Study on land port path optimization based on improved genetic algorithm

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Abstract. In the face of the development of supply chain globalization, whether it is the choice of goods clearance or transportation mode, the establishment of land waterless port for product transportation, rapid customs clearance, convenient enterprises have a great role. Based on the analysis of the present situation and existing problems of land ports in China, the paper uses improved genetic algorithm to optimize the previous transportation paths. This paper analyzes the present situation and existing problems of waterless ports in China so as to optimize the previous transportation paths by using improved genetic algorithm. Through continuous iterative optimization, the collection paths are shortened and the no-load rate is reduced, so as to make full and reasonable use of transport vehicles, provide better service for enterprises and reduce more costs for waterless ports.

1. Introduction
With the continuous development of China's logistics industry in recent years, the turnover and transportation of goods has been not limited to the coastal areas, under the double action of the fierce competition of the coastal port of our country to the inland hinterland resources and the demand of the inland provinces to open to the outside world, the Land Port begins to build and expand rapidly in the inland, moreover, with the proposal and construction of Belt and Road in China, the future development of anhydrous port can be said to be a bright spot, therefore, it is necessary to collect and collect goods efficiently for enterprises, outlets and so on in the Land Port service area, and to optimize the transportation organization research. The genetic method can solve this kind of problem, not only can reduce the transportation mileage, raise the income, but also play a certain role in promoting the whole social and economic development and the implementation of national policy. In order to reduce the cost of logistics and create more contribution for the society, it is necessary to collect goods efficiently for enterprises and outlets in the Land Port service area and optimize the research of transportation organization.[1]

2. Analysis of function and problems of Land Port
Land Port refers to the logistics center established in the inland area with the functions of customs declaration, inspection, issuance of bills of lading and other port services. In the inland importers and exporters can also complete the booking declaration, inspection and other formalities at the local Land Port, and then deliver the goods to the forwarder and the shipping company, the meaning of which is shown in figure 1.
2.1. Functional analysis of Land Port
(1) The functions of cargo distribution and environmental protection: Land port, as an upgraded logistics hub with port capacity, distribution is its most basic function, it is closely linked with coastal ports and plays the role of evacuating (pooling) goods for the latter.[2] As shown in figure 2.

(2) Logistics value-added services: Land Ports connect the original decentralized logistics system together to achieve one-stop service, so that the entire supply chain operation system will become more transparent, conducive to timely detection and correction of supply chain operation problems, improve supply chain security needs.

(3) Serving the economic functions of the hinterland: The establishment of Land Ports has facilitated the export of local sources of goods, breaking the restrictions on the transport of goods that can not be transported or the price of goods is expensive, which has brought economic benefits to the local area. The introduction of goods and technology from other regions through land ports can also facilitate the development of local regions, This can also solve the problem of unbalanced regional development in China.

2.2. Analysis of problems in Land Port
In recent years, with the rapid development of logistics industry in China, the construction of Land ports has also made great achievements, and with the promotion of Belt and Road construction in China, the development of inland anhydrous port has become an inevitable trend. [3]The Land Ports that have been built in our country play an important role in the local economic development and transportation convenience, but the construction of the Land Ports needs many preconditions, and the development of the Land Ports in our country is still in the development stage, and there are still many shortcomings: (1) The scale of multimodal transport is not sufficient, the implementation of multimodal transport is difficult and the allocation of funds is not reasonable; (2) The low level of standardization of the logistics industry and the lack of smooth logistics convergence affect the efficiency of the supply chain; (3) High transport costs and low vehicle utilization between Land Ports lead to overall inefficiency.[4]

3. Application of genetic algorithm to optimization of Land Port path

3.1. Problem description
The traditional method of collecting goods is point-to-point transportation, which is easy to cause the situation of low loading rate or waste of resources returned by empty vehicles, and the number of transport vehicles is large, which makes the operation cost very high. When considering this problem, think of the Chinese postman problem, how to make the postman do not repeat every road, but also make the postman take the shortest way to complete the delivery. In this question, we consider that the owners of the carpool, starting from the land port, in turn through the various delivery points, where the capacity of the car allows, in each divided area, from one point to the next point, and so on, finally to the land port, greatly improve vehicle utilization. Because the land port faces a large number of shipping points, it needs a lot of cars to participate.[5]

As a result, two major issues need to be addressed urgently:

The owner of the vehicle directly from the starting point to the land port, the vehicle utilization rate is low;

The irregular arrival of the owner of the land port brings challenges to the management of the port.

3.2. Modeling of scanning method

(1) Symbols established

P-Land Port
i- Delivery point
N- Collection of all shipping points
t- Working period, \( t \in T \)
\( d_{ij} \) -Paths formed at any two shipping points
Q-Maximum load per truck
\( q_n \) -Quantity of goods per point of shipment
\( V_s \) - Collection of shipping points for K pickup service
K-All bus assemblies

(2) Decision variable

\( x_{ijk} \): 0-1 variable. When a pickup truck passes (i,j) and the order is i to j, return value is 1.
\( y_{ik} \): 0-1 variable. Return value of K, i, of a pickup truck is 1.
\( z_{ik} \): 0-1 variable. Return value t 1 if the pickup k passes through the planned time.

