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Research Article

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Logistics distribution route optimization based on genetic ant colony algorithm

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ABSTRACT

In order to achieve the goal of energy saving and emission reduction in logistics delivery vehicles, to achieve low cost low exhaust pollution in logistics distribution path optimization, that is to find the reasonable application of algorithm optimize the path. In view of the shortages of existing genetic algorithm and ant colony algorithm which have the characteristics of some limitations, such as ant colony algorithm's convergence slow, easy going, the characteristics of such as genetic algorithm premature convergence in the process of path optimization, process complex, integrating and improving the ant colony algorithm and genetic algorithm in order to solve logistics route optimization problem. At last, through simulation experiment, it is proved that the improved genetic ant colony algorithm is correct and effective.

Keywords: Genetic algorithms; Ant Colony Algorithm; Genetic Ant Colony Algorithm; Route Optimization

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INTRODUCTION

The development of a new generation of logistics industry, has resulted in a gradually increase of distribution vehicles in logistics industry, but at the same time, it also has brought more automobile exhaust, increased pollution, and air quality index has decreased gradually. Modern logistics industry is an important component of China's economic development, in order to achieve common sustainable development of economy and environment, it is necessary to reduce energy consumption while increasing the green area. The energy consumption in the logistics industry is mainly in the distribution process, in order to achieve low consumption of the energy, it will be dedicated to solve the distribution route optimization problem, using reasonable and effective algorithm to realize the logistics distribution path optimization is the important foundation of sustainable development and the ultimate goal.

GENETIC ANT COLONY ALGORITHM

The basic theory of ant colony algorithm

The ant colony algorithm is a new search algorithm which imitates the process model of ant collective cooperation to find food, and has better research results applied to the combinatorial optimization problem.In the experimental model of double bridge, the assumption is that in an asymmetric type of bridge, the remainder pheromone of the ants in the walking path is proportional to the number of ants at the end of the bridge, the more ants are on the bridge, the more the residual information is, and the others select path according to retained information.Example assumes that short bridge is A, the long is B, A_m and B_m is the number of ants across two bridges respectively, and $A_m + B_m = m$, If m ants have come two bridges,the probability of the m + 1th across A bridge meets:

$$P_A(m) = \frac{(A_m + k)^h}{(A_m + k)^h + (B_m + k)^h} \quad (1)$$

In the formula, A and B are parameters for matching the real data. The probability of the m + 1th across A bridge

meets:

$$P_B(m) = 1 - P_A(m) \quad (2)$$

When ants are across two bridges, according to (1) calculates the probability $P_A(m)$ across the A bridge, and then generates a random number uniformly distributed $[0,1]$.If $\leq P_A(m)$,the ants are across the A bridge, or across the B bridge.

The parameter selection of ant colony algorithm

Time will make artificial ant residual path information of a memory capacity gradually evaporate.The parameter ρ of residual pheromone volatilization, not only directly affects the convergence speed of the algorithm, also influences its global search ability, and $\rho \in [0,1]$ in algorithms. The ants are choosing the same path, the algorithm stop to enter the local optimal solution. The smaller volatile parameters ρ is, the less the volatile of path pheromone residue is,and then the longer ants choosing the same path is.However, if ρ is larger, the repeatability of routing select between ants will abate, which makes random selective enhancement of ants.

Because the distribution of the residual pheromone is evener, which reduces the positive feedback of information, at the same time increases the randomness of the algorithm.But if the ant number m is too small, it is easily into the algorithm stagnation, which abates the global, and improves the convergence of the algorithm.When the number of cities is n , the number of ants m , meets $m \in [0.75n,1.5n]$, is the most reasonable.

Information inspired parameter ∂ , expresses a random intensity of effect in ant search path, mapping a relative key of ant's accumulation of information in group search. The greater information inspired parameter ∂ is, the greater the chance of choosing the same path for ants is, which makes the algorithm search the randomness abate, and easily into the local optimal solution. However, if inspired parameter ∂ is too small, algorithmic search randomness will be enhanced, but it will hinder the algorithm to obtain the optimal solution.

The basic principle of genetic algorithm

Genetic algorithm is a kind of algorithm of random probability iterative search, which isbased on Darwin's classical theory of "natural selection, survival of the fittest".The basic idea is the genetic variation of species evolution applied to calculating the optimal solution. Being left in the process of evolution is the most adaptable to environment, and the calculation for iteration can obtain far the most optimal solution.

Genetic algorithm is based on the population formed by potential solutions to resolve problems as a starting point, and each population contains a certain number of individuals, and these individuals are encoded by genes, making individuals into a chromosome of characteristics of individual entities.Genetic algorithm simplifies coding work and based on "survival of the fittest, survival of the fittest" theory, it continuously iterates and evolves better approximate solutions.Select individual is decided by individual fitness function of the problem domain and applies genetic operators to achieve crossover and mutation, and produce new stocks set until the iteration works out the best individual, that is, it finds the approximate optimal solution.

Genetic algorithm is mainly used to choose, crossover and mutation operations form.It is the first to random initialization of a certain amount of the parent individual, and gets its individual fitness function. In accordance with the optimizing principles, evolution produces new offspring, according to the fitness function choice and cross parent individuals generates new individuals.Offspring is to implement mutation.Then offspring fitness is again calculated, which is cycled until the best individual is produced, that is, the optimal solution of the problem.

