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Competitive Particle Swarm Optimization with Secret Agent (C-PSO-SA)

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1. Introduction

Particle Swarm Optimization (PSO) is known as one of Swarm Intelligence. PSO algorithm is modeled after generic swarm. PSO is easily possible to find solutions.

In this study, we propose Competitive PSO with Secret Agent (C-PSO-SA). C-PSO-SA is added in excessive advertising to be based on PSO. We investigate behavior of C-PSO-SA by computer simulation.

2. C-PSO-SA algorithm

PSO algorithm is used two expression from Eqs. (1) and (2).

$$\vec{v}_{k+1} = \vec{a}\otimes\vec{v}_k + \vec{b}_1\otimes\vec{r}_1\otimes(\vec{p}_1-\vec{x}_k)+\vec{b}_2\otimes\vec{r}_2\otimes(\vec{p}_2-\vec{x}_k) \quad (1)$$

$$\vec{x}_{k+1} = \vec{c}\otimes\vec{x}_k + \vec{d}\otimes\vec{v}_{k+1} \quad (2)$$

$$\begin{cases} \vec{v}_k : \text{particle velocity} \\ \vec{x}_k : \text{particle position} \\ \vec{p}_1 : \text{own previous best position} \\ \vec{p}_2 : \text{globally best position in the whole swarm} \\ \vec{a}, \vec{b}_1, \vec{b}_2, \vec{c}, \vec{d} : \text{coefficient} \\ \vec{r}_1, \vec{r}_2 : \text{random numbers.} \end{cases}$$

The algorithm of the standard PSO and C-PSO-SA is described below;

Step 1 { Decide for $\vec{v}_0, \vec{x}_0, \vec{p}_1, \vec{p}_2$ }

$\vec{v}_0$ and $\vec{x}_0$ are decided random number for all particle. $\vec{p}_1$ and $\vec{p}_2$ are decided from Eq. (3).

$$\vec{p}_1 = \min\{\vec{x}_k\}, \vec{p}_2 = \min\{\vec{p}_1\} \quad (3)$$

Step 2 { Update for $\vec{v}_k, \vec{x}_k$ }

Eqs. (1) and (2) decide to update $\vec{v}_k, \vec{x}_k$.

Step 3 { Update for $\vec{p}_1, \vec{p}_2$ }

Eq. (3) decides on updating $\vec{p}_1, \vec{p}_2$.

Step 4 { Secret Agent section }

We change the value of $\vec{p}_2$. In addition, we change $\vec{p}_2$ in increment of one dimensions. Finally, two swarm provide each other $\vec{p}_2$.

Step 5 { End decision }

If $\vec{p}_2$ is smaller than the threshold value, the algorithm ends. Also, if k (loop count) measure up to the threshold value, the algorithm ends.

In this study, we decide coefficients; $a = 0.6$, $b_1 = b_2 = 1.7$ and $c = d = 1$.

3. Numerical Experiments

In order to confirm the performance of PSO and C-PSO-SA algorithm, we apply PSO and C-PSO-SA to the two function (Table 1).

Table 1: Optimization Test Functions

name	Formula
Rastrigin	$f(x) = \sum_{i=1}^{n}(x_i^2 - 10\cos(2\pi x_i) + 10)$
Griewank	$f(x) = \frac{1}{4000}\sum_{i=1}^{n} x_i^2 - \prod_{i=1}^{n}\cos(\frac{x_i}{\sqrt{i}}) + 1$

In the simulation, we apply 30 dimension to test function. The number of particle is 30, the simulation times is 100. The results are shown in Table 2. Evaluated value is defined by the Eq. (4).

$$(Evaluated\ value) = \frac{(Number\ of\ particle) \times (Average)}{(Success\ rate)} \quad (4)$$

We can not observe a change of results in Rastrigin function. However, the result of C-PSO-SA is better than PSO in Griewank function. Because, we consider to be due to mutate dimension on this study in **Step 4**.

Table 2: Result of Optimization

		PSO	C-PSO-SA
Rastrigin	Average	429.46	429.46
	Success rate	91	91
	Evaluated value	141.58	141.58
Griewank	Average	**617.34**	685.56
	Success rate	89	**100**
	Evaluated value	208.09	**205.66**

4. Conclusions

In this study, we proposed Competitive Particle Swarm Optimization with Secret Agent(C-PSO-SA). We investigated behavior of C-PSO-SA by the simulation and confirmed the efficiency. In the future work, we would like to apply a lot of functions.

Reference

[1] Trelea, I. C. "The particle swarm optimization algorithm: convergence analysis and parameter selection", Information processing letters, 85(6), pp. 317–325, 2003.