Applications Research of Intelligent Optimization Algorithms in Traveling Sales Problem

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Abstract: TSP has a strong engineering background and practical application value. However, the traditional solutions of TSP have many disadvantages. The common intelligent optimization algorithms include neural network algorithm, genetic algorithm, simulated annealing algorithm, ant colony algorithm and so on, which can be used to solve TSP problems. In this paper, the basic principles of the above algorithms to solve TSP problems are elaborated, and their advantages and disadvantages are analyzed to provide some references for relevant researchers.

1. Introduction

With the sustained and rapid development of China's economy, people's demand for transportation has also increased significantly [1]. Due to the rapid increase in the number of vehicles, urban traffic congestion is serious, traffic accidents occur frequently, logistics costs remain high, and logistics timeliness cannot be guaranteed. The proportion of logistics cost in GDP in China remains high, about 20%, much higher than that in developed countries, which accounts for 10% of GDP, and that in middle developed countries, which accounts for 16%. However, the shortage of urban idle land resources leads to higher and higher cost of road construction and widening, and the speed of road construction and widening is far behind the growth rate of urban vehicles. At this time, improving the utilization rate, safety and comfort of urban roads and reducing the cost of urban logistics become urgent problems to be solved. Logistics distribution dispatching system is proposed to solve the above problems. It can provide reliable traffic information, efficient and fast emergency services, and has significant effect in reducing logistics costs. It can meet the needs of modern logistics economy, punctuality and flexibility. So far, there are many theories and algorithms of logistics distribution scheduling system abroad, and remarkable results have been achieved in practical application. However, domestic research in this area is only at the preliminary theoretical stage, and there is still a blank in the development of practical logistics distribution scheduling system. The fundamental reason for this phenomenon is that most of the algorithms only consider some constraints of TSP (Traveling Salesman Problem), and set many assumptions, which limit their application scope and lack flexibility in practical application. Research on the algorithm that can properly solve the TSP, and on this basis, develop an intelligent logistics distribution scheduling system has realistic theoretical and practical significance [2].

2. Connotation of TSP and Its Traditional Solutions

2.1 Connotation of TSP.

The traveling salesman problem is one of the famous problems in the field of mathematics. Suppose a traveling businessman wants to visit n cities, he must choose the path he wants to take. The restriction of the path is that each city can only visit once, and finally return to the city where he started. The goal of path selection is to obtain the minimum of all paths. Described in the language of graph theory, in positive weight graph G= (V, E, W), a loop containing at least one point in graph G is called salesman loop, a salesman loop with minimum weight is called best salesman loop, and the problem of finding the best salesman loop is called traveling salesman problem. The main reasons for

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the difficulty of TSP lie in the following. Two aspects. There is no effective algorithm to judge whether G is a Hamilton graph or not, and it is not known whether such an effective algorithm exists. It is very blind to search for the Hamilton loop of G without knowing whether G is a Hamilton graph. Even if G is a Hamilton graph, it is not known that G is a Hamilton graph and requires a Hamilton loop of G. There is an effective algorithm, and it is not known whether such an effective algorithm exists. The city is the vertex of the graph, the road is the edge of the graph, and the distance of the road is the length of the edge. It is a minimization problem in which the starting and ending points are at a particular vertex and each vertex is accessed exactly once. Usually, the model is a complete graph. If there is no path between two cities, a very long edge can be added to complete the graph without affecting the calculation of the optimal loop. TSP is a combinatorial optimization problem. This problem can be proved to be NPC computational complexity. Therefore, any method that can simplify the solution of this problem will be highly valued and concerned [3].

