An artificial fish swarm algorithm and its application

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Abstract: In order to enhance the performance of artificial fish swarm algorithm in solving optimization problem, this paper added the membrane computing to artificial fish swarm algorithm, an improved artificial fish swarm algorithm of solving Time-table Problem of Universities was proposed. Simulation results show that the improved algorithm has better feasibility and validity for solving Time-table Problem of Universities.

1 Introduction

The artificial fish swarm algorithm is proposed by Li Xiaolei [1] in 2002, it is a concrete application of the thought of swarm intelligence [2]. Artificial fish swarm algorithm is a kind of bionic optimization algorithm through simulation of fish behavior in nature, four operators were simulated four kinds of behavior of artificial fish so as to achieve the effect of local optimization of the algorithm, and according to their status updates and the surrounding environment, make their own in the population to find out the global optimal value. The algorithm has a strong ability to adapt to the quasi solution problem, no need to provide too much information of the objective function, global optimization ability good. Many scholars on this novel bionic optimization algorithm proposed many improved methods, for example, the simplified mobile way of fish swarm algorithm[3], using adaptive step size [4], reduce the search domain [5], which makes the algorithm have been improved in some aspects, but there are still operational speed is slow, easy to fall into local optimum, low convergence precision.

Membrane computing [6] is proposed by Ghcorghe Paun in 1998, membrane computing is a computing model from the life of the individual cell level, its purpose is to simulate the mechanism of the cells of life individual treated compound and achieve the optimization calculation.

According to the operation speed is slow, low convergence precision, easy to fall into the local extremum of artificial fish swarm algorithm, simplify the foraging behavior, according to the difference factor adaptive adjustment of step, line of sight, congestion factor, the number of attempts and other parameters, and the use of membrane computing communication rules to keep population diversity, the paper proposed an artificial fish swarm algorithm based on membrane computing.

Time-table Problem of Universities is a many factor of the global optimization problem, it is a NP- complete problem [7]. Since Time-table Problem of Universities involved in many information, the methods for Time-table Problem of Universities are the classical algorithm, structure algorithms and intelligent optimization algorithms. The intelligent algorithms have been paid more and more attention, they are used to solve combinatorial optimization and NP. This paper puts forward an artificial fish swarm algorithm based on membrane computing to solve Time-table Problem of Universities.

2 Artificial fish swarm algorithm and the membrane computing

2.1 Artificial fish swarm algorithm

Four operators of foraging, cluster, collision, moving randomly of artificial fish swarm algorithm are used for the optimization calculation. Among them, X= (x1, x2, ... xn) expresses the

individual state in the artificial fish populations, Xi (i=1,... , n) expresses the variables to be optimized; Y=f (X) expresses the food concentration value of artificial fish individual, where Y is the value of the objective function; Di, j=||Xi-Xj|| expresses the distance between two fish; δ expresses delta crowded degree factor; Visual expresses the maximum distance of artificial fish can be perceived; Step expresses mobile step of the artificial fish; the default behavior of foraging behavior is random behavior, the default behaviors of swarm behavior and following behavior are foraging behavior.

2.2 The algorithm description

```
Procedure Artificial Fish Swarm Algorithm
AF_ init();
While the value is not satisfied
{AF_ prey()
{If the value is better
AF_ move();
Else random_ move();
}
AF_ swarm()
{If the centre value is better
AF_ move();
Else AF_ prey();
}
AF_ follow()
{If another value is better
AF_ move();
Else AF_ prey();
}
}
Get result;
End while
End Artificial Fish Swarm Algorithm
```

2.3 Membrane computing

Generally, a P system of degree n can be expressed as:

$$\prod = (V, T, C, \mu\ w_1, ..., w_m, (R_1, \rho_1), ..., (R_m, \rho_m)) \quad (1)$$

Among them: V is the alphabet, where elements are called objects; $T \subseteq V$ is the output alphabet; $C \subseteq V - T$ is catalyst, its role is to assist some rules implementation in the process of the optimization, but the catalyst itself remains unchanged; μ expresses membrane structure, which contains the m membranes, various membranes and regions with label set H, H ={1,2,..., m}, where m is called degree of $\prod$; the (μ, v) represents the evolutionary rule.

3 Artificial fish swarm algorithm based on membrane computing

3.1Parameter analysis

When the step size of step is larger, the convergence speed of fish is faster, but the convergence precision of fish is low; on the contrary, when the step size of step is small, the accuracy of convergence of fish swarm algorithm can be improved, but the convergence speed will slow down; the visual is bigger, the artificial fish can have large search range, it advantageous to a global search, but it is easy to produce the shock phenomenon and affect the overall performance of the algorithm. The try_ number is bigger, the following behavior and cluster behavior are more

prominent, convergence speed is faster; on the contrary, the try_ number is smaller, the random behavior of fish more prominent, so the algorithm can search the global optimal solution in a wider range, but the prominent random behavior can cause value of fitness shock, it is not conducive to the local search. In view of the above question, this article through the introduction of adaptive parameter adjustment and membrane computing theory, proposed an improved artificial fish swarm algorithm based on membrane computing.

