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Research Article

Path Optimization and Logistics Economic Benefits Based on Sparsely Sampled GPS Trajectory Data

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Affected by the technological revolution of the Internet and the rise of e-commerce, the logistics, and transportation industry has become the main artery of the economy, and higher requirements are placed on logistics and distribution. Nowadays, how to minimize the cost of logistics distribution is an important research goal of logistics economic benefits. To this end, this article investigates and discusses the logical distribution based on interval variables, and on the basis of previous studies, has carried out some fruitful research and attempts on the logical distribution model and solving algorithm. The beginning of this article explains the research background and the importance of this article. Analyzed and reviewed the current research status at home and abroad, and pointed out that the fuzzy and probabilistic methods used in previous studies to describe the variable assumptions used were too strong. The method used in this article to characterize interval variables does not need to know the probability distribution and density function that the variables obey, so it has more applicability. However, in view of the widespread popularity of sensor equipment and mobile communication equipment, more and more sparsely sampled trajectories, such as road patrol data, company employee check-in data, and base station data, are always poorly sampled for flight path data used to connect to mobile phones. The method of collecting this type of data is different from traditional GPS data and does not require items with GPS positioning equipment. The scanning width is much better than traditional trajectory data, but the scanning accuracy of a single object is insufficient. The intersection recognition method based on GPS trajectory data effectively improves the economic benefits of logistics transportation. In this paper, the study of sparsely sampled GPS trajectory data and intersection identification methods is applied to improve the economic efficiency of logistics and promote the development of the economic efficiency of logistics.

1. Introduction

As an important part of human economic activities, logistics activities will develop with the development of productivity. When the productivity reaches a certain level, there will be redundant products, and the logistics used in the exchange process will also keep pace with the times [1]. After the industrial revolution, with the arrival of mass production and consumers, the logistics industry developed rapidly. The source of today's logistics development began in the 1950s and 1960s and matured in the 1970s and 1980s. From a global perspective, it has only half a century of development history [2]. As a result, some famous overseas economists and management scientists regard domestic logistics wealth as the last mysterious and unknown country in the economic transportation economy [3]. At present, logistics and transportation in the field of transportation have become one of the most important issues in the process of economic globalization [4]. The international industry and the scientific community agree that the logistics industry is becoming the largest source of profit [5]. The transportation function is one of the seven basic functions of all modern logistics [6]. Obviously, it occupies a very important position. A large part of the entire logistics system is transportation costs [7]. How to effectively control and reduce transportation costs will greatly affect the total cost of logistics. Saving is an important core of our logistics economic benefits [8]. As we all know, the factors that affect the cost of logistics and transportation are mainly technical factors, such as the failure to popularize and better understand management information systems and management techniques, and the unscientific and human factors of transportation planning, especially the lack of professional talents and strategic cost awareness and overall staff cost awareness. [9]; First of all, let us use sparse sampling to establish a vehicle path planning template for interval requirements [10]. The difference is that each customer's demand is considered to be a transportation model that is coordinated with the interval number at the time of delivery, but applying this operation will produce a greater distance [11]. Taking the interval-variable logistics distribution model as the goal, the GPS trajectory data algorithm is used to solve the problem [12]. Using the intersection identification method proposed by standard test data to analyze the economic benefits of this logistics distribution model, we found that for each customer, our decision-makers will have a comparison between the vehicle load and customer demand at about 0.6 with the best results, the transportation cost can be reduced to the greatest extent and the economic benefits of the entire logistics distribution process can be maximized [13].

2. Related Work

An integrated vehicle path model for loading and unloading with a time window was introduced based on a satisfaction function [14]. The main feature of the model is to relax the time window constraints, so that satisfaction is no longer a Boolean variable [15]. For this model: use the improved model differential evolution algorithm to solve the problem and the transition probability in the differential evolution algorithm, the penalty function of the objective function [16]. In order to analyze the economic benefits of this model, we obtain: width is directly related to customer satisfaction. The wider the time window, the easier it is for customer satisfaction [17]. In addition, couriers should use a large number of transportation tools to make transportation as efficient as possible, thereby reducing transportation costs and improving economic efficiency [18]. The construction of a Delaunay triangulation network was introduced to cluster the point clusters according to the characteristics of the dense nodes of the intersections, to first determine the center position and spatial area of the complex intersections, and second, select 39 major urban road networks nationwide as training. The model is fully excavated [19]. The advantage of the data structure lies in the enrichment of sample types and capacity through simplification, rotation, and flipping. Finally, the neural network of GoodLeNet is selected for training because it has rich local capabilities and can learn its advanced fuzzy skills [20]. A complex intersection represents a gathering area, connected by several intersecting highways, ramps, sidewalks, and other secondary roads [21]. It represents the typical microstructure of the road network and is also the most common and basic road network. In the synthesis of large-scale topographic maps, the identification of complex intersections is one of the most important steps in road network selection, simplification, and classification. However, due to its complex structure and diverse morphological changes, accurate identification of complex intersections in road networks has always been difficulties of research [22]. A complex neural network intersection detection method was introduced based on GoogLeNet. First, select the road network data of major cities across the country as the sampling source of the complex intersection sample, and then use vector data to mirror and construct the Delaunay triangle around the complex intersection in a simplified manner. Preliminary positioning of complex intersections by the network uses mirroring and simplification. To increase the sample size, the radial constrained D-P algorithm extracts the global feature points of the curve and proposes a new method of identifying the global feature points of the curve. Calculate the reference value of the straight line between the interval points and the reference value of the vertical line from the intermediate point to the straight line from the standard deviation, and extract the global characteristic points of the curve by comparing the curvature of each point on the curve with the total curvature of the curve.

