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O2O Distribution Route Optimization based on Floyd Algorithm

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Abstract

The O2O platform has developed rapidly. The original one-person-one-order delivery model has a large number of personnel and high delivery costs. This paper adopts the method of one person with multiple orders, using Floyd algorithm to solve the shortest distribution path, which greatly improves the distribution efficiency, reduces the distribution cost, and reduces the personnel occupation.

Keywords

Floyd algorithm; O2O platform; Distribution route optimization.

1. Introduction

The popularity of the Internet has led to the rapid development of e-commerce, and has also prompted the O2O model that combines online and offline commerce to receive widespread attention. O2O stands for Online to Offline, which refers to the combination of online Internet and offline physical stores. The O2O platform uses online promotion to guide customers to make offline consumption, on the one hand to strengthen user stickiness, on the other hand to attract traffic to physical stores and expand sales channels. At the same time, consumer demand has increased, the scale of order distribution continues to expand, and people's requirements for convenience and timeliness of consumption are getting higher and higher. While meeting the individual needs of users, major O2O platforms also consider how to reduce operating costs. As an important link between consumers and the O2O platform, distribution is critical to improving company efficiency, reducing company transportation costs, and achieving standardization and scientific logistics distribution.

Hirose et al. through organizing actual business activities and clarifying consumers' responses to O2O, combined with O2O theory and practice, concluded that the O2O model can obtain more benefits than the traditional e-commerce model [1]. Taking into account the purchase risks that consumers are likely to encounter, Xiao and Dong adopted a hidden semi-Markov model to build a reputation management system, which helps to reduce the risk cost of consumers in O2O e-commerce[2]. Hou and Xu proposed a fuzzy comprehensive weight transportation route optimization method to solve the vehicle route problem of road damage under natural disasters [3]. Tang and Zhou proposed an improved firefly swarm optimization (GSO) algorithm based on particle swarm optimization (PSO) to solve the path planning and optimization problems of unmanned combat aircraft [4]. Gevaers et al. established a model of online customers placing orders, merchants receiving orders, and fixed-point delivery [5]. Devari et al. used the customer's social network and combined with the crowdsourcing distribution model to fully demonstrate its potential benefits [6].

2. Problem and model

2.1. Introduction to Floyd algorithm

Floyd algorithm is a matrix iterative algorithm proposed by k.W.Floyd in 1962, which can find the shortest distance between any two points. The basic idea of Floyd algorithm is that in the

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weighted adjacency matrix of the graph, v matrices D(1), D(2),..., D(v) are constructed sequentially by inserting vertices, so that the resulting matrix D (v) It becomes the distance matrix of the graph, and the matrix of insertion points is also calculated to obtain the shortest path between two points.

2.2. Problem description

The O2O platform adopts a one-person, one-order approach. A delivery person takes an order without providing route optimization for the delivery person. After receiving the order, the delivery person can only choose the route based on his own judgment. If it is an unfamiliar address, it will reduce The efficiency of distribution cannot meet the time limit requirements of customers for goods. Now, due to the expansion of the order scale of the O2O platform, it is planned to merge orders with similar customer addresses or similar business addresses within the same period of time, so that multiple orders can be distributed on one line, thereby reducing the phenomenon of one person, one order and personnel occupation, and improving delivery efficiency. Shorten the delivery time.

2.3. Symbols and variables

Table 1 Symbols and their meanings

Symbols	meaning
w	Weight matrix
v_i	Vertex i
n	Number of vertices
d	square matrix of n
k	Number of iterations
dij	The distance between two adjacent points v_i and v_j

2.4. Mathematical model

In the O2O platform distribution process, the one-person-multiple-order method is adopted to maximize customer satisfaction. The best path is the shortest distance. The expression is

$$minL = \sum d_{ij}$$

The steps of Floyd algorithm are as follows.