2.2 Traditional Solutions of TSP.

For a long time, people have been solving TSP and formed some traditional solutions. They are mainly divided into exact solution algorithm and approximate solution algorithm. The exact solution algorithm searches the whole solution space of the whole problem to obtain the optimal solution in all solution sets. Accurate solution algorithms include integer programming, dynamic programming, branch and bound algorithm, etc. Although these algorithms can get exact solutions, they are seldom used in practical applications because of the long computation time and low computational efficiency caused by the large search space. The earliest exact algorithm for solving TSP is exhaustive method, which is simple in thinking and can directly and quickly find the optimal solution of a small number of city points. However, when solving large-scale data sets, the amount of calculation is too large, the efficiency of calculation is not high, and the time is unbearable. Approximate solution method can also be called heuristic solution algorithm, and part of approximate solution algorithm is also called intelligent optimization algorithm. The comprehensive performance evaluation criteria of TSP algorithm include: the accuracy of algorithm solution, i.e. the degree of approaching the optimal solution; the complexity of algorithm solution, including the complexity of time and space; the adaptability of algorithm solution, i.e. the degree of universality of algorithm in various fields; and the rigor of algorithm solution, i.e., ensuring the algorithm solution. Full theoretical basis. Typical approximation algorithms include insertion algorithm and nearest neighbor algorithm. Although these algorithms can quickly calculate the feasible solution, the degree of approximation to the optimal solution is not satisfactory. Intelligent optimization algorithm mainly includes neural network algorithm, genetic algorithm, search algorithm, simulated annealing algorithm, particle swarm optimization algorithm and ant colony algorithm. It is a very active research field in recent years. It makes use of the principle of bionics to make the algorithm self-adjust constantly in the process of calculation so that it has adaptive ability. Intelligent optimization algorithm cannot get the optimal solution in a limited time, but its degree of approaching the optimal solution is very gratifying [4].

3. Intelligent Optimization Algorithms of Traveling Sales Problem

3.1 Artificial Neural Network.

The main idea of artificial neural network is to replace the objective function in TSP with energy function. The interconnection authority of neurons is determined by energy function. With the gradual change of network state, when the energy reaches equilibrium, the local optimal solution can be obtained. Because the neural network is a data-driven non-linear mapping model, it can realize any complex causal mapping and then find some rules of behavior change. At present, neural network technology has made some achievements in solving TSP, but there are serious defects in the neural network. It is difficult to determine the parameters of the algorithm. It is necessary to obtain a relatively good parameter through repeated data testing, which severely limits the application scope of the neural network. Hopfield neural network has many successful applications. Its main

application forms are associative memory and optimal computing. To solve the specific optimization problem with Hopfield network, the following steps are needed. For the undetermined problem, a suitable representation method is selected to make the output of the neural network correspond to the solution of the problem. The energy function of the neural network is constructed so that the minimum value corresponds to the optimal solution of the problem. The energy function is reversed. Introduce the structure of the neural network. Set up the network by the network structure and make it run, then the stable state is the solution of the problem under certain conditions. For TSP, if we use the traditional exhaustive search method, we need to find the combination of all paths, and then compare them to find the best path. With the increase of the number of cities, the computational workload of this method increases sharply. This is a problem that cannot be solved satisfactorily in limited time with traditional serial computers. In practical applications, such problems often do not require a strict optimal solution, as long as it is close to the optimal solution.

3.2 Genetic Algorithm.

Holland's genetic algorithm is a probabilistic search algorithm, whose core idea comes from such basic understanding. Genetic algorithm is a random parallel search algorithm based on natural selection and genetic principles. It is an efficient optimization method for searching global optimal solution without any initialization information. From simplicity to complexity, the process of biological evolution from low level to high level is a natural, parallel and robust optimization process. The coding technology and genetic operation of genetic algorithm are relatively simple, easy to realize, and the optimization is not restricted by restrictive conditions, but it is prone to prematurity and poor convergence. Several parents are selected and paired by crossover probability, and new individuals are generated according to the rules of crossover algorithm. The commonly used normative methods are single-point crossover, partial mapping crossover, cyclic crossover, and so on. In order to maintain the diversity of population individuals and prevent them from falling into local optimum, it is necessary to randomly determine the mutation individuals according to a mutation probability and carry out corresponding mutation operations, usually using the inverse mutation operator. If the predetermined termination condition is satisfied, the iteration is stopped, and the obtained path is considered satisfactory; otherwise, the fitness value of each individual in the new generation population is calculated. Simple genetic algorithms often have obvious shortcomings such as slow convergence speed, easy to fall into local optimization and low optimization accuracy.