3. Road Junction Recognition System Based on Sparsely Sampled GPS Trajectory Data

3.1. Arterial Road Recognition Algorithm. This paper presents a method for identifying primary and secondary roads at complex intersections subject to multifunctional constraints. The basic idea is: first extract the characteristic points of the arc of the complex intersection, break the arc according to the characteristic point, and then identify the arcs of the parallel group of parallel lines to obtain the road trunk of the complex intersection.

GoogLeNet's complex intersection detection method based on a neural network accurately identifies complex intersections in the road network, including complex intersections with less interference, complex intersections with horn or clover type, and branches of complex intersections with more interference this provides a prerequisite for the identification of main and auxiliary roads at complex intersections in this paper. The main road sections and secondary road sections of complex intersections are related to each other, and there is a topological relationship. The main route is composed of parallel clusters composed of parallel arches, and the secondary road sections are dominated by ramp arches. Figure 1 shows some types of complex intersections that have been identified in the road network. Figure 1(a) shows a complex intersection with less disturbance, and Figure 1(b) shows a complex intersection with more disturbance and more irregularities. For intersections, Figure 1(c) shows a horn-shaped complex intersection, and Figure 1(d) shows a clover-shaped complex intersection.

Aiming at the shortcomings of the radial constrained DP algorithm in extracting the global feature points of large-scale curves, the selection method based on the DP algorithm feature points and the selection method based on the constrained DP feature points are combined with the radial algorithm, and an improved curve function point extraction is proposed. The main content is: extract the global feature points of the curve through self-fitting,

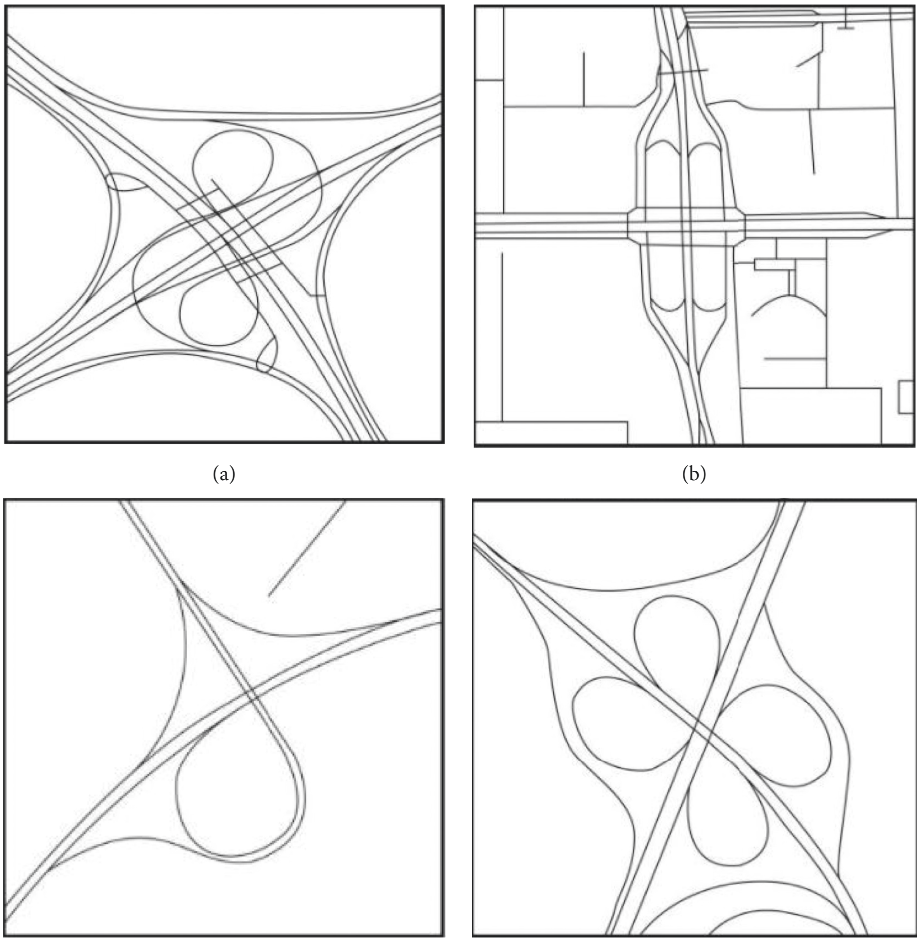

Figure 1: Recognition types of complex intersections. (a) Less interference at, (b) Complex intersections with multiple (c) Complex horn-shaped (d) Complex horn-shaped.

first calculate the mean and median of the vertical distance between the point and the interval, and the mean and median of the interval, and then select the mean or median with good standard deviations. The number is used as a reference for keeping the characteristic points of the curve. Finally, the overall and global characteristic points of the curve are extracted by comparing the curvature of each point on the curve.

The essence of the line element simplification algorithm is to minimize the number of its nodes while maintaining the curve shape attributes as much as possible, while maintaining as many global feature points as possible. In order to extract the characteristic points of the arc, an improved Douglas–Peucher (DP) algorithm is used. The algorithm extracts the global feature points of the arc through self-fitting, uses the standard deviation point and the reference value of the vertical line to calculate the reference value and the center of the distance line, and compares the points on each curvature curve with the total curvature of the curve to extract the arc Global feature points.

