^*(t)) \right| \quad (1)$$

Where $x_{best}(t)$ is the optimum solution, and $x^*(t)$ is the true maximum solution. In Case1, E (t) is calculated only immediately prior to the change. 20 changes are generated in one run. In Case 2, E (t) is calculated for each iteration. The maximum iteration is 2000. Repeat this for 20 runs and evaluate the search performance by the mean in each case. The parameters of ABC-alis are set as follows: $\mathrm{N_s} = 100$, $\mathrm{N_l} = 10$, and the rate of cd = 0.25. And the parameters of SPSO were N=200, p_{max} = 20, c1 = c2 = 1.4, w = 0.8. The number of individuals is twice that of ABC-alis in order to make the number of evaluations in one iteration the same.

The result of case 1 and 2 are displayed in Table 1 and 2, respectively. The mean and standard deviation of each method is displayed in each row of the table, and the result of the type of change (T1 - T6) is displayed in each column.

From the results of Case 1 and Case 2, it reveals that ABC-alis can adapt with various dynamic changes. In particular, from the graphs of Fig. 1 and 2, it is clear that ABC-alis has the remarkable difference in speed of tracking to dynamic change as compared with SPSO. The search performance of ABC-alis greatly exceeds SPSO in the problem that dynamic change done every iteration like Case 2. In this way, ABC-alis can be said to have robustness against the environment which continue to change dynamically.

4 CONCLUSIONS

ABC algorithm with improvements is called ABC Algorithm based on Adaptive Local Information Sharing (ABC-alis). In order to verify the tracking ability to various dynamic changes about ABC-alis, ABC-alis and SPSO were applied to experiments on two cases using "moving peaks" problem of GDBG.

In particular, "Case 1: Periodic Change" is the problem in which the frequency of dynamic change occurrence is small, but the magnitude of change is large. "Case 2: Continuing Change" is the problem in which the dynamic change is always continued but the magnitude of change is small. The experimental result revealed that the following implications: (1) ABC-alis can adapt with various dynamic changes; (2) ABC-alis has high tracking ability against continuous change. As future work, there are two plans that ABC-alis is compared with methods other than SPSO and verification in higher dimensional dynamic optimization problems.

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