ISSN 2522-6398 Vol. 3, Issue 6: 1-3, DOI: 10.25236/FER.2020.030601

On Intelligent Optimization Algorithm in Mathematical Modeling

Huang Dezhi

Wuhan Donghu University, Hubei 430212, China

ABSTRACT. *Mathematical modeling is the process of solving practical problems by establishing mathematical models. In the process of mathematical modeling, it is very important to find the optimal solution to the problem. In real life, many problems can be solved by traditional optimization models. However, there are also many practical problems without a benign structure, which need to be solved with the help of intelligent optimization algorithm. This paper first introduces the basic theory of mathematical modeling and intelligent optimization algorithm, and then analyzes the common particle swarm algorithm, ant colony algorithm and genetic algorithm in mathematical modeling.*

KEYWORDS: *Mathematical modeling, Intelligent optimization algorithm*

1. Basic theory of mathematical modeling and intelligent optimization algorithm

Mathematical modeling is a complex and systematic process. It requires the modeler to observe the problem in depth and then establish it through experiments, analysis, judgment, and induction. Mathematical modeling makes the bridge between mathematics and reality[1]. At present, teachers in mathematics teaching in universities often cultivate students' mathematics application ability through mathematical modeling teaching. The main purpose of data modeling is to solve problems in reality. However, many problems in reality have no benign structure, and the optimal solution cannot be obtained by using traditional optimization algorithms. In this case, it is necessary to establish a non-standard model that conforms to the actual problem according to the original structure and rules of the problem, and then combine perception, analysis, judgment, and induction to find the optimal solution to the problem from the non-standard model.

The intelligent optimization algorithm has global, parallel and efficient optimization performance, and has the advantages of strong versatility, strong robustness, and no need for special information about the problem[2]. Different from the traditional optimization algorithm, the intelligent optimization algorithm is inspired by nature and emphasizes the method of finding optimization problems from the structure and laws of things. For example, simulated annealing algorithm is inspired by the annealing process of solid materials; genetic algorithm is inspired by the survival of the fittest in nature; and so on. The intelligent optimization algorithm can calculate the answers to the questions by adjusting the individual structure and algorithm parameters. In recent years, with the rapid development of advanced technologies such as the Internet, big data, and cloud computing, the problems in reality have become more and more complicated. In order to optimize the problem within a given time and find the optimal solution, various intelligent optimization algorithms need to be actively applied.

2. Intelligent Optimization Algorithms Commonly Used in Mathematical Modeling

There are many intelligent optimization algorithms commonly used in mathematical modeling, such as particle swarm optimization, ant colony optimization, genetic algorithm, simulated annealing algorithm and so on. This paper takes particle swarm optimization algorithm, ant colony algorithm and genetic algorithm as examples to analyze and explain.

2.1 Article Swarm Optimization

The particle of particle swarm algorithm is actually a feasible solution to the optimization problem. Particle swarm optimization is an intelligent optimization algorithm proposed by American scholars Kennedy and Eberhart by simulating the foraging behavior of bird swarms. The main flow of the algorithm is: (1) randomly initialize a certain number of particles to form a particle swarm; (2) calculate the fitness value of each particle; (3)

ISSN 2522-6398 Vol. 3, Issue 6: 1-3, DOI: 10.25236/FER.2020.030601

update the position of the optimal particle and the global optimal position; (4) update the speed and position of the optimal particle in the current iteration; (5) all the particles in the example group follow the current optimal particle to perform a global search in the solution space; (6) use iterative optimization and evolution strategies to find the optimal solution to the problem. It can be seen that the particle swarm optimization algorithm is an effective global optimization algorithm. It mainly realizes the exploration of the optimal solution of the particles in the solution space through the cooperation and competition between the particles.

Particle swarm optimization algorithm is robust. In mathematical modeling, particle swarm optimization is easy to describe and converge. When solving, only a small evolutionary population is needed, so the adjusted parameters are very few, and the solving speed is fast[3]. However, particle swarm optimization is greatly affected by particle inertia weight and speed adjustment parameters. If there are problems with particle swarm inertia weight and speed adjustment parameters, it will greatly affect the solution quality of particle swarm optimization. For example, when the particle swarm inertia weight is equal to zero, the particle velocity has no memory, which in turn causes the particle swarm to shrink to the current global optimal position, and no longer searches for a better solution.