The specific steps are:

Step 1: Intersect all the points of the curve, connect each point in the range of the curve, and draw a vertical line connecting each point in the range through the midpoint, as shown in Figure 2, and so on, until they intersect The curve is all the points, the vertical lines are, respectively, marked as M_1, M_2,M_3, ..., and the length of the connection between the interval points are marked as N_1, N_2, N_3,....

Step 2. Calculate the length M of each vertical line and the connection length N of each interval point, calculate the median MP, mean MQ, and standard deviation $D(M)$ of the vertical line, and calculate the connection median of each interval point, the length of the interval NP, the average value NQ, and the standard deviation D(N) (the standard deviation here refers to the standard deviation calculated using the median as the reference value, and the standard deviation calculated using the average value as the reference value) dispersion. Compared with the data set, the

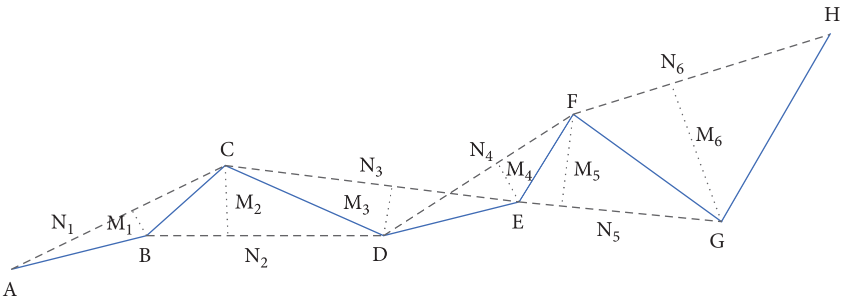

Figure 2: Schematic diagram of preliminary processing of the curve.

Table 1: The number of the length M of each vertical line and the length N of the connection of each interval point.

Article i	1	2	3	4	5	6	7	...	n
The length of each vertical line M	Mi	Mi	m_3	m_4	Ms	m_6	My	...	Mn
The length of each interval point connection N	N\	Ni	n_3	n_4	n_5	n_6	N7	...	Nn

smaller the standard deviation, the smaller the dispersion, and the larger the standard deviation, the greater the dispersion, as shown in Table 1.

The formula is as follows:

$$\begin{aligned}
M_Q &= \frac{M_1 + M_2 \ldots M_n}{n}, \\
N_Q &= \frac{N_1 + N_2 \ldots N_n}{n}, \\
\delta_M &= \sqrt{D(M)}, \\
D\left(M_Q\right) &= \frac{\left(M_1 - M_Q\right)^2 + \left(M_2 - M_Q\right)^2 + \cdots + \left(M_n - M_Q\right)^2}{n}, \\
D\left(M_P\right) &= \frac{\left(M_1 - M_P\right)^2 + \left(M_2 - M_P\right)^2 + \cdots + \left(M_n - M_P\right)^2}{n}, \\
\delta_N &= \sqrt{D(N)}, \\
D\left(N_Q\right) &= \frac{\left(N_1 - N_Q\right)^2 + \left(N_2 - N_Q\right)^2 + \cdots + \left(N_n - N_Q\right)^2}{n}, \\
D\left(N_P\right) &= \frac{\left(N_1 - N_P\right)^2 + \left(N_2 - N_P\right)^2 + \cdots + \left(N_n - N_P\right)^2}{n}.
\end{aligned} \tag{1}$$

3.2. Ramp Recognition Algorithm. The back road of a complex intersection is usually arched, and the overpass ramp is the clearest. Therefore, accurately identifying the ramp of a complex intersection is an important part of simplifying the intersection. The ramp is arched as a whole, and there are changes in some places that cannot be easily measured from the curvature. The curvature only reflects the local characteristics of the curve and cannot accurately reflect the overall shape of the curve. In order to quantify the overall shape characteristics of complex intersections, this article defines the circle as the most compact plane shape, and the straight line is the least compact plane shape. A metric to measure the shape characteristics of the region, namely, compactness, is proposed, which can accurately reflect the spatial distribution of the region, the tightness. The mathematical expression of compactness is shown in thefollowing formula:

$$C = 4\prod \times \frac{A}{P^2}. \tag{2}$$

In the formula, A represents the area of the polygon, $\prod$ is a constant, C represents the compactness of the plane, and P represents the perimeter of the polygon. If the tightness of the arc segment surrounding the polygonal plane shape is greater, it means that the shape of the arc segment is more similar to that of a circle, and the greater the possibility that the arc segment belongs to a slope; when the arc segment surrounds the polygon, the tightness of the plane is smaller the arc, the more straight line the shape of the arc is, and the less likely it is that the arc belongs to a slope. The compactness of a circle is 1, and its planar shape is the tightest. The closer to a straight line, the less compact the plane tends to zero. Calculate the compactness of the planar shape of each arc in the complex intersection, put all the arcs in the same complex intersection in a set, find the two extreme points of each arc, and then find the shortest connecting the two extreme points The distance arc forms a closed polygon, and then calculates the perimeter and area of the polygon and maintains the compactness of the arc until it covers all arcs in the set; in this way, the compactness of the arcs in all complex intersections is achieved. Therefore, the distance threshold between the two ends of the arc is used to identify the slope in the complex intersection.