(3) Transport model

Assuming that the following conditions should be satisfied, the vehicle arranges the path:

Each vehicle must use a waterless port as its destination and destination.
Each distribution point is served with a distribution vehicle.
Every vehicle must not exceed the maximum load.

Building transport models (1)-(10)

\[
Z = \min \sum_{k=1}^{n} \sum_{i=0}^{n} \sum_{j=0}^{n} d_{ij} x_{ijk} \quad (1)
\]

\[
\sum_{i=1}^{n} q_{i} y_{ik} \leq Q, k \in K \quad (2)
\]

\[
\sum_{k \in K} z_{ik} = 1, i \in N, t \in T \quad (3)
\]

\[
\sum_{i \in N} z_{itk} = 1, t \in T, k \in K \quad (4)
\]
\[
\sum_{j \neq k, j \neq v_k} x_{ijk} \leq 1, i \in v_k, k \in K
\]  
(5)

\[
\sum_{j \neq k, j \neq v_k} x_{ijk} \leq 1, i \in v_k, k \in K
\]  
(6)

\[
\sum_{j \neq k, j \neq v_k} x_{ijk} + \sum_{j \neq k, j \neq v_k} y_{ijk} = 1, i \in v_k, k \in K
\]  
(7)

\[
x_{ijk} \leq y_{ik} \cdot y_{jk}, i \in N, j \in N, k \in K
\]  
(8)

\[
\sum_{j \neq k, j \neq v_k} x_{ijk} = \sum_{j \neq k, j \neq v_k} y_{ijk} = K, 1 \leq i, j \leq n
\]  
(9)

\[
\sum_{i, j \neq v_k} X_{ijk} \leq |s| - 1, s \subset v_k
\]  
(10)

3.3. Improved genetic algorithm
After the scanning group, the problem will be converted to VRP problem. In this problem, as the number of delivery points increases, the complexity of the research problem will increase exponentially. However, the traditional genetic algorithm has the problems of low operational efficiency and slow response, so the traditional genetic algorithm is upgraded in this problem. Through the improved genetic algorithm, and by changing the chiasma, mutation and other strategies to slow down the premature algorithm, as well as the problem of poor local search, the initial population creation is optimized to speed up the algorithm. [6] The specific process is shown in figure 3.

![Flow chart of genetic improvement algorithm](image)

Figure 3. flow chart of genetic improvement algorithm.

3.4. Case analysis
Take KunShan port as an example, there are 20 shipping points beside KunShan port, and the shipment quantity of the shipping points is stored in the Cellular Matrix A. The maximum load of each vehicle is set to 1400KG. Construct polar coordinates, rotate polar axis anticlockwise, with vehicle load of 1400KG as constraint. Group processing is shown in Figure 4. 20 emission points are divided into three areas by scanning method, and the total emission weight of each area is not more than 1400KG. Use three vehicles to collect goods.
Figure 4. delivery point area.

Set up: Population size is 120. Algorithm termination conditions are ‘Iteration=400’. The crossing rate is 90%. The variation rate was 0.02%. The penalty weight of vehicle overload is 300 yuan. Therefore, the priority of the delivery point can be obtained according to the priority of the delivery point and the vehicle transportation constraints: 3>2>4>1,7>6,14>13; Freight collection and transportation constraints: 14 and 15, 11 and 12. The simulation data of the distance and the number of iterations in the process of cargo collection path optimization of dry port are obtained under various constraints. As shown in Figure 5

Figure 5. path convergence.

In order to verify the superiority of IGA, the same experimental data is used and the basic data of the algorithm is set up in accordance with GA and POS algorithm. The results are shown in Table 1.

| IGA | GA | PSO |
|-----|----|-----|
| Iteration times/frequency | path length/km | Iteration times/frequency | path length/km | Iteration times/frequency | path length/km |
| 25  | 678.22 | 265  | 710.73 | 370  | 793.74 |
| 75  | 584.49 | 470  | 661.15 | 525  | 682.19 |
| 125 | 558.65 | 755  | 622.81 | 860  | 653.99 |
| 149-400 | 552.37 | 895-1300 | 614.75 | 990-1430 | 632.18 |

It can be seen from the above table that in the same case, choosing IGA algorithm can quickly get better solution than GA and POS when the number of iterations is smaller, which fully shows the effectiveness of IGA algorithm.

4. Conclusions

There is no doubt that Land Ports play a vital role in regional economic development, and with the rapid development of China's logistics industry in recent years and the support of the national Belt and Road policy, attention has been paid to the construction of inland Land Ports, but the problems are also developing continuously, the improved genetic algorithm used in this paper not only promotes the distribution of goods and the optimization of the route, but also plays an important role in improving
the efficiency of transportation, reducing the cost and reducing the difficulty of Land Port management.

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