First determine the floor plan weight matrix. A plane graph is composed of vertices and edges. The edges are connected by different vertices, and each edge has a weight. Weight matrix w, $w=[w_{ij}]_{n\times n}$,

(1) When the vertex and vertex constitute an edge, and the length of the edge is l_{ij} ,then $w(i,j)=l_{ij}$

(2) When the vertex and the vertex do not form an edge, then $w(i,j)=\inf$

(3) $w(i,i)=0, i=1,2,\ldots n$

Second, determine the distance matrix of the floor plan. First give the weight matrix of the floor plan: $w=[w_{ij}]_{n\times n}$, Perform iterative operations on the matrix

$d_1=[d_{ij}^{(1)}]_{n\times n}$, where $d_{ij}^{(1)}=\min\limits_{1\le s\le n}[w_{is}+w_{sj}]$, $d_2=[d_{ij}^{(2)}]_{n\times n}$, where $d_{ij}^{(2)}=\min\limits_{1\le s\le n}[d_{is}^{(1)}+d_{sj}^{(1)}]$; $d_k=[d_{ij}^{(k)}]_{n\times n}$, where $d_{ij}^{(k)}=\min\limits_{1\le s\le n}[d_{is}^{(k-1)}+d_{sj}^{(k-1)}]$; when $d_k=d_{k+1}$, $d=d_k=[d_{ij}]_{m\times n}$

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Finally, determine the shortest path between two points on the plane. On the basis of weight matrix w and distance matrix d, find the shortest distance d_{ij} between vertex v_i and vertex v_j.

Through Floyd path optimization, the shortest distance between vertices and other vertices can be found. The introduction of this algorithm can help dispatchers choose to pick up orders along the road and plan the shortest path.

3. Case analysis

Take some merchants and distribution areas in a certain area as an example, 10 merchants and communities in a district. Orders are placed through the 020 platform, and the order receiver can choose the number of orders and the number of destinations according to their route conditions. Convert each point on the map to a plan view, and assign a value to the edge of each point according to the distance between the two points, as follows

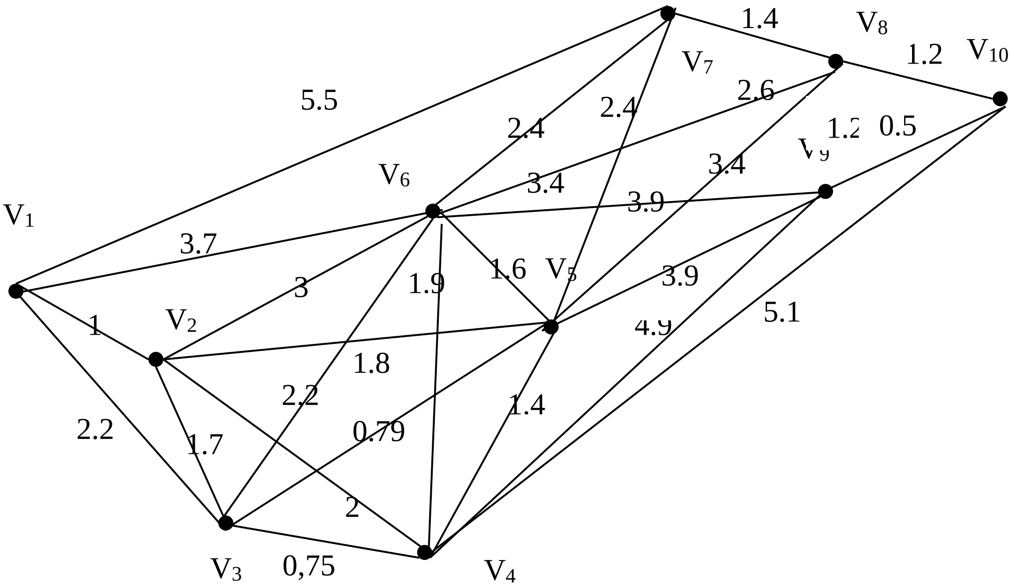

Figure 1 A plan view of each area

Through the Floyd algorithm for path optimization, the shortest distance between each vertex and the other vertices passed by can be found. The introduction of this algorithm can help the dispatcher choose to pick up orders along the road and plan the shortest path. Through Matlab software, the weight matrix of the floor plan is as follows:

