Available online www.jocpr.com

Journal of Chemical and Pharmaceutical Research, 2014, 6(5): 693-697

Research Article

ISSN : 0975-7384
CODEN(USA) : JCPRC5

Study on multi-resource constraints vehicle scheduling problem based on improved genetic algorithm

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ABSTRACT

With the development of world economy, logistics industry has to meet the requirements increasingly. Vehicle scheduling management is an important part of logistics system. How to implement the vehicle in the case of multiple resource constraints of reasonable scheduling is the key problem to promote the prosperity and development of modern logistics industry. Therefore, through the research of logistics distribution vehicle scheduling needs, in view of the traditional genetic algorithm, hindered the development of vehicle scheduling and improve to slow the rapid development of logistics industry shortcomings. A genetic algorithm which is improved, efficient, for the normal vehicle scheduling problem with a range of applicability is proposed. By demonstrating example, it shows that the algorithm is feasible and effective.

Keywords: Multiple resource constraints; Vehicle scheduling problem; Improved genetic algorithm; Examples demonstrate

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INTRODUCTION

The Genetic Algorithm is firstly proposed by J.Holland, and re-identified and deduced by Hollanl later on. Its core idea is every outstanding individual will appear the direction of index increasing in every dynamical population biology[1].That is to say, it is convergent, so it can be applied in practice preferably. This algorithm is a randomly searching and calculating method which has better adaption and flexible optimized object, so we do not need the successive optimized object, or the optimized object to differentiate, or has the good stability and parallel searching ability. At the same time, the genetic algorithm does not need the initial solution and arbitrary initial population biology can operate and outcome. We use randomized optional strategy in this algorithm, that is to say, it makes the outstanding individual go to the next generation through the survival of the fittest, and then after the cross - fertilization and Genetic behavior, it realizes weakness or disappearance.

In order to realize the optimization of vehicles dispatching, the main content of genetic algorithm is as follows: (1) give the researching object number. Only when we transform the spatial data issue into a bunch of genes data which can be dealt with by this algorithm can we use the genetic algorithm to handle this problem for the genetic algorithm has poor handling ability to spatial problems.(2)Initialize the population biology. In order to achieve the operation of the spatial problems, we must optionally transform the spatial problems into population biology which has many individuals, and these individuals can response the answer of one space optimized issue. Thus, the key issue is how to form the initialized population biology. (3) Using the fitness function. Every individual in the transformed population biology will affect the merits of the whole issue. So we have to use the fitness function to evaluate the individuals' ability, and apply the data to other genetic operation. (4) Select the excellent individual. In the genetic algorithm, only the excellent past age can have great meaning to the younger generation, causing the great individual and gene can multiply the greater generation. (5) Intersect and form the new individual. The intersection of single

gene can influence the astringency and shorten the calculating time. We select the individual having the good genes to intersect with the better genes and get the greater gene combination. Generally, the intersection has two steps. Firstly, we should pair the last generation randomly, and confirm the intersection point of these individuals which can be paired randomly, then transform or intersect the partial information, and then produce the new individual.

THE IMPROVED GENETIC ALGORITHM

There are many ways to improve the traditional genetic algorithm [3]. In this paper, we improve and renew the genetic algorithm on the code structure, improve the intersecting and compiling operation, and expand the population biology at last. There are four aspects to be improved in total, and each on is as follows:

Step1. Improving the code program. We choose the order of natural number to code the chromosome for the solution structure of the vehicles dispatching is particular. The whole dispatching internet built by the customer n needs m cars to realize the delivery. And then code the chromosome to a data whose length is n+m-1, the n natural numbers realize that it marks the full permutation with m+1 naughts, such as

$$0, i_1, i_2, ..., 0, i_f, ..., i_k, 0, ..., 0, i_p, ..., i_q, 0$$

in that Ij is the customer j on some wire, and o represents the DC(distribution center). The chromosome structure after the coding can represents that the vehicles send $i_1, i_2, i_3, ..., i_c$ from the DC and then return to the DC, which forms the first subsidiary dispatching internet. And then the second is also the same, forming the second subsidiary dispatching internet. Going along like this, all the customer can be visited. This subsidiary dispatching internet formed by the chromosome is not in order, while the particularly ordered subsidiary dispatching internet is the solution of the vehicles dispatching process.

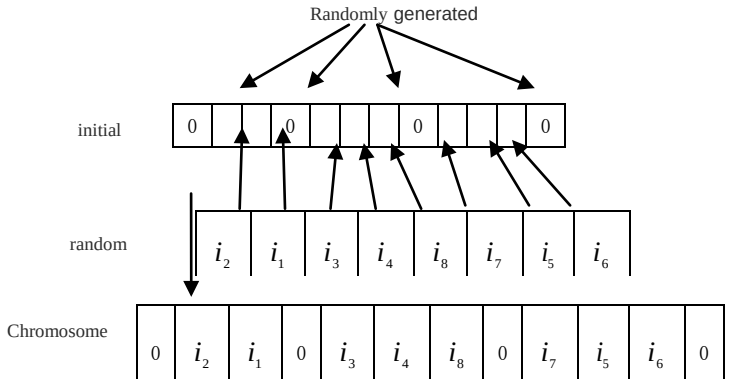

Fig.1 The code of chromosome initialization

Step2.we insert 0 into the former one or the later one. Going along like this till we get a lot of individuals in the population biology. Mark 8 as the customer and we need 2 vehicles. The process of coding the chromosome is shown in fig.1.