3.3. Road Junction Simulation Experiment and Result Analysis. According to the experimental data of OSM urban transportation network data, the initial ratio of the data is 1: 10,000, and they are initially set as complex intersections. A

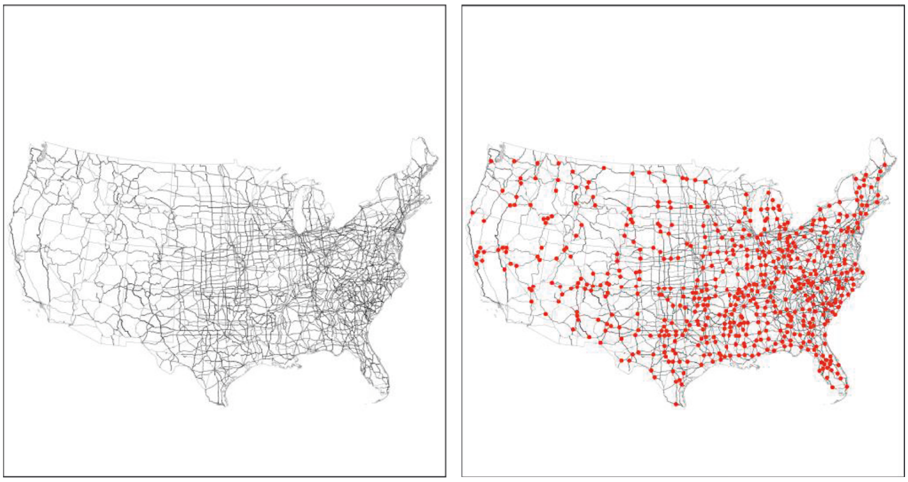

Figure 3: Verification data and positioning points to be identified.

Table 2: Comparison of complex intersection recognition results of two neural network models.

Neural network model	Manual discriminant number	Model classification number	Correct number of model classification	RR/ (%)	PR/ (%)	F
AlexNet network model	1785	1994	1593	89.24	79.89	0.84
GoogLeNet network model		1809	1652	92.55	91.32	0.92

total of 2,102 intersections have been identified. As shown in Figure 3, under the same data set, the method in this paper is compared with the method based on AlexNet neural network proposed by others to test the accuracy and adaptability of the method in this paper.

The experiment uses two neural network models to identify the complex intersections included in the urban road network of traffic data, counts the number of model classifications and correct classifications of the complex intersection models in the two network models, and manually distinguishes the number of intersections. And then calculate the precision ratio (PR), recall ratio (RR), and measurement value (F-score) between the two neural network models. The mathematical functions are shown in equations (3)–(5) and the results are shown in Table 2.

$$\mathrm{PR} = \frac{\mathrm{TP}}{\mathrm{TP} + \mathrm{FP}} \times 100\%, \tag{3}$$

$$\mathrm{RR} = \frac{\mathrm{TP}}{\mathrm{TP} + \mathrm{FN}} \times 100\%, \tag{4}$$

$$F = \frac{2 \times \mathrm{PR} \times \mathrm{RR}}{\mathrm{PR} + \mathrm{RR}}. \tag{5}$$

Among them, TP (True Positive) means that the label is positive and the prediction is also positive; FP (False Positive) means that the label is negative and the prediction is positive; FN (False Negative) means that the label is positive and the prediction is negative; the measure is the recall rate And the harmonic mean of precision.

It can be seen from Table 2 that using the sample training library created in this article, the detection and recognition rates of complex intersections based on the AlexNet network model and the GoogLeNet network model are both around 90%, indicating that the sample library articles in this article contain multiple types of complex intersections and intersections. Reasonable sampling parameters. These two models can better identify the deep fuzzy features of complex intersections, and effectively identify complex intersections in the road network; in addition, the detection method based on the GoogLeNet network model has an accuracy improvement of 11.43 compared with the detection method based on the AlexNet network model%, which shows that the GoogLeNet network model more accurately describes and classifies complex intersections on the deep attributes of complex intersections, and these intersections are identified with a higher probability in the correct classification. In addition, the accuracy and method callback in this article are both greater than 90%, which shows that training neural networks based on the combination of vector and raster data are more effective than training directly using raster data. Vector data itself, as a high-level feature, has no additional impact on the background image, has less noise, and contains high purity of information, which is more conducive to improving the accuracy of model training.

Table 3 shows the overall results of using the GoogLeNet neural network model of complex intersections to identify OSM road network data.

Table 3 shows that the two neural networks have basically the same detection results for typical complex and low-noise intersections, while the detection results for irregular

Table 3: Comparison of the recognition results of different types of complex intersections by the two neural network models.

Recognition methods	Type of intersection				
	Class I	Class II	Class III	Class IV	Total
Manual discriminant number	857	129	283	516	1785
AlexNet network model	824	116	232	421	1593
GoogLeNet network model	827	118	253	454	1652

and complex horn, clover, and multiple interference intersections are based on the GoogLeNet network model on the AlexNet network model. The detection results of the system are increased by 21 and 33, respectively, and the accuracy is increased by 7.40% and 6.40%, respectively, indicating that the former is significantly better than the latter in the detection ability of local details.

