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Tourist Route Planning Problem and Fast Track Solving Method

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Abstract: *With the development of China's economy and society, the number of tourists is increasing rapidly, the demand for the planning of tourist routes is more diversified, so it is urgent to design a fast and efficient travel route. For the route planning problem, scholars have carried out many researches, but so far, it has not got the algorithm with high accuracy and fast calculation speed. Therefore a synthesis algorithm is proposed based on a variety of heuristic algorithm. The algorithm has faster calculation speed and better operation result through the introduction of the ideal route and statistical simulation. Finally this algorithm is applied to tourist route planning problem successfully.*

Keywords: *TSP; tourist route planning; design; opt*

1. Introduction

Tourism, as a new form of entertainment consumption, is an important activity to improve the quality of people' life. At the same time, tourism can promote effectively the development of urban economy, promote social employment and promote the effective integration of culture and the environment. Tourist routes are the necessary links to connect tourists and scenic spots. Reasonable tourist routes is not only conducive to arrange their tourism activities, avoid "roaming", but also to play the tourist attractions, to use time rational and dominate travel expenses systematically.

With rapid evolution in computing technology in the last two decades, many computational techniques have been used in producing acceptable solutions for TSP, such as neural networks (Leung, Jin, & Xu, 2004; Masutti & de Castro, 2009), simulated annealing (Lo & Hus, 1998), genetic algorithms (GA) (Albayrak & Allahverdi, 2011; Jayalakshmi & Sathiamoorthy, 2001; Tsai, Yang, Tsai, &Kao, 2003), ant colony optimization (ACO) (Dorigo & Gambardella, 1997; Liu, 2005; Puris, Bello, & Herrera, 2010). Aditi Khanra, Manas Kumar Maiti & Manoranjan Maiti(2015) formulated a new model of TSP) with uncertain parameters, the model was solved by a hybrid method combining the Particle Swarm Optimization (PSO). Jie Bai & Gen-Ke Yang(2013) proposed a model induced max-min ant colony optimization (MIMM-ACO）to bridge the gap between hybridizations and theoretical analysis. Gaifang Dong, William W. Guo & Kevin Tickle(2012) proposed a new hybrid algorithm, cooperative genetic ant system (CGAS) to deal with the problem in regularly reaching the global optimal solutions for TSPs due to enormity of the search space and numerous local optima within the space. Ya'nan Wang(2012) designed out the travel route systematically for Heilongjiang Province .

Through the above analysis, it can be seen that the algorithm is numerous for solving the route planning. In general, they are lack of specific deep research, so it has theoretical and practical significance to research the algorithm deeply for solving the tourist route planning.

2. Model And Method

2.1. Model Formulation

In this tour, salesman starts from a city, visits all the cities exactly once and comes to the starting city using minimum distance. Let x_{ij} be the distance for traveling from *i*-th city to *j*-th city. Then the model is mathematically formulated as (Dantzig, Fulkerson, & Johnson,1954).The TSP model is mathematically formulated as:

Determine $x_{ij,}\quad i=1,2,\ldots,N;\quad j=1,2,\ldots,N$

to minimize $$\sum_{i=1}^{N}\sum_{j=1}^{N} d_{ij}x_{ij},$$

subject to $$\sum_{i=1}^{N} x_{ij}=1,\quad j=1,2,\cdots,N \tag{1}$$

$$\sum_{j=1}^{N} x_{ij}=1,\quad i=1,2,\cdots,N \tag{2}$$

$$\sum_{i\in S}\sum_{j\in S} x_{ij}\le |S|-1,\quad \forall S\in V,\quad x_{ij}\in\{0,1\}. \tag{3}$$

where $x_{ij}=1$ if the salesman travels from city-*i* to city-*j*, otherwise $x_{ij}=0$.

Constraints (1) and (2) state that each vertex can only be entered from one side and get out of one side. Constraints (3) ensure to eliminate the effect of the sub circuit.

2.2. Optimization Algorithm

This paper a new local optimization algorithm is proposed, which mixes the insertion node method, double point exchange method, 2-opt, or-opt ect, more accurate solution can be obtained quickly and efficiently with finite iterations.

2.2.1. Insertion node

Insertion node method refers to that some node is inserted into any other two nodes one by one in the given initial delivery line.

