Design of Drug Recovery Scheme Based on Path Optimization

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Abstract. Countries with the upsurge of garbage sorting, all over the World attach importance to the recycling of expired medical products. The design of reverse logistics network of expired drugs has become a key problem in the field of pharmaceutical safety. Considering that expired drugs can not be recovered effectively, this paper studies the problem of drug recovery logistics by using TSP model and mileage saving model. It is beneficial to arouse the enthusiasm of enterprises and residents to participate in the recovery of expired drugs, thus reducing the production and manufacturing costs of pharmaceutical enterprises in China and reducing the pollution of waste drugs to the environment.

1. Introduction
According to the White Paper on the Recovery of Expired Drugs from Chinese Families, about 78.6% of families in China have spare drugs, but 30% to 40% of them are more than 3 years old; 82.8% of households do not have the habit of regularly cleaning up expired medicines. More than 90% of the respondents had the experience of discarding expired drugs with domestic waste, and the country produced about 15000 tons of expired drugs a year. If the expired spoiled drugs are not handled properly, they will cause serious pollution to the environment. More importantly, a number of packaged expired drugs, once recovered by criminals, will pose a huge threat to public life. Expired drugs have a serious impact on the normal drug market and people's health and life safety, so it is particularly important to recognize the harm of expired drugs and establish an effective recovery mechanism for expired drugs. However, the enthusiasm of residents to take the initiative to recycle drugs is not high. By taking measures of on-site service of drug recovery personnel to recover expired drugs and giving certain welfare to residents, the enthusiasm of residents to recover expired drugs can be improved.

In the recycling path problem, the traveller problem is a special case of the VRP problem, that is, when the VRP contains only one path. TSP problem is the basis of solving VRP problem and the problem of combination optimization. Here we use the GA genetic algorithm in the MATLAB to solve the salesman problem. However, in the practical problems, it is difficult to solve the problem of using traveller when it contains the limitation of vehicle transportation route, vehicle loading and so on, which has high application value and scientific significance[1].

2. TSP Problem Solutions Based on Genetic Algorithm

2.1. TSP Problem modelling
Normally, TSP problem can be expressed by the following content, there are N cities in a region, there is a certain distance between each city in the region, a traveller needs to visit these cities, each city is r
required to visit, and each city can only visit once, needs to return to their cities of departure upon completion of their visits, how to arrange the tour route of the traveller, so that the total length of the path that the traveller has entered is the shortest.

According to the actual content of the problem, researchers first need to number cities, such as 0, 1,...,n-1. After the numbering is completed, the researcher can start with the distance information of different cities and construct a two-dimensional array. The mathematical model of the TSP problem needs to contain information such as the total distance length, the number of total cities and the distance between two different cities[2].

2.2. TSP Problem Genetic Algorithm Design

Initializing the set of population and fitness function (including termination condition) is an important content in the design of genetic algorithm for TSP problems. According to the previous discussion, the coding method is the initial population which is randomly generated for the need of problem research. The related fitness function mostly adopts the function of finding the maximum value of the function. According to the characteristics of the TSP problem, there is a positive correlation between fitness and the path of the scroll bar, that is, the smaller the fitness of the individual, the shorter the path of the individual. During the process of solving the TSP problem, the function of penalty coefficient related to the number of traveling cities and the content of the problem can not be ignored.

After the genetic algorithm is applied to the TSP problem solving process, the initial population and fitness function can be regarded as other parameters related to the TSP problem solution. according to the relevant contents of the TSP problem, the number of randomly generated population sizes can be regarded as the initial population, taking the reciprocal of the objective function value of the TSP problem as the fitness function selection method is also the commonly used fitness function determination method in the process of problem handling[4].

3. Application of mileage saving method in recycling route

3.1. Basic idea of mileage saving method

The basic idea of the mileage saving method is: by a recycling vehicle that can be loaded with drugs, a long a preferred route, one by one to the customer's location to recover the drug, to ensure that the driving mileage, save transportation costs. The specific implementation is shown in Figure 1. In the Figure 1, Suppose P is a recycling center, A and B are the customers of the service. The original distribution plan is: send two cars from P, reach the customers A and B respectively and return to the point P on the original road, the driving distance is: 2a+2b. The idea of the mileage saving method is to send a car for recycling along the way, that is, starting from P to A and then to B for recycling, and finally returning from B to P, the driving distance is: a+c+b. The difference between the mileage of the two schemes is: a+b-c, the nature of the triangle can be seen as a+b-c must be greater than zero, thus achieving the purpose of saving mileage[5].
3.2. **Steps to the mileage saving method in recycling path optimization**

Based on the basic idea of the mileage saving method, look for such a triangular loops in the distribution network. Load as much medicines as possible, and save as much mileage as possible[6]. The specific steps are as follows:

- Form an initial solution. Make a transportation odometer and list the shortest distance between the recycling center and the user.
- Calculate the degree of saving. According to the formula of saving history
- Sort the savings in descending order.
- Combine the loops. According to the load capacity constraints and the mileage savings, connect each customer node in order, and finally determine the recovery route.