3.3 Simulated Annealing Algorithm.

The starting point of simulated annealing algorithm for optimization problem is based on the similarity between annealing process of solid material in physics and general optimization problem. The solids are heated to a full height and then cooled slowly. When the solids are heated, the internal energy of the solids becomes disordered with the increase of temperature, while the particles tend to be ordered gradually, at each temperature. It reaches the equilibrium state, and finally reaches the ground state at room temperature, with the minimum internal energy. The basic idea of the algorithm is to start with a given initial value solution, introduce random factors and generate another solution randomly from the neighborhood. The acceptance criterion allows the objective function to vary in a limited range. After a large number of solution transformations, the relative optimal solution of the optimization problem with given control parameter t can be obtained. Then the value of the control parameter t is reduced and the iteration process is repeated. When the control parameters gradually decrease and tend to zero, the system tends to be more and more balanced. Finally, the system state corresponds to the global optimal solution of the optimization problem. Because solid annealing must be slowly cooled to achieve thermal equilibrium at each temperature and eventually to equilibrium state. Therefore, the value of control parameters must be slowly attenuated to ensure that the simulated annealing algorithm finally tends to the global optimal solution of the optimization problem. Simulated annealing algorithm generates another new solution randomly from its neighborhood. For TSP, its neighborhood refers to that the two paths are the same except for local differences. The superiority of the simulated annealing algorithm depends on the initial temperature and annealing time. When the initial temperature is too low or the annealing speed is too fast, the

algorithm will fall into the local optimal solution, but if the number of iterations is high, the running time will be greatly increased with the decrease of annealing speed.

3.4 Ant Colony Algorithm.

The basic principle of ant colony algorithm derives from the shortest path principle of ant foraging in nature. According to the observation of entomologists, it is found that although the vision of ants in nature is not developed, they can find the shortest path from food source to nest without any hint, and can search for new optimal path adaptively after the environment changes. Ants search for food independently and release pheromones during the course of food searching. Pheromones affect subsequent ant's choice of path. The stronger the pheromone, the more likely it is to be chosen by ants. For ant algorithm, the initial pheromones of each path are the same, but with the passage of time, more and more pheromones on the optimal path will be found, and finally the purpose of seeking the optimal or sub-optimal solution will be realized. In ant colony algorithm, the setting of the number of ants M is an important factor affecting the performance of the algorithm. If M is too small, the path pheromone that has not been searched tends to zero, the global search ability is too poor, and the stability becomes worse. Over-congress leads to over-average pheromones on all paths, too strong randomness, too slow convergence rate, and too weak positive feedback ability of information. Compared with genetic algorithm, ant colony algorithm has greatly improved the solution of TSP. I think the reason is that the positive feedback adjustment of ant colony in the process of finding the path is based on the adjustment of pheromone concentration, which makes the path length converge easily. At the same time, due to the use of roulette algorithm, there is a certain diversity, which is not affected by the initial value. Ant colony algorithm also has some limitations. Although it has been greatly improved compared with genetic algorithm, sometimes it still cannot find the optimal solution and can only find the sub-optimal solution.

4. Conclusion

The computational complexity study shows that TSP is a typical NP problem. For large-scale TSP, people cannot find a perfect solution algorithm at present. All intelligent algorithms can only be solved within a certain range of accuracy. For large-scale TSP, people cannot find a satisfactory solution at present. At present, the known intelligent optimization algorithms are all exact solutions in some specific ranges, which are not universal. Fusion of various algorithms. Because of the advantages and disadvantages of each algorithm, we should learn from each other and make up for each other.

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