According to experimental data, eccentricity (DOE) refers to the ratio of the distance (L) from the geometric center of the complex intersection to the center of the sample divided by half of the diagonal distance (R) of the sample. The closer the ratio is to 0, the more complex and precise the intersection is found, and the closer to 1, the more deviated from the center position.

$$\mathrm{DOE} = \frac{L}{R} \times 100\%. \tag{6}$$

Calculate the distance from the geometric center of all complex intersections into the center of the sample, then calculate the average of all distances, and divide the average by half of the diagonal of the sample to get the average distance from the center of the sample. Calculate the geometric center of the sample. The complex intersection is 24 m, and the average distance from the center of the sample based on the AlexNet neural convolutional network to the geometric center of the complex intersection is 73 m:

$$\begin{aligned}\mathrm{DOE}_{\mathrm{GoogLeNet}} &= \frac{L}{R} \times 100\% = \frac{24}{0.5 \times \sqrt{256^2 + 256^2}} \times 100\% \\ &\approx 13.26\%, \\ DO\ E_{\mathrm{AlexNet}} &= \frac{L}{R} \times 100\% = \frac{73}{0.5 \times \sqrt{256^2 + 256^2}} \times 100\% \\ &\approx 40.33\%.\end{aligned} \tag{7}$$

It can be said that the eccentricity of the method in this paper is relatively small, indicating that the method in this paper has a high anti-interference ability.

3.4. Recognition Experiment of Auxiliary Roads at Complex Intersections. The experimental data are data from OSM of Urban Road Network. The initial ratio of the data is 1:10000. A total of 66 complex intersections were obtained, including 422 trunk roads and 653 secondary trunk road sections, as shown in Figure 4. The method in this paper is compared with manual experiments to verify the accuracy of the method in this paper.

The method in this paper recognizes 66 complex intersections in the OSM road network with a total of 1075 road sections to identify main roads and auxiliary road sections. Among them, the number of main roads to be identified is 422, and the number of unrecognized auxiliary road sections is 653. The total recognition results are shown in Table 4. There are 395 main roads correctly recognized and 27 main roads recognized incorrectly, of which 584 are correctly recognized minor road sections and 69 are misrecognized minor road sections.

It can be seen from Table 4 that the recognition accuracy rate of complex road junctions is 93.60%, the recognition accuracy rate of complex intersections and small sections is 89.43%, and the comprehensive recognition accuracy rate of complex intersections is 91.07%. It shows that the method in this paper considers the topological relationship of the primary and secondary arterial roads in complex intersections. Under the multifunctional constraints, the parallel clusters in the complex intersection can be identified first to obtain the main road, and then the second road section can be obtained by identifying the lanes of the complex intersection. Not only can it effectively identify the main road sections and secondary road sections of complex intersections with obvious characteristics, but also can effectively identify the main road sections and secondary road sections with similar local shapes at complex intersections, and at the same time meet the requirements of automatic map synthesis. The simplification requirements of complex intersections simplify complex intersections in large-scale road networks more accurate and wise.

4. Logistics Economic Benefit Evaluation System

4.1. Evaluation Method of Satisfaction Function

4.1.1. Advantages of Satisfaction Function Based on Time Window. The advantage of the time-slot-based satisfaction function is that it can reflect people's subjective feelings more truly, instead of using Boolean variables to rigidly manage them. In the traditional time window problem, a feasible solution must satisfy all the conditions of the time window. If customers are served within the time they expect, they will feel very good, otherwise, they will feel particularly bad. In this case, his satisfaction (or even the service level of his server) can be described by a dichotomous variable, that is, if there are only two discrete cases, use 0 and 1, and if satisfied, it is 1. If not satisfied, it is 0.

However, we assume that the time window may be interrupted due to operational or economic reasons, and from a human point of view, a certain tolerance will appear

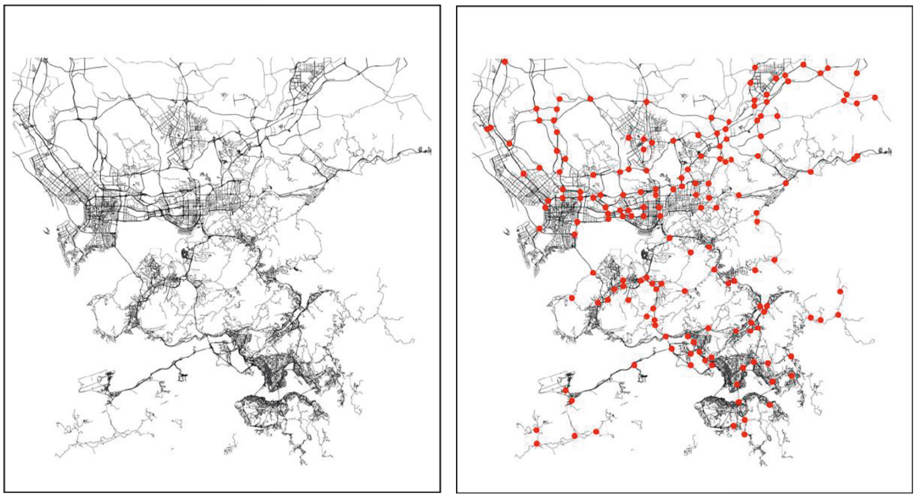

Figure 4: Raw data and acquired location points of complex intersections.

Table 4: Recognition results of arterial roads and auxiliary road sections in complex intersections.

Number		Types of	
	Class I	Class II	Total
Number to be identified	422	653	1075
Identify the correct number	395	584	979
Number of identification errors	27	69	96
Accuracy	93.60%	89.43%	91.07%

in the mind of the customer. On this basis, we are redefining customer satisfaction. Before that, there are two basic concepts that need to be explained:

The earliest tolerable time (eet): This is the time that the client can accept before the time slot. We believe that the service starts now. The customer is not the most satisfied, but it is still within the acceptable range.

Tolerable latest time (elt): This is a time that the customer can accept later than the time window. We believe that at this time, although customers feel that the service is too late, it is not too late and is still within tolerance.