Step3. Improving the fitness evaluation. The fitness evaluation of improved genetic algorithm is the same with the target function under the constraint model. The smaller sufficiency of the individual in the population biology is, the better is.

Step4. Improving the chosen operation. When we calculate the sufficiency of the individual using the improved fitness function, firstly we need to reorder them according to their values, big or small. Supposing the scale of the population is p, mark the individual having the smaller sufficiency as 0, the biggest as P-1.Randomly produce a number r conforming to the standard normal distribution, making $r* = |\frac{r}{3}|$,if the r we produced is greater than 3 we need to reproduce a r which satisfy the conditions. The probability of standard normal distribution of the randomized number between -3 and 3 is 99.9%.In this situation, $r*$ is located between 0 and 1, satisfying $t = r*(p-1)$ .Supposing chromosome NO.t is chosen to the new population, the probability that the chosen

chromosome is closer to the symmetry axis 0, the bigger the excellent population. The value probability of the randomized number is the shape of normal distribution.

Step5. Improving the intersecting operator. Vehicle dispatching has particular structure, but the chromosome coding in the traditional genetic algorithm adopts the mixed method of single-point, multi-point, and changing to arrange, which destroy the chromosome and excellent substring form, and it cannot create the new filial generation if the two chromosomes of the last generation are the same. Thus, we must improve the traditional genetic algorithm. Selecting the location of DC 0 when it intersects coding based on the particularly coded chromosomes, preventing to damage the excellent substring and the last chromosome. Furthermore, the method that makes the substring move to the first place of the chromosome to intersect not only can keep the integrity of the excellent substring, but also can create the newly excellent substring in the case that parents' individual chromosomes are the same, and create the better new substring individual with the help of improved variant operation. Thus improve algorithm's ability to search the excellent individual and the convergent speed. The detailed operating process is as follows:

Firstly, intersect and duplicate the chromosomes. Chose two chromosomes named A and B, whose probability value is 0.85, and then produce two natural numbers between 1 and m , named r_1 and r_2 .In the new algorithm, we require the substring chromosomes in A to be duplicated into the fore-end of the last generation named $B*$,at the same time, we duplicate the substring chromosomes in B into the fore-end of the last generation named $A*$. Next, choose the location of the rest 0 and insert the 0 into the head and end of the next generation's chromosomes named $B*$ and $A*$, and insert the rest 0 of m-2 to the blank space randomly, satisfying the arbitrary 0 having content. Finally, complement the rest genes of the chromosomes, that is to say, fill the different genes of the last generation and next generation into the rest chromosomes, thus create a new individual.

Step6. Improving the varied operation. Selecting a chromosome randomly whose probability is 0.15, and create two natural numbers between 1 and n＋m. If the two groups of genes corresponding nonzero value then it will intersect and create a new individual; if not, it will be going on until the intersecting numbers created. We apply the improved algorithm on chromosomes $0i_4i_50i_3i_1i_20i_7i_6i_80$ to mutate and create a series of new chromosomes named $0i_3i_70i_1i_2i_50i_4i_6i_80$. The detailed process is shown in figure 2.

	Randomly selected to produce two natural Numbers to chromosome encoding											
	↓											
The previous generation chromosomes	0	i_3	i_4	0	i_1	i_2	i_5	0	i_7	i_6	i_8	0
Change	↓											
The mutated chromosome	0	i_3	i_7	0	i_1	i_2	i_5	0	i_4	i_6	i_8	0

Fig.2 The Detailed Process of Compiling Operation

Step 7: Improving the terminated condition. If we repeatedly create the population biology to five times and we get nothing, then we will stop the algorithm. If it does not satisfy the terminated condition then it will turn back to the original place, or we will adopt step 8.
Step8. Outputting the results. Output and create the individual which has the greatest sufficiency in the population biology, and produce the optimized solution of the issue, realizing the best dispatching scheme of the vehicles.

THE EXAMPLE ANALYSIS OF IMPROVED GENETIC ALGORITHM

To prove that the improved genetic algorithm can get the optimized solution of vehicle dispatching in the multi-resources constraint condition and the reliably practical application, we carry on the data validation with the help of software. We use function rand（） in the Matlab to randomly produce 10 customers in the square of [0,100] and set up a complete dispatching network, numbering them as 1,2,…,10. According to the require of need, we randomly produce the coordinate of the dispatching network center and all the customer in the field of [0,8].The function inputted includes: the prime cost 1.2¥ per kilo, the distance 123 meters, 20 min od each mission, the speed 45 kilos per hour in dispatching, and we get data of randomized distance of the algorithm produced at last.