2.2.2. Or-opt method

In the or-opt method, two adjacent nodes are inserted into the other location or are relocated. As shown in Figure 1.

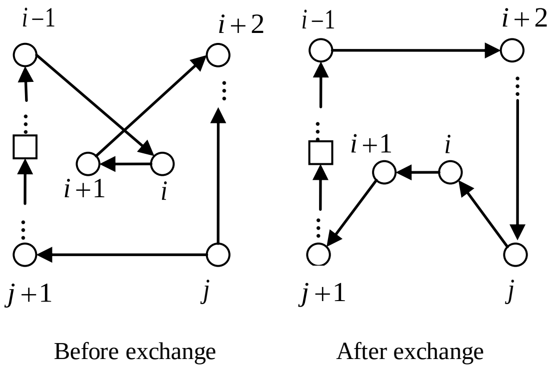

Fig1. *Or-opt algorithm exchange of single line diagram*

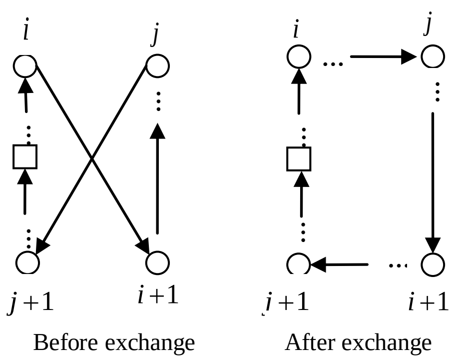

Fig2. *2-opt algorithm exchange diagram*

2.2.3. 2-opt method

In order to get better results, the delivery result obtained from the random- exhaustive method needs to be further optimized. As shown in Figure 2.

2.2.4. Double point exchange method

Double exchange method is defined to exchange the location of two delivery points discretionarily in the given initial distribution line. As shown in Figure 3.

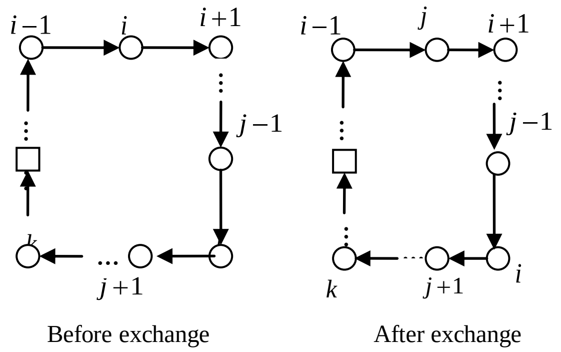

Fig3. *Double point exchange method diagram diagram*

2.2.5. Synthesis algorithm

In the synthesis algorithm, the insertion node method, double point exchange method, 2-opt, or-opt need to be used interchangeably, which can make the delivery time shorter and the shipping lines to get the biggest improvement.

2.3. The Optimality Test of the Algorithm

In order to understand the changes of the ratio between the ideal scheduling distance and the optimum solution obtained by the synthesis algorithm, we select 40 groups of random distribution nodes and distribution centers for large sampling, we calculate respectively and gain the mean percentage change data of sampling distribution distance in the case of 2 to 10 nodes. The final proportion change diagram is presented. As shown in Figure 3.

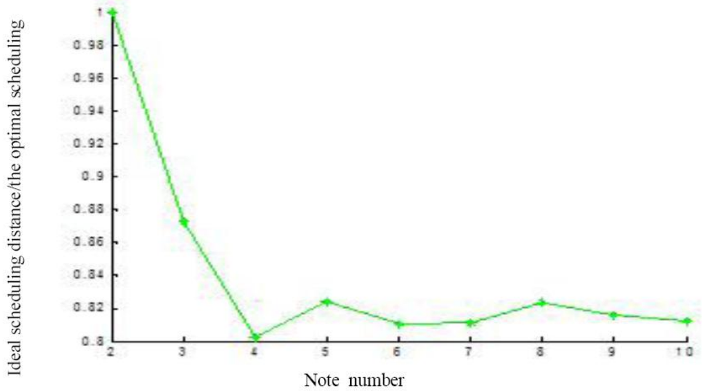

Fig4. *The ratio variation diagram of ideal scheduling distance and the optimal solution by synthesis algorithm between*