An example was used to illustrate the relationship between these concepts. If the customer wants us to send them a batch of goods between 11:00 and 12:00, but for whatever reason, the customer cannot fully guarantee that they will wait for us between 11:00 and 12:00. Of course, if you can provide service between 1:00 and 12:00 in the morning, that is the best, and service satisfaction is also the best for customers, but due to the uncertainty of factors such as travel time, if you There at 22:30. At this point, the customer may have just arrived at the store and is preparing. We arrived earlier at this time, but it is acceptable to the customer. On the contrary, if we arrive later, as long as it is acceptable, in this case, due to this flexible processing method, the customer can also accept it. Therefore, it is necessary and appropriate to determine the appropriate processing method of the earliest tolerable moment and the latest tolerable moment.

4.1.2. Characterization of Satisfaction Function Based on Time Window. Although customers can accept delays and early arrivals, apparent satisfaction has clearly been recorded. At this point, compared with the previous two points, satisfaction will only be the effect between the best and the worst. In order to deal with this kind of human feelings, we use fuzzy theory to solve this method. Based on the above definition, we use the fuzzy membership function to establish the function between arrival time and satisfaction as follows:

$$L(t) = \begin{cases} 0, & t < eet, \\ f(t), & eet \le t < e, \\ 1, & e \le t \le l, \\ g(t), & l \le t < elt, \\ 0, & elt \le t. \end{cases} \tag{8}$$

The definitions of $f(t)$ and $g(t)$ are as follows:

$$f(t) = \frac{t - eet}{e - eet}, \qquad g(t) = \frac{elt - t}{elt - l}. \tag{9}$$

In this way, only the time window $[e, t]$ and the earliest tolerable time, the latest tolerable time, and the vehicle arrival time can be used to calculate customer satisfaction.

Satisfaction with customer service can be expressed as follows:

$$L_i(t) = \begin{cases} \dfrac{1 - eet_1}{e_1 - eer_t}, & \text{if } ect_1 \le t \le e, \\ 1. & \text{if } e_1 \le t \le l_i, \\ \dfrac{elt_t - 1}{e/t_t - l_t}, & \text{if } l, \le t \le elt_t, \\ 0. & \text{if otherwise.} \end{cases} \tag{10}$$

The entire mixed multi-objective integer programming model is as follows:

$$\text{Min} \sum_{k=1}^{\bar{k}} \sum_{j=1}^{n} x_{0,jk}, \tag{11}$$

$$Mn \sum_{k=1=1,j=0}^{i} \sum_{i=}^{n} c_{kk}, \tag{12}$$

$$\text{Max} \sum_{i=1}^{n} L_1 \left(\sum_{k=1}^{E} \sum_{i=0}^{n} t_1^k x_{ikk} \right), \tag{13}$$

$$\text{S.t.} \sum_{k=1}^{\bar{k}} \sum_{i=0}^{n} x_{i,kk} = 1, \quad j = 1, L, n, \tag{14}$$

$$\sum_{i=0}^{n} x_{ijk} - \sum_{t=0}^{n} x_{jik} = 0, \quad j = 0, 1, \ldots, n, k = 1, \ldots, \bar{k}, \tag{15}$$

$$\sum_{j=1}^{n} x_{0,k} \leq 1, \quad k = 1, \ldots, \bar{k}, \tag{16}$$

$$\sum_{i=0}^{n} \sum_{j=0}^{n} d_i x_{ijk} \leq C; \quad k = 1, \ldots, \bar{k}. \tag{17}$$

The above model can be reconstructed with other models under certain conditions and can easily become other classic models. Remove the objective function (8), and this model becomes a comprehensive charging and discharging problem with difficult time window constraints. If the constraint model (14) is removed on this basis, it becomes a vehicle driving problem with a difficult time window. When the time zone restriction is removed, this problem becomes a classic vehicle routing problem. If the conditions are difficult and only one vehicle is allowed to complete all service tasks, this problem becomes a classic TSP problem. Even if we use a soft time window to replace the time window condition in the hard model, the model will develop into a vehicle driving problem with a soft time window. When fuzzy time windows are used in the vehicle routing problem model, the problem becomes a vehicle routing problem with fuzzy time windows.

4.2. Simulation Experiment and Economic Benefit Analysis

4.2.1. Numerical Simulation. This chapter mainly focuses on the numerical simulation of previous models and algorithms. All results are calculated with MATLAB 2011 under the 3.20 GHz 7 Windows environment. Our numerical experiments use standard test data. We will first consider using our model algorithm to solve a small problem. The relevant parameters used in the algorithm are as follows: NP is 100, MAXGEN is 75, MAXGEN1 is 100, F is 0.55, CR is 0.1, C.mas is 0.9, maximum distance L is 5000, maximum vehicle load is 200, time window width (W) Set to 30, and the maximum number of vehicles is 25. These aspects represent the results of 100 customer groups. The first line to be changed is the name of the standard data file used here, 2 to 5 and 6 to 9 represent the number of vehicles, total transportation routes, total service levels, and program execution time. From the table, we can also read the number of vehicles (W), total distance (ID), and total service satisfaction (TS). In order to prove the effectiveness of the algorithm, we also give the program execution time (Time (s)).

From Table 5, we can see that our algorithm is an efficient algorithm: for 100 customers, in most cases, for the total distance, the result of the differential evolution algorithm is greater than the result of the genetic algorithm, but the total satisfaction is different. The evolutionary algorithm is larger than the genetic algorithm, and it is difficult to ensure that the total path is short and the degree of satisfaction is high at the same time. In addition, the number of vehicles in each group is basically the same, and all situations can be solved without problems. Finally, we found that the travel time is related to the number of vehicles. The fewer vehicles, the faster the travel speeds.

