1-27

Particle Swarm Optimization with Predator

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1. Introduction

Particle Swarm Optimization (PSO) is known as one of Swarm Intelligence. PSO algorithm is used for the system of fish school. It is simple and easily possible to find solutions. However, PSO algorithm is difficult to escape from local minimum.

In this study, we propose PSO with Predator (PSO-P). PSO-P is added in relationship between small fish and predator to be based on PSO, and the feature of PSO-P is easy to escape local minimum. We investigate behavior of PSO-P by computer simulation.

2. PSO-P algorithm

PSO algorithm uses two expression from Eqs. (1), (2), because we simulation one dimensional it.

$$v_{k+1} = a \times v_k + b_1 \times r_1 \times (p_1 - x_k) + b_2 \times r_2 \times (p_2 - x_k) \quad (1)$$

$$x_{k+1} = c \times x_k + d \times v_{k+1} \quad (2)$$

In this time, expression values decide by Eqs. (1), (2):

$$\begin{cases} v_k : \text{particle velocity} \\ x_k : \text{particle position} \\ p_1 : \text{own previous best position} \\ p_2 : \text{globally best position in the whole swarm} \\ a, b_1, b_2, c, d : \text{coefficient} \\ r_1, r_2 : \text{random numbers} \end{cases}$$

The algorithm of standard PSO and PSO-P is described below;

Step 1 { Decide for v_0, x_0, p_1, p_2 }

v_0 and x_0 decide random number for all particle. p_1 and p_2 decide from Eq. (3).

$$p_1 = \min\{x_k\}, p_2 = \min\{p_1\} \quad (3)$$

Step 2 { Update for v_k, x_k }

Updating v_k, x_k, using for Eqs. (1), (2).

Step 3 { Update for p_1, p_2 }

Updating p_1, p_2, using for Eq. (3).

Step 4 { Predator section }

Predation decision do for particle around predator. If it is true, we reposition the half of particle that are preyed particle.

Step 5 { End decision }

If 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.

The loop of standard PSO is Step 2, 3, 5. The loop of PSO-P is Step 2–5.

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

3. Numerical Experiments

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

Table 1: inspection function

name	expression
Sphere	$f(x) = x^2$
Rastrigin	$f(x) = x^2 - 10\cos(2\pi x) + 10$
Griewank	$f(x) = \frac{x^2}{4000} - \cos(x) + 1$

Particle of number is 100, the simulation times is 100. The results are shown in Table 2. The unit of Table 2 is milliseconds.

Table 2: Result of Optimization

		PSO	PSO-P
Sphere	AVE	**824**	911.5
	MIN	550	**520**
	MAX	**1350**	1490
Rastrigin	AVE	**817.8**	901
	MIN	560	**540**
	MAX	**1410**	2170
Griewank	AVE	39.1	**38.5**
	MIN	30	30
	MAX	50	50

Table 2; PSO-P is more quickly PSO in minimum of Sphere function, Rastrigin function, and average of Griewank function. However, other results of PSO-P are slower or equal. Because this study used to one dimensional PSO.

4. Conclusions

In this study, we proposed PSO with Predator (PSO-P). We investigated behavior of PSO-P by the simulation and confirmed the efficiency. In the future work, we would like to apply high dimensional PSO.

Reference

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