Particle Swarm Optimization in Immune Network Mechanism

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ABSTRACT: In this paper, based on the particle swarm optimization in the environment of all the particles and their own search experience, using immune network mechanism of the clonal selection mechanism, this paper proposes a particle swarm optimization algorithm based on immune network mechanism. Based on the immune network theory system as a kind of adaptive to maintain population diversity and self-regulating, leading to the algorithm based on immune mechanism with the overall, strong local search ability, making this kind of algorithms in pattern recognition and machine learning has been effectively used.
KEYWORD: Particle Swarm; Immune; Immune PSO

1 INTRODUCTION

In simulated environment of biological groups formed a swarm intelligence immune network theory, and the immune network theory of particle swarm optimization algorithm through competition and collaboration between the particles to achieve in a complex search space to find the global optimum. It has the characteristics of easy to understand, easy to realize, strong global search ability, has been widely concerned in the field of science and engineering, and has become the fastest development of intelligent optimization algorithms. Artificial neural network based on immune neural network is a simplified brain model, genetic algorithm is the simulation of genetic evolution process, the use of network based mechanism particle swarm optimization algorithm is the origin of the simulation of a simple social system. Although the network mechanism particle swarm optimization algorithm has developed rapidly and achieved considerable results, but its theoretical basis is still relatively weak, especially in the basic algorithm of parameter settings and optimization.

2 RESEARCH ON PARTICLE SWARM OPTIMIZATION ALGORITHM BASED ON IMMUNE NETWORK MECHANISM

2.1 *Principles of the immune system*

With the immune algorithms, based on the biological immune information processing mechanism by the simulation on the principle of biological immune system, using an immune system antibody diversity and self-regulating function, to keep optimization problem solution the diversity of the population, so as to provide new ideas for solving complex problems. At the same time, the immune system is a highly parallel distributed, adaptive information processing learning system, its structure and behavior characteristics are very complex. According to the immune system inspired from biological acquired immune clonal selection principle, in the biological immune system, once the pathogens invade the body is decomposed into fragment antigen, B lymphocytes can combine to produce a corresponding antibody and antigen, while a number of B cells into the long-term survival of the memory cell, it is through the blood, lymph and tissue fluid circulation, as a fast, efficient elimination of identical or similar infections caused by antigen laid the foundation. The immune system uses high clonal variation of unisexual reproduction way to search, to avoid the crossover operation of the genetic system caused by the interference pattern, also has not stimulated the demise of the cells and memory cell generation process and ensure the diversity of antibodies.

2.2 *Particle swarm optimization algorithm based on immune network mechanism*

Based on the immune network mechanism of particle swarm optimization, the potential solution of each optimization problem is the particle in the search space. Hypothesis search in a D dimension

of the target space, a community N particle in the which the i particle said for a D dimension of the vector

$X_i = (x_{i1}, x_{i2}, \cdots, x_{iD})$, $i = 1,2,\cdots, N$;

The vector i particles flying speed is also a D dimension, denoted as

$V_i = (v_{i1}, v_{i2}, \cdots, v_{iD})$, $i = 1,2,\cdots 3$;

The i particles so far to search optimal position is called pbest, denoted as

$p_{best} = (p_{i1}, p_{i2}, \cdots, p_{iD})$, $i = 1,2,\cdots, N$;

The optimal position of the whole particle swarm up to now is the global extremum, denoted as

$g_{best} = (p_{g1}, p_{g2}, \cdots, p_{gD})$;

In finding these two optimal values, the particles are updated as follows: (1) and (2) to update their speed and position:

$$v_{id} = w * v_{id} + c_1 r_1 (p_{id} - x_{id}) + c_2 r_2 (p_{gd} - x_{id}) \quad (1)$$

$$x_{id} = x_{id} + v_{id} \quad (2)$$

The c_1 and c_2 learning factor, also known as r_1 and r_2 acceleration constant, uniform random number in the range of [0,1].The formula (1) is composed of three parts, the first part is "inertia" or "momentum", which reflects the movement of the particles "habit", which represents the trend of the particles to maintain their previous speed; The second part is "cognitive" section, which reflects the particle's memory or memory of its own historical experience, and it represents the trend of the particle to the best position of the particle; The third part is "society", which reflects the historical experience of the cooperation and knowledge sharing among the particles, and represents the trend of the best position of the particle in the history of the group or the neighborhood, According to experience, usually $c_1 = c_2 = 2$ · $i = 1,2,\cdots, D$ · v_{id} is the velocity of particles, $v_{id} \in [-v_{\max}, v_{\max}]$, $v_{\max}$ Is a constant, set by the user to limit the speed of particles. r_1 and r_2 is a random number between $[0,1]$.