In the previous model introduction, we also introduced that if we relax the constraints of the time window and make the length of the time window infinite, customer satisfaction will no longer be a problem to be considered, and our model will degenerate into a time window. The problem of integration of loading and unloading is solved. If we take the test data in lc101 as an example, in the case of standard testing, we get the following results: The first figure shows the convergence of the algorithm, which shows that our algorithm is effective. The genetic algorithm finally reached a total distance of 951.1305, 9 vehicles were used, the overall service level was 100%, and the program execution time was 250.7684 seconds. In contrast, the differential evolution algorithm achieved better results, with a total driving distance of 916.8929. The number of vehicles used is 6, the overall satisfaction is 100%, and the program execution time is 250.7684 seconds. At the same time, we also used our results to compare the best results in the past and found that 829.9400 of the best results of the standard test case is the best result of this data, which is better than our best result 916.8920. This is because of our first result. An optimization goal is to minimize the number of vehicles.

The result of genetic algorithm convergence is shown in Figure 5:

The convergence result of the differential evolution algorithm is shown in Figure 6:

Based on these results, on the one hand, we can draw conclusions from our convergence results. Our algorithm itself has no deviations, algorithm design errors, and logic errors in the calculation process. After many repeated calculations, we can draw a comparison of our calculation results, concentrated and dense. On the other hand, our algorithm may have some advantages over more traditional genetic algorithms, which may reflect the high level of our algorithm. In the process of convergence, the genetic algorithm is more likely to fall into the local optimum, and there is a certain premature trend. If a gene conservative strategy is adopted, the defect of non-convergence of some

Table 5: Calculation results of small-scale loading and unloading integrated vehicle routing problem.

	GA				De			
File name	VN	TD	TS	Timers (s)	VN	TD	TS	Timers’ (s)
LclOl	5.0000	2047.3257	53.9471	375.3661	6.0000	1912.3212	56.8738	268.1964
Lcl02	6.0000	1971.4478	55.4908	351.4982	6.0000	1806.7123	57.0021	254.1159
LclOS	5.0000	1878.1978	60.5881	318.3044	5.0000	1564.6428	50.6467	229.5555
Lcl04	5.0000	1813.8689	63.6318	320.1064	5.0000	1765.3033	45.1533	233.9762
Lcl05	6.0000	1830.7826	52.1885	354.5755	6.0000	1537.5746	56.8470	255.2628
Lcl06	6.0000	1976.9573	48.2792	337.4069	5.0000	1731.2166	55.6746	253.0221
Lcl07	6.0000	2241.9175	53.1753	368.9323	6.0000	1702.5625	54.3812	305.3447
LclO8	6.0000	1947.5183	60.7660	359.7078	6.0000	1602.9425	62.6871	309.3736
Lc109	5.0000	1871.6373	588954	336.6809	6.0000	1822.3856	64.1883	255.5116
LrlOl	4.0000	1875.2844	38.4959	310J746	4.0000	1689.9430	59.6056	213.6742
Lr1O2	5.0000	2024.0457	56.5340	353.6706	5.0000	1663.5637	62.3928	239.0061
Lr103	4.0000	1923.8673	55.1671	284.1393	4.0000	1580.5635	67.4715	202.7491
Lrl04	4.0000	1798.1114	58.4036	286.8648	4.0000	1652.8367	74.2263	199.1114
Lr105	5.0000	2295.9771	54.2255	341.7699	5.0000	1819.4346	59.2435	242.1321
Lrl06	5.0000	1769.5195	6L1344	307.2870	5.0000	1708.8334	60.6870	225.1821
LrlO7	4.0000	1715.2067	61.2422	312.4140	4.0000	2708.8333	72.9372	204.0778
Lrl08	4.0000	1695.3547	57.6145	316.5692	4.0000	1557.6036	71.8783	199.7644
Lrl09	5.0000	2023.2663	53.6353	336.8699	5.0000	1819.4357	55.2435	210.9158
LrllO	40000	1973.5848	58.5754	330.9589	4.0000	1573.1996	69.2678	187.2176

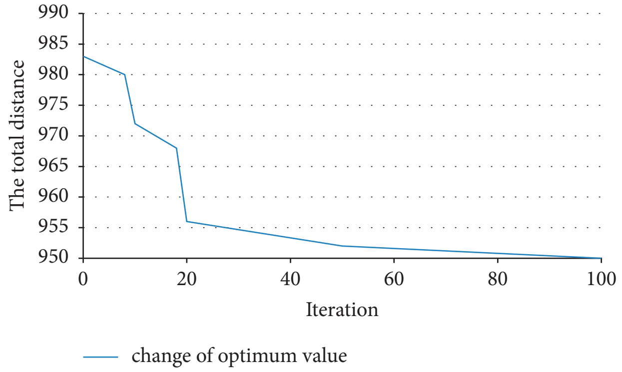

Figure 5: Convergence results of genetic algorithm.