Table 2 Shortest distance table

	1	2	3	4	5	6	7	8	9	10
1	0	1	2.2	2.95	2.8	3.7	5.5	6.2	6.7	7.2
2	1	0	1.7	2	1.8	3	5.3	5.2	5.7	6.2
3	2.2	1.7	0	0.75	0.79	2.2	4.29	4.19	4.69	5.19
4	2.95	2	0.75	0	1.4	1.9	4.3	4.8	4.9	5.1
5	2.8	1.8	0.79	1.4	0	1.6	3.5	3.4	3.9	4.4
6	3.7	3	2.2	1.9	1.6	0	2.4	3.4	3.2	3.7
7	5.5	5.3	4.29	4.3	3.5	2.4	0	1.4	2.6	2.6
8	6.2	5.2	4.19	4.8	3.4	3.4	1.4	0	1.2	1.2
9	6.7	5.7	4.69	4.9	3.9	3.2	2.6	1.2	0	0.5
10	7.2	6.2	5.19	5.1	4.4	3.7	2.6	1.2	0.5	0

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According to the plan view of each area, some areas cannot be reached directly, so the shortest path between each point can be known through the shortest distance table. Through the Matlab program, the shortest vertices of the points that cannot be reached are calculated in turn, and finally the following routing table is formed, and the vacant parts are the vertices that can be reached.

Table 3 The shortest route table

	1	2	3	4	5	6	7	8	9	10
1	0			3	2			2,5	2,5	2,5,9
2		0					5	5	5	5,9
3			0				5	5	5	5
4	3			0			6	5		
5	2				0					9
6						0				9
7		5	5	6			0			8
8	2,5	5	5	5				0		
9	2,5	5	5						0	
10	2,5,9	5,9	5		9	9	8			0

In order to make the path optimization results more obvious, this article randomly selects a path and compares the results before and after optimization. Select the path $V_1 \rightarrow V_{10}$, From the shortest path matrix, the shortest distance of $V_1 \rightarrow V_{10}$ is 7.2, From the Matlab program, the vertices on the shortest path are: V1, V2, V5, V9, V10.

According to the weight w matrix to reflect the connection between the vertices of the plane graph, the weight matrix w is used to find the shortest path. The shortest path from V1 to V10 is $V_1 \rightarrow V_2 \rightarrow V_5 \rightarrow V_9 \rightarrow V_{10}$

Compare the two paths after using one person, one order and the order merge path optimization, The result is shown below.

Table 4 Comparison before and after optimization

	path	number of order	mileage	Number of people
Before optimization	$V_1 \rightarrow V_2$,$V_1 \rightarrow V_5$,$V_1 \rightarrow V_9$,$V_1 \rightarrow V_{10}$	4	21.8	4
After optimization	$V_1 \rightarrow V_2 \rightarrow V_5 \rightarrow V_9 \rightarrow V_{10}$	4	7.2	1

It can be seen from the above table that compared with before optimization, the mileage has been saved by 67% and the personnel has been saved by 3 people.

4. Conclusion

This paper uses the Floyd algorithm to optimize the distribution path of the O2O platform. On the basis of the original one-person-one-order model, a one-person-multiple-order method is adopted to reduce the occupation of distribution personnel, save distribution costs, and improve distribution efficiency. The calculation examples show that the use of Floyd algorithm has a greater impact on mileage saving and reducing personnel occupation, which lays a foundation for the further expansion of route optimization in logistics applications. This article only considers the shortest path, and in the actual application process, there are still some

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restrictions on time, traffic, and distribution limitations, which require more restrictions in the algorithm.

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