The advantages and disadvantages of ant colony algorithm and genetic algorithm

Advantages of ant colony algorithm are: good adaptability, high robustness, good parallel processing performance, global search capability, and merging with other algorithms. But it also contains some deficiencies and defects: too long for searching when algorithm is used, easily to get bogged down in a local optimum, weak foundations of mathematics application, setting the initial parameter can also influence the algorithm, and it is more serious.

Target is determined by the probability of genetic algorithm rules and guidelines.Excellent characteristics of genetic algorithms are characterized: adaptability and versatility of algorithm are wonderful, good global optimization of the algorithm, the parallelism of the algorithm is more subtle, and easily to solve the problem of parallel processing, and good scalability. Although genetic algorithm contains more than a few advantages, theories and practical application still needs further improvement, mainly manifested in the following aspects: study on theory of genetic algorithms is still relatively backward, parameter setting of genetic algorithm is difficult to achieve, the effective way to deal with

its constrained issue is weak, and easy to premature.

In the practical application of ant colony algorithm, the operation factor is the ant residual pheromone update accumulation, and gradually to the convergence of the optimal path, but in the early algorithm, the pheromone is very scarce, and makes the convergence speed slow down. Assumes that the urban size is not less than 30 in the TSP problem, the global search ability of genetic algorithm (GA) is gradually reduced, but the search performance of ant colony algorithm is better than the search performance of genetic algorithm.But after the city size increases, ant colony algorithm is gradually showing lack of search performance, stall phenomenon, the optimal solution obtained has become more complex.

Genetic ant colony algorithm

Due to the lack of reasonable residual pheromone distribution in the initial stage,ant colony algorithm makes search path complex. Because the genetic algorithm has advantages of random search quickly, and global convergence, easily to obtain the optimal solution by evolutionary iteration algorithm, so the integrated application of these two algorithms is more advantageous to the algorithm convergence speed, the optimal solution generated by genetic algorithm is as initialization distribution data of the ant colony algorithm residual pheromone. Relying on the fusion of two kinds of algorithms improves the logistics distribution to calculate the optimal solution of the path, gives full play to the advantages of two kinds of algorithm, and avoids some of the deficiencies and defects. Convergence rate curves of the two meet in Fig.1.

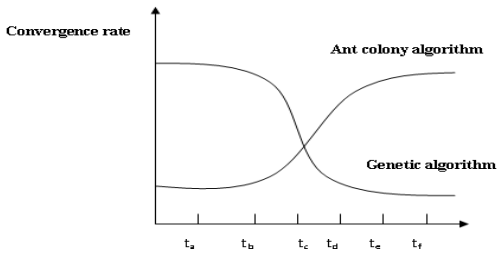

Fig.1 Convergence speed-time curve

Genetic ant colony algorithm, the basic idea is: first to make total convergence time t_c the least and the best: Before the best moment, a good randomness and faster convergence speed of genetic algorithm is full application to complete each path of reasonable distribution of pheromones, after the best moment,good positive feedback of ant colony algorithm and better parallel processing ability and high efficiency are fully used to complete the global optimal path search.

EXAMPLE ANALYSIS

In order to verify the effectiveness of genetic ant colony algorithm, it is the main application of MATLAB to verify it.Setting the parameter values in the model are to meet:

$$\begin{aligned} &C_\theta(0.0000\ ,0.1666\ ,0.0555\ )\\ &C_\rho(0.0150\ ,0.0050\ ,0.0016\ )\\ &C_{p_r}(0.6180\ ,0.1273\ ,0.0424\ )\\ &C_{p_m}(0.1000\ ,0.0333\ ,0.0111\ ) \end{aligned} \tag{5}$$

Mainly through the logistics distribution routing problem of $eil51$ completes simulation experiment, which provides the optimal solution is 426, its evolution path results are shown in Fig.2.

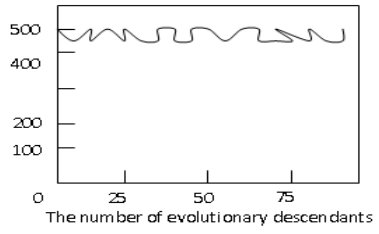

Fig.2 Path optimization curves

Using software to simulate the optimal path for the instance, which is the optimal solution, is shown in Fig.3.

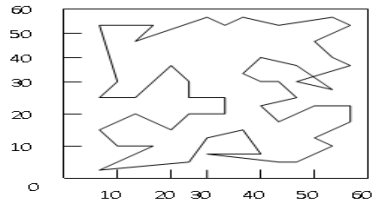

Fig.3 The optimization path of logistics distribution

CONCLUSION

Logistics distribution, to achieve energy conservation and emissions reduction of the vehicle, and the purpose of the low consumption low exhaust pollution, the key problem is to realize the logistics distribution path optimization in transportation. Genetic algorithm and ant colony algorithm has some limitations, the genetic ant colony algorithm combined the two algorithm is more flexible and more widely applied. And examples verify the effectiveness of the proposed algorithm, it not only can solve the genetic algorithm which is easy for the phenomenon of cyclic redundancy, also can solve the slowing down defects of loop iteration in the early period of the ant colony algorithm to search , has a good application in practice.

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