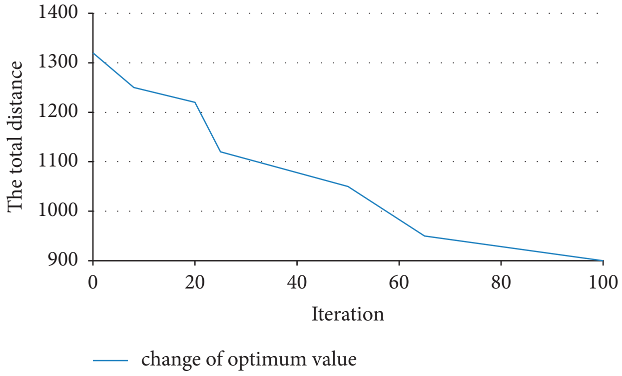

Figure 6: Convergence results of differential evolution algorithm.

algorithms in the province can be overcome to a certain extent, but if the parameter settings are not appropriate, it will often lead to premature conditions. As for the calculation time when the algorithm is running, the calculation hardware conditions of the differential evolution algorithm and the genetic algorithm are the same. From the results, the differential calculation efficiency is slightly higher. Relatively speaking, our calculation results show that due to our understanding of the differential evolution algorithm and improved operations based on this problem, our algorithm can overcome prematurely on the one hand, and ensure convergence on the other hand. We guarantee the accuracy and credibility of the results so that we can use these calculation results to make decisions based on actual logistics and distribution conditions.

Through the previous discussion, we have seen the effectiveness and benefits of small-scale problem models and algorithms, but in the era of the modern big data explosion, the problems we face are often no longer the previous small-scale quantitative level, but with the data. With the expression of scale, the problem becomes more complicated, and the difficulty of calculation and practical application also becomes more difficult with this change. So now we are ready to test hundreds of customers or even thousands of customers to test the results of models and algorithms. The calculation data used in the calculations here are all derived from standard test cases. Due to the long calculation time of each file, in order to avoid too long results, we have selected some representative calculation results as the basis for our analysis and investigation.

We all know that the larger the scale, the more complicated the problem. Whether it is the actual coordination or the solution of the algorithm model, many changes need to be made. The following are the parameters we set during the calculation: NP is 100 and MAXGEN is 50. MAXGEN1 is 100, F is 0.5, CRm is 0.1, CRm.a. I is 0.9: the maximum travel distance L is 5000, and the maximum number of vehicles is 30. The width of the time window is also 30. Therefore, the results of 200, 400, and 1000 customers are calculated as shown in Table 6. From the table we can see the number of vehicles (WN), total distance traveled (1D), overall

Table 6: Medium and large-scale vehicle path calculation results.

GA					De					
File	VN	TD	TS	Time (s)	VN	TD	TS	Time (s)	k	C
LC1_2_1	10	9922.5489	37.0618	592.7897	10	9906.6478	50	403.493	50	200
LC1_2_2	11	10063.5378	50.2131	501.8384	10	10002.0372	56.7532	411.9451	50	200
LC1_2_3	10	10731.299	53.3521	521.2435	10	10001.3457	45.1429	412.3722	50	200
LC1_2_4	10	9960.6069	66.0345	550.0335	10	9909.0377	68	427.9126	50	200
LC1_2_5	1	9989.027	43.2383	554.2728	11	9943.6377	62.6601	412.13	50	200
LRC2_2_6	2	1165.4969	46.8884	279.234	2	10731.8378	63.9723	255.279	50	1000
LRC2_2_7	2	11710558	53.8024	288.0708	2	10724.5743	58.5696	258.4265	50	1000
LRC2_ 2_8	2	1176.9827	59.8012	268.9302	2	10663.4743	69.3481	256.2385	50	I000
LRC2_2_9	2	1123.4237	57.8921	270.7881	2	10392.1572	58.897	258.0468	50	1000
LRC2_2_10	2	1152.9283	57.2842	2735517	2	10247.9347	58.283	252.2985	50	1000
LCI_4_1	21	3013.6947	34.5287	966.2769	21	29448.1087	53.37	879.9314	100	200
LC1_4_2	20	3414.0173	45.3797	1035.537	20	32892.1646	57.1118	881.5325	100	200
LCI_4_3	21	3540.8037	59.2479	998.9298	21	31943.3463	59.4696	851.4147	100	200

satisfaction TS, program duration (time), maximum number of available vehicles (k), and vehicle load. As shown in Table 6:

It can be seen from the results of this large and medium-sized case that our algorithm and model can get good results in different situations. The table shows that some service levels have been reduced but are unfair to customers. Suppliers should not sacrifice customer interests in order to reduce costs. Dealers should use the largest possible means of transportation because they can ensure that fewer vehicles are used to serve customers. The number of vehicles is usually proportional to the cost. In addition, we can also see from the table that for this problem, the computational efficiency of the differential evolution algorithm for large-scale test cases is higher than that of the genetic algorithm. Finally, we can also conclude that the differential evolution algorithm tends to solve the problem of high customer satisfaction, and we find that the overall satisfaction is lower than the overall satisfaction of other scales. The main reason is that we need more vehicles to complete the loading and unloading services, and with the expansion of the scale, the problems between roads have become more complicated, and it is difficult to guarantee high satisfaction for all customers at the same time.

5. Conclusion

To sum up, the main work of this article includes three aspects: one is to apply the possibility conversion method in the interval number optimization theory to the study of the economic advantages of logistics transportation; the other is to apply savings, and the research on comprehensive guidance of loading and unloading vehicles with time windows The third aspect is to provide research methods and ideas for interval variables in transportation research. This article has achieved some groundbreaking results, but there are also some shortcomings. The work of interval variables in logistics and transportation economics also requires more researchers to conduct more in-depth research and exploration in the future.

Data Availability

The data used to support the findings of this study are available from the author upon request.

Conflicts of Interest

The author declares that there are no conflicts of interest.

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