This paper presents a diversity factor α , it expresses in the proportion of same individual in fish swarm, with the rate of change to control the try_ number, step and perspective.

$$\begin{cases} visual = visual \bullet \lambda + visual_{\min} \\ Step = Step \bullet \lambda + Step_{\min} \\ try\_number = try\_number_{\min} - try\_number \bullet \lambda \\ \lambda = \exp(-30\alpha) \end{cases} \tag{1}$$

3.2 The algorithm flow

Step1: population initialization, generating a hierarchy of two layers from inside to outside: membrane 1and membrane 2, every membrane contains a fish;

Step2: Each individual artificial fish of membrane 1 followed by the implementation of foraging, cluster, rear end behavior, according to (1) to update their position;

Step3: According to the rules of communication judge whether carry the fish into the membrane 2, update the populations of membrane 2;

Step4: Each individual artificial fish of membrane 2 followed by the implementation of foraging, cluster, rear end behavior, according to (1) to update their position;

Step5: According to the rules of the exchange to determine whether carry the fish into the film 1, update the populations of membrane 1;

Step6: Judgment termination condition. Achieve a prescribed number of iterations, then stop the operation, otherwise go back to step Step2.

4 The analysis of simulation

This paper selects Gansu Normal College for Nationalities (4grades, 240 classes, 700 teachers) as an example to test. Parameter settings: the horizon of visual is 4, the minimum viewing distance of min_ visual is 1, step is 3, the min_step is 1, repeated attempts try_number is 3, the minimum repeated attempts min_ try_number is 2, the fish scale is 50. Compared with the algorithm of this paper and artificial fish swarm algorithm, it is used to verify the effectiveness of the algorithm of this paper. In the experiment, figure 1 is a row of class diagrams of standard artificial fish swarm algorithm, figure 2 is the row of class diagram of this algorithm. It can be seen from the graph, the row of class of the algorithm is more scientific.

5 Conclusions

This paper proposes an artificial fish swarm algorithm based on membrane computing. The algorithm is applied to solve Time-table Problem of Universities, the performance have been improved obviously. Experiments show that: the algorithm is feasible and effective for solving Time-table Problem of Universities.

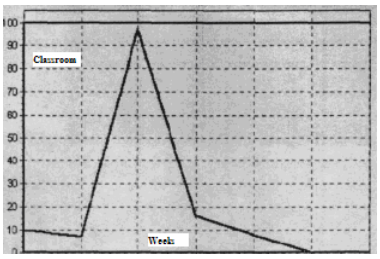

Fig. 1 The classroom resources distribution curve of artificial fish swarm algorithm

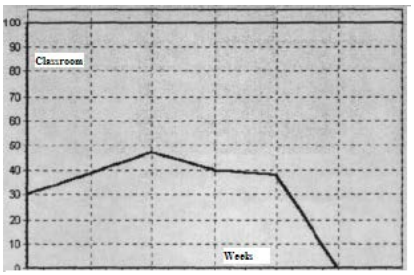

Fig. 2 The classroom resources distribution curve of the algorithm of this paper

References

[1] Li Xiaolei, Shao Zhijiang, Jixin Qian. An animal autonomous body optimization model: fish swarm algorithm [J]. Systems engineering theory & practice, 2002, 22 (11): 32-38.

[2]MAES P. From animals to animals 4: Proceedings of the fourth international conference on simu lation of adaptive behavior [M]. The MIT Press, 1996.

[3] Wang Lianguo, Hong Yi, Zhao Fuqing, Yu Dongmei. A simplified artificial fish swarm algorithm [J]. Mini micro system, 2009, 8 (8): 1663-1667.

[4] Liu Yanjun, Jiang Mingyan. An improved artificial fish swarm algorithm based on adaptive vision and step [J]. Computer engineering and application, 2009, 45 (25): 35-37.

[5] Fan Yujun, Wang Dongdong, Sun Mingming. Improved artificial fish swarm algorithm [J]. Journal of Chongqing Normal University (NATURAL SCIENCE EDITION), 2007, 24 (3): 23-26.

[6] Huang Liang. Membrane computing optimization method research [D]. Doctoral dissertation of Zhejiang University, 2007.

[7] Garey M R, Johnson D S. Computers and Intractability: A Guide to the Theory of NP-Completeness [M]. San Franciso,CA: Freeman,4,109-122(1979).