2.2 Ant Colony Algorithm

Ant colony algorithm is an intelligent optimization algorithm proposed by Italian scholar Marco Dofigo and others who were inspired by ant collective foraging. When foraging, ants can find the shortest path between food and nest without any prompt. If an obstacle occurs on the original shortest path, the new shortest path will be searched in a short time. The main reason why ants can find the shortest path between food and nest in any case is mainly due to the pheromone left by the ants on the shortest path. The basic principle of ant colony algorithm is the principle of shortest path selection when ants foraging. The basic flow of the algorithm is: (1) initialize the ant colony size, pheromone factor, pheromone constant, heuristic function factor, maximum number of iterations, etc.,at the same time, read the data into the data and perform basic processing; (2) place the ants in different locations and calculate the destination of the ants until all ants reach all destinations; (3) calculate the length of each ant to reach the destination, calculate the optimal solution in the current number of iterations, and update the total amount of pheromones released by all ants on the path passed; (4) output relevant indexes in the process of program optimization.

Ant colony algorithm simulates the process of exploring the shortest path when ants collectively forage, and it has a good effect in solving discrete combination optimization. In the current mathematical modeling, there are many combinatorial optimization problems, and these combinatorial optimization problems can be solved by ant colony algorithm.

2.3 Genetic Algorithm

The genetic algorithm was first proposed in Holland's monograph "Adaptation of Natural Systems and Artificial Systems". Genetic algorithm is a typical evolutionary algorithm, which is based on the law of biological evolution ("survival of the fittest") and takes the problem as a simulated biological evolutionary environment, so that individuals in the population can find the optimal solution under the evolutionary rules[4]. The main process of genetic algorithm is: (1) Parameter coding. The coding methods are mainly binary coding and real coding. (2) Initial group setting. Randomly give a group of initial chromosomes (data or array), and then put these chromosomes into the biological evolution environment simulated by the problem. (3) Design of fitness function. The fitness function is a criterion for distinguishing good or bad chromosomes in a population. During operation, the fitness function is designed according to the requirements of solving the problem itself. (4) Genetic operation design and control parameter setting. Let the chromosomes in the group select a new group of chromosomes that adapt to the environment according to the biological evolution rules (crossing, mutation).

The basic idea of genetic algorithm is that the most suitable individuals often produce a larger population of offspring, that is, "survival of the fittest". Compared with other intelligent optimization algorithms, genetic algorithm has no more mathematical requirements, and it can effectively carry out global search by virtue of the evolutionary characteristics of chromosomes. For some complex combinatorial optimization problems, genetic algorithm can get the optimal solution quickly. However, the convergence speed of genetic algorithm is slow, and it takes more time to calculate.

3. Conclusion

ISSN 2522-6398 Vol. 3, Issue 6: 1-3, DOI: 10.25236/FER.2020.030601

In mathematical modeling, intelligent optimization algorithms can effectively solve some more complex combinatorial optimization problems. However, in practical applications, modelers carefully study and master the basic theories of different intelligent optimization algorithms, and understand the processes, advantages and disadvantages of different algorithms, and the scope of application. When applying various intelligent optimization algorithms, not only “know it”, but also “know why”, so as to be targeted in modeling. In addition, modelers should actively participate in mathematical modeling competitions, and apply intelligent optimization algorithms to the competition, thereby continuously promoting their ability to apply intelligent optimization algorithms.

References

[1] Du Yong, Qi Xiaoyang,Wang Xiujuan (2019).Teaching methods of intelligent optimization algorithm in mathematical modeling[J].Science Journal of Normal University, vol.39, no.6, pp.73-76.
[2] Huang Juan,Wang Jun (2018). mathematical modeling optimization based on different artificial intelligence algorithms[J].Automation and instrumentation, no.6, pp.47-49.
[3] Wang Xianchao, Han Bo, etal (2016). Application of particle swarm optimization in solving mathematical modeling optimization problems[J]. Journal of Fuyang Normal University (NATURAL SCIENCE EDITION), vol.33, no.2, pp.117-121
[4] Cheng Shi,Wang Rui, et al (2018). Swarm intelligence optimization algorithm[J]. Journal of Zhengzhou University (Engineering Edition), vol.39, no.6, pp.1-2.