4. **Case studies**

4.1. **Travel quotient problem solving**

Assuming that our emergency drug distribution center is part of the medical recovery center, drug recovery workers go to the community to recycle drugs after receiving the recovery message. It is assumed that communities are interconnected and can be reached by straight distances, irrespective of the issue of weight recovery and scattered around distribution centers. The customer coordinates are shown in Table 1. The solution process is designed as follows:

| Community Name  | Abscissa | Ordinate |
|-----------------|----------|----------|
| DC              | 1000     | 500      |
| Community A     | 300      | 1200     |
| Community B     | -1300    | 700      |
| Community C     | -400     | 1500     |
| Community D     | -1400    | -900     |
| Community E     | -200     | -1100    |
| Community F     | 450      | -1350    |
| Community G     | 1750     | -650     |
position = [1000 500; 300 1200; -1300 700; -400 1500; -1400 -900; -200 -1100; 450 -1350; 1750 -650].
population size=40; Maximum evolution=200; Cross probability=0.9; Probability of variation=0.1; ge
neration gap=0.9[7]; the optimal path is 1-8-7-6-5-4-3-2-1. and the total formation distance is 9321.21 m,
as shown in Figure 2.

4.2. Solving the Saving Mileage Method
Suppose the distribution center O, has customers (A~I), the customer distribution diagram formed is sh
own in figure 3, among OA=1.0, OB=1.6, OC=1.4, OD=1.0, OE=0.8, OF=2.4, OG=1.8, OH=2.4, OI=1.2, CE =1.4, HF=1.4 km. A, B, C, D, E, F, G, H, I have drug waste or drugs requiring goods 3.4, 1.6, 2.6, 5.6,
3.8, 7, 1.8, 0.6, 2.4 kg respectively, and the distribution center has recycling bins with a load of 10 kg.

Using the shortest path method, the distance between each node of the network is obtained. as sh
own in Table 2.

Figure 2. MATLAB solves the optimal road map

Figure 3. Customer Distribution
Table 2. The Shortest Path for Network Nodes

|   | O   |   |   |   |
|---|-----|---|---|---|
| A | 1.0 | A |
| B | 1.6 | 0.8 | B |
| C | 1.4 | 1.4 | 0.6 | C |
| D | 1.0 | 2.0 | 1.4 | 0.8 | D |
| E | 0.8 | 1.8 | 2.0 | 1.4 | 0.6 | E |
| F | 2.4 | 3.4 | 4.0 | 3.4 | 2.6 | 2.0 | F |
| G | 1.8 | 2.8 | 3.4 | 3.2 | 2.8 | 2.6 | 0.8 | G |
| H | 2.4 | 2.4 | 3.2 | 3.4 | 3.2 | 1.4 | 1.0 | H |
| I | 1.2 | 0.6 | 1.4 | 2.0 | 2.2 | 2.0 | 3.2 | 2.8 | 1.8 | 1 |

- Calculate the mileage savings between customers. The results are shown in Table 3.

Table 3. Number of savings for customer nodes

|   | A   | B   | C   | D   | E   | F   | G   | H   | I   |
|---|-----|-----|-----|-----|-----|-----|-----|-----|-----|
| B | 1.8 | B   |
| C | 1.0 | 2.4 | C   |
| D | 0   | 1.2 | 1.6 | D   |
| E | 0   | 0.4 | 0.8 | 1.2 | E   |
| F | 0   | 0   | 0.4 | 0.8 | 2.0 | F   |
| G | 0   | 0   | 0   | 0   | 0   | 3.4 | G   |
| H | 1.0 | 0.8 | 0   | 0   | 0   | 3.4 | 3.2 | H   |
| I | 1.6 | 1.4 | 0.6 | 0   | 0   | 0.4 | 0.2 | 1.8 | 1   |

- The saving process is arranged in order of size.
- The mileage saving method is used to optimize, in the case of satisfying the loading amount. To form three lines O-H-F-G-O, O-I-A-B-C-O, O-D-E-O, use only three medicine boxes with a load of 10 kg. Total distribution mileage: 2.4 + 1.4 + 0.8 + 1.8 + 1.2 + 0.6 + 0.8 + 1.4 + 0.6 + 1.0 + 0.6 + 0.8 = 13.4 km. 13.8 km. less than initial one-to-one distribution recovery.

5. Conclusion

Without considering the loading capacity of recovered vehicles, the path problem in drug recovery logistics is optimized by designing genetic algorithm. Under the consideration of the recovery vehicle loading capacity, the recovery path problem is optimized by the mileage saving method. Many factors need to be considered in the actual situation, and the global optimization ability of genetic algorithm is still the main content of research needs attention and innovation. When the logistics network is complicated, especially under the large distribution network, the total calculation workload of optimizing the logistics distribution line by using the mileage saving method is very large, and the complexity of the operation also increases, in order to form the optimized distribution line more quickly, the above model can be improved by cluster analysis.

References

[1] ZH, Xu, JW, Qian, YF, Huang. (1861-1862) Solve TSP Problem Discrete Wolf Group Algorithm [J]. Control and decision-making, (10).
[2] R, Jiang. (2016) Genetic algorithm in TSP Application of the problem [J], Software Tribune, (15): 127-129.
[3] John J. (2013) Proceedings of the First International Conference on Genetic Algorithms and their Applications [M]. Taylor and Francis.
[4] JM, Li, SF, Lin, LR, Gao. (2006) The hybrid genetic algorithm is used to solve multiple targets...
TSP Problem[J]. Journal of Xi'an University of Science and Technology, (10): 515-518.

[5] YL, Niu, JM, Wang (2006) Journal of Transportation and Transportation Engineering.

[6] L, Liu (2006) Empirical Study on Logistics Distribution Model[D], Chengtu: Southwestern University of Finance and Economics.

[7] Goldberg DE. Genetic algorithms in search, optimization and machine learning[M]. Boston: Addison-Wesley Longman Press, 1989.