2.3 *Particle swarm optimization algorithm based on immune network*

Based on immune particle swarm optimization algorithm is an important characteristic of immune antibody diversity and immune memory, etc.) and the immune mechanism (clonal selection, inhibition concentration) application in particle swarm optimization algorithm, in the premise of retain the original particle swarm optimization algorithm excellent characteristics, trying to choose, to make full use of the correlation immune theory to solve the optimization problem, so as to suppress the optimizing process of particle group stage degradation phenomenon. Therefore, according to the different immune mechanism and practical application, we can construct different immune particle swarm optimization algorithm and immune network mechanism particle swarm optimization algorithm structure diagram (Figure 1):

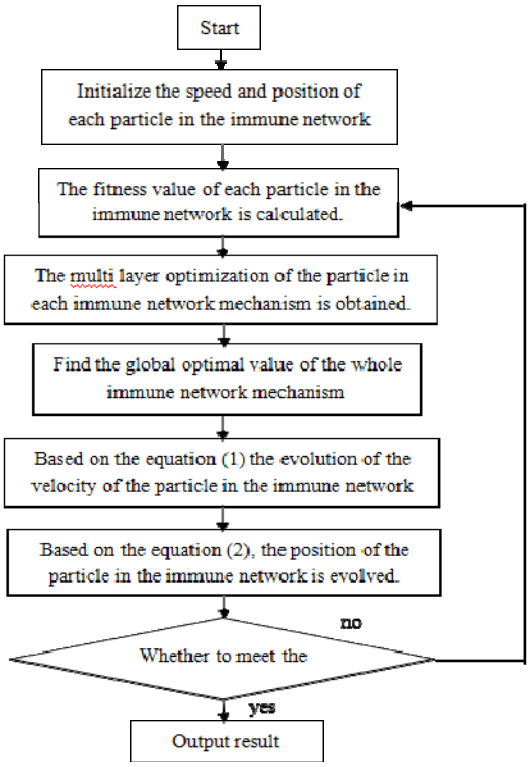

Fig. 1 the flow of the immune particle swarm optimization algorithm

3 SIMULATION EXPERIMENT DATA TEST

Griewank is used to test the ability of the network mechanism particle swarm optimization to search the global optimal solution by using the typical Griewank test function of a number of high dimension. The objective function is taken as the fitness of antibody to evaluate the good performance of the antibody, and the minimum value of the following two functions in the definition domain is obtained:

$$\text{Griewank(1)} = \sum_{i=1}^{n} \left(x_i^2 - 10\cos(2\pi x_i) + 10 \right)$$

Griewank(2)

$$= \frac{1}{4000} \sum_{i=1}^{N} x_i^2 - \prod_{i=1}^{N} \cos\left(\frac{x_i}{\sqrt{i}}\right) + 1, -10 \le x_i \le 10$$

Griewank(3)

$$= \sum 100 \left(x_{i+1} - x_i^2 \right)^2 + \left(1 - x_i\right)^2, -30 \le x_i \le 30$$

According to a plurality of Griewank function is a typical nonlinear multimodal function, it has an extensive search space, a large number of local minima and tall obstacles, is generally considered to

be genetic algorithm is very difficult to deal with the complex multimodal problems. The experimental parameters are set to popsize=50, dim=2, gen=500, Upper and lower bounds of particlesupbound=[10 10], lwbound=[-10 -10], $w=0.6, c_1 = c_2 = 2$,

Clone multiplier $N = 5$, Network threshold value is $ts = 0.001$.When the threshold is close to 0.001, the optimization speed is the fastest, this is because the threshold is bigger, the same particle removed, re join the new particles, although increased diversity, but also weakened the particle search speed, If the function value is too small, the network cannot restrain the effect. After the experiment, it is found that the threshold value of the network is 0.001, which is the appropriate value.

4 CONCLUSION

Based on the immune network theory of particle swarm optimization algorithm's ultimate goal is to establish an optimal particle swarm. Cells more specific, network simplification degree is low (low compression rate), and cell generalization ability is strong network simplified (high compression ratio).According to the immune system network learning particle swarm inhibit each other, increase particles diversity of the population, and the immune network of parallel and cloning mechanism of join, increase the scope of the search, and preserving optimal strategy, is introduced, to accelerate the progress of high dimensional optimization algorithm convergence.

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