Fig.3 The data of algorithm example randomly produced

code	coordinate	Temporal Demand	Time window constraints
0	（55,56）km	0t	-
1	（59,41）km	2.2t	14:50-15:20
2	（32,94）km	2.3t	9:00-9:30
3	（58,12）km	6.8t	10:30-11:30
4	（60,85）km	3.6t	10:05-10:45
5	（36,71）km	1.2t	14:00-14:30
6	（14,66）km	5.6t	11:05-11:45
7	（34,25）km	3.2t	9:50-10:25
8	（67,40）km	1.8t	14:00-14:30
9	（75,79）km	3.4t	11:00-11:25
10	（19,46）km	1.6t	15:40-16:20

The straight-line distance of the selecting coordinate in the field is the practical distance of the nodal point. Transform the limitation of obeying the resource-constrain to the losing distance. We must estimate the total pcu which we need in the whole dispatching mission, making ∂=0.86, the pcusatisfying $m = [\sum_{i=1}^{n} q_i / \partial Q] + 1 = 3$.

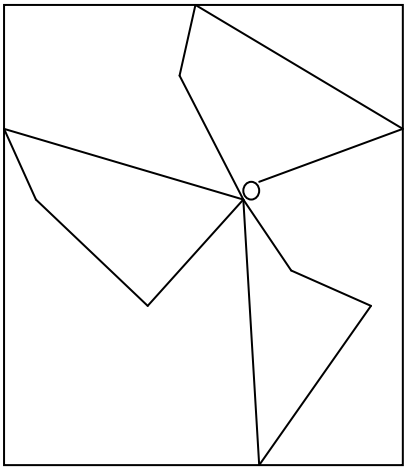

Fig.4 The vehicle dispatching scheme under loading resource-constraint condition

In the practical logistics vehicle dispatching, the dispatching issue constrained by the multi-resources can realized the better management and distribution. Because of the developed modern transportation, there are many chained gas station in each lattice point, so we consider the persistent driving ability of vehicles as unfailing. Thus, we just need to solve the dispatching optimized solution of the vehicle models. After the improvement of traditional genetic algorithm, now we optimize the vehicle dispatching under loading resource-constraint condition: ruling the dispatching car as 3, in light of the detailed operating steps such as intersection and variation, function the program 26 times, and finally we get the optimum solution convergence, and we know that if the prime cost is 866.12¥, the dispatching is the most simple, so is the profit. The scheme of dispatching is shown in figure 4

Optimizing and outputting the time window resource-constraint of the vehicle model according to the improved genetic algorithm, we iterate and converge 30 times, and after the calculation we get the optimized dispatching prime cost which the dispatching mission needs is 1201.03 under the condition of 4 cars' dispatching. The detailed dispatching routine is shown in the figure 5

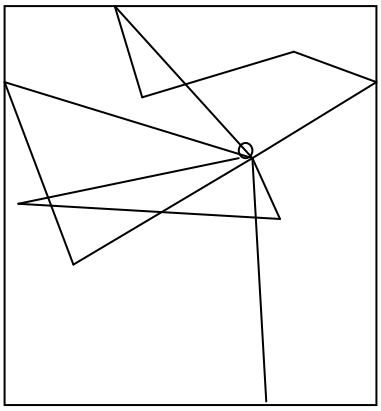

Fig.5 The vehicle dispatching scheme under the time window resource-constrain

And then, we input and output the vehicle dispatching model under the condition of multi-resources constrain, and compare as well as analyze its driving routine, form length, capacity tonnage, the times of iterating the algorithm, and the time which calculation needs.

We can learn from the detailed data from this chart that the vehicle dispatching issue under loading resource-constraint can be reasonably optimized in driving routine, length, and capacity tonnage and so on. And the iteration time as well as the time of calculation is less than former, the most important is the prime cost is much less. However, the vehicle dispatching under condition of time window resource-constraint is not satisfying with the punishing cost caused by time window, so it has to sacrifice the length to insure the time so as to meet demand, so the dispatching cost is much higher. We can see in the experimental example, the improved genetic algorithm can not only better optimize the localized demand vehicle dispatching issue under the condition of multi-resources constrain, but also can improve the efficiency of solving and the convergence of the overall situation.

CONCLUSION

We discuss the analyze the genetic algorithm of vehicle dispatching under the multi-resources constraint and the improved genetic algorithm in detail, changing the disadvantage of slow convergence in the traditional genetic algorithm, making the application of improved genetic algorithm become much wider, thus promote the application of vehicle dispatching in the genetic algorithm, the growth of logistics, as well as the development and ability of the economy.

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