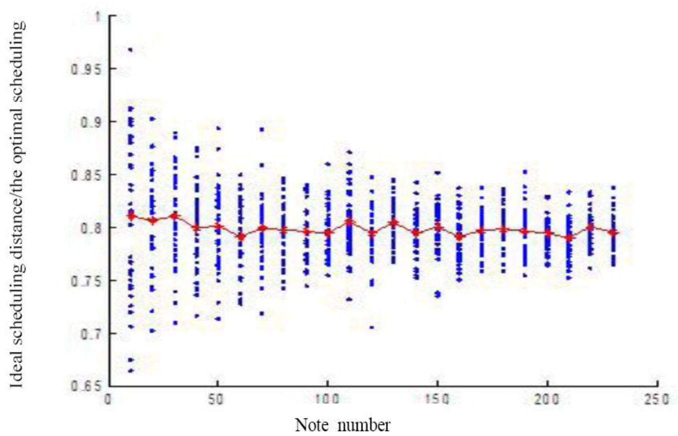

Fig5. *The ratio variation diagram of ideal scheduling distance and the optimal solution by synthesis algorithm between*

It can be found that the ratio of ideal scheduling distance and optimal dispatching distance is stable basically between 0.81 and 0.82 in the case of less distribution nodes through figure 4. At the same time, considering the optimality of the integrated algorithm, figure 5 is the ratio variation diagram of the optimal scheduling distance and the integrated algorithm to schedule the distance after using the integrated algorithm to calculate more nodes.

3. CASE ANALYSIS

According to the latest statistics, China has 201 state 5A-class tourist attractions. They are all over the 31 provinces, autonomous regions and centrally- administered municipality except the Hong Kong, Macao and Taiwan. Assuming self-driving travel enthusiasts want to tour again in China, we design different travel routes for them. We numbered these regions from 1 to 31, we assume the speed is 90km/h, driving 8 hours a day, travel enthusiasts travel from Xian , the the ancient capital city, after finishing the routes planned ,then return to Xian.

1 for Beijing, 2 for Tianjin, 3 for Hebei, 4 for Shanxi, 5 for Inner Mongolia, 6 for Liaoning, 7 for Jilin, 8 for Heilongjiang, 9 for Shanghai, 10 for Jiangsu, 11 for Zhejiang, 12 for Anhui, 13 for Fujian, 14 for Jiangxi, 15 for Shandong, 16 for Henan, 17 for Hubei, 18 for Hunan, 19 for Guangdong, 20 for Guangxi, 21 for Hainan, 22 for Chongqing, 23 for Sichuan, 24 for Guizhou, 25 for Yunnan, 26 for Tibet, 27 for Shaanxi, 28 for Gansu, 29 for Ningxia, 30 for Qinghai,31 for Xinjiang. The tourist attractions and the provinces and cities exhibition diagram is shown in Fig6.

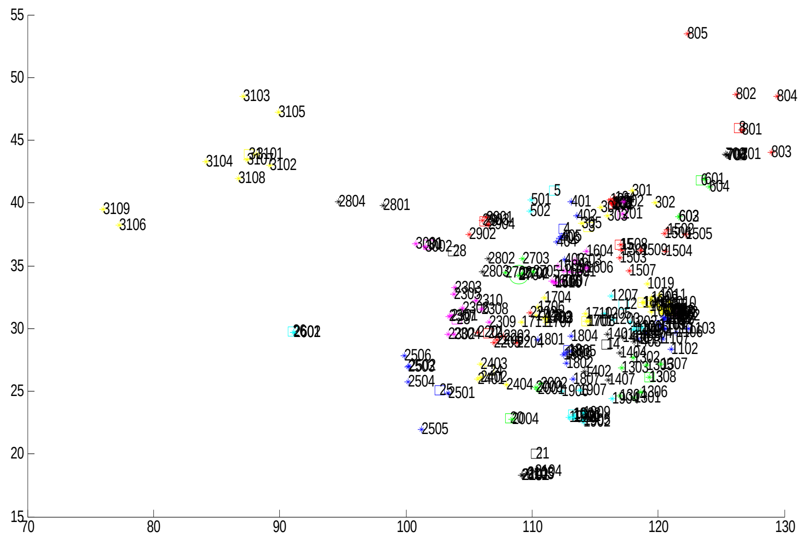

Fig6. *The tourist attractions and the provinces and cities exhibition diagram*

The 31 cities of the country are divided into four circles to travel. Each circle represents a tourist route. Route planning is as following:

Rout one:

27, 16,3, 15,2,6,7,8,1,5,4, 27

Shaanxi→Hubei→Hebei→Shandong→Tianjin→Liaoning→Jilin→Heilongjiang→Beijing→Inner Mongolia→Shanxi→Shaanxi

According to this tour line, it needs to drive 5660km, 7.9 days on the freeway; and it needs to spend 61.8 days including the highway travel time and the scenic tour time in the provinces, autonomous regions and municipalities. So it takes 69.7 days to finish the tour.

Rout two:

27, 18, 14, 13, 11,9, 10, 12, 27

Shaanxi→Hunan→Jiangxi→Fujian→Zhejiang→Shanghai→Jiangsu→Anhui→Shaanxi

According to this tour line, it needs to drive 3870km, 7.9 days on the freeway; and it needs to spend 65.7 days including the highway travel time and the scenic tour time in the provinces, autonomous regions and municipalities. So it takes 71.1 days to finish the tour.

Rout three:

27, 22, 24, 25, 20, 21, 19, 17, 27

Shaanxi→Chongqing→Guizhou→Yunnan→Guangxi→Hainan→Guangdong→Hubei→Shaanxi

According to this tour line, it needs to drive 5150km, 7.2 days on the freeway; and it needs to spend 56.9 days including the highway travel time and the scenic tour time in the provinces, autonomous regions and municipalities. So it takes 64.1 days to finish the tour.

Rout four:

27,30, 28, 29, 31, 26, 23, 27

Shaanxi→Qinghai→Gansu→Ningxia→Xinjiang→Tibet→Sichuan→Shaanxi

According to this tour line, it needs to drive 8740km, 12.1 days on the freeway; and it needs to spend 50.9 days including the highway travel time and the scenic tour time in the provinces, autonomous regions and municipalities. So it takes 63 days to finish the tour.

Specific tour diagram as shown in figure 7.

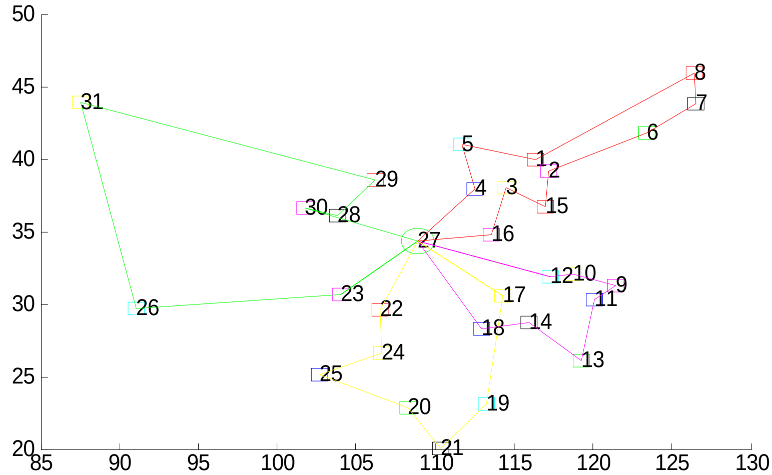

Fig7. *The diagram of tourist routes planning for four times*

4. Conclusion and Discussion

4.1. Conclusion

In this paper, a synthesis algorithm is proposed, which can solve the problem of travel route planning quickly and efficiently, and it is obviously superior to other algorithms in scheduling distance or computation time. Its high accuracy and high speed of solution can be used in other areas of distribution route planning, it has a strong practical application value.

4.2. Discussion

In this paper, although we design the tourism route planning, it is not considered the real-time road information and a variety of uncertain factors in the process of building the model and the solving process. Therefore, it has a lot of defects in dealing with randomness.

Acknowledgements

On the purpose of high degree of information, it will be able to meet better the need of the practical application to study the distribution routes planning with real-time road information based on GIS and GPS.

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