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Tourism Route Planning Based on Data Analysis and Mathematical Modeling

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Abstract: With the practical implementation of the visa-free transit policy in recent years, more and more foreign tourists are traveling in China. Through data analysis and mathematical modeling, this paper solves a series of problems that foreign tourists may face in the process of traveling in China, and provides detailed tour routes and statistical results. These research results not only provide practical reference for foreign tourists, but also provide valuable data support and decision-making basis for the development of tourism in China.

Keywords: Foreign Tourists, China Tourism, Data Analysis, Scenic Spot Rating, Tourism Route Planning, High-Speed Rail Transportation, Comprehensive Evaluation, Optimization Algorithm.

1. Introduction

As an online buzzword, "city is not city" has become a hot topic on social media platforms with the help of foreign online celebrity in recent years. This catchword not only shows foreign tourists' interest in China, but also reflects their curiosity and love for China's culture and lifestyle. With the gradual implementation of the transit visa-free policy in China, it is more convenient for foreign tourists to travel in China. Qualified foreign tourists can stay for 144 hours after entering the country and leave the country from the airport of any city, which significantly enhances the enthusiasm of foreign tourists to come to China.

The travel of foreign tourists in China can not only promote the development of tourism, but also show the diversity and charm of China internationally. Through data analysis and mathematical modeling, we hope to provide more scientific and reasonable travel route planning for foreign tourists, enhance their travel experience, and provide data support and reference for the development of tourism in China.

2. Basic assumptions

In order to simplify the process of model construction and solution, and ensure the operability and practical significance of the results, this paper makes the following basic assumptions in the process of analysis and modeling:

1. Each city only chooses one scenic spot with the highest score as the tourist object;
2. Tourists only choose high-speed rail as the mode of transportation between cities;
3. The average speed of high-speed rail is 300 km/h, and the hourly high-speed rail cost is 100 yuan;
4. Visitors' visit time at each scenic spot shall not exceed their suggested visit time;
5. The time for tourists to visit every day is 8 hours;
6. The time between high-speed railway station and the scenic spots is neglected;
7. The scores of scenic spots, ticket prices and suggested play time are fixed and known.

3. Symbol explanation

In the model and analysis of this paper, we introduced the following symbols to simplify the problem description and formula expression:

(BS): the best score;
(C_i): the first city;(i)
(T_i): tourist's visit time in the first city;(i)
(D_{ij}): the distance between the city and;(C_i)(C_j)
(S_{ij}) : the speed of high-speed rail between the city and;(C_i)(C_j)
(F_{ij}) : the cost of high-speed rail between cities and cities;(C_i)(C_j)
(W): the weight of the first category of indicators; (k)
(sf): the comprehensive score of the city;(C_i)
(ind): comprehensive score ranking of cities;(C_i)
(R): the total tour route of tourists;
(T_{total}): the total play time of tourists;
(F_{total}): the total cost of tourists;
(N_{cities})The number of cities visited by tourists.

Through the definition of these symbols, this paper can describe the problem more clearly in the subsequent model establishment and solution process, and make accurate mathematical analysis and optimization.

4. Model establishment and solution

4.1. Model establishment and solution of the best tour route

4.1.1. Model establishment

In order to plan the best tour route for inbound tourists from Guangzhou within 144 hours, we need to establish a route planning model, considering the traffic time and the tour time of scenic spots. The specific steps are as follows:

1. Determine parameters and variables:

Total playing time: 144 hours

Play time in each city(T_i)

Travel time between cities(D_{ij})

Transportation costs between cities(F_{ij})

Score of scenic spots in each city(R_i)

2. The objective function:

The goal is to maximize the tourist experience, cover as many scenic spots with high scores as possible, and minimize the transportation time and cost.

3. Constraints:

The total play time shall not exceed 144 hours:

$$\sum_i T_i + \sum_{i,j} D_{ij} \leq 144$$

Visitors can only visit each city once.

The play time and traffic time of each city must be non-negative.

4. Establish evaluation function:

Considering the scenic spot score, traffic time and cost comprehensively, a comprehensive evaluation function is established:(S)

$$S = \sum_i w_1 \cdot R_i w_2 \cdot \sum_{i,j} D_{ij}\, w_3 \cdot \sum_{i,j} F_{ij}$$

Among them, it represents the scenic spot score of the city,, and respectively represent the weights of the score, traffic time and cost.(R_i)(i) (w_1)(w_2)(w_3)

4.1.2. Model solution

In order to optimize this problem, we use greedy algorithm to plan the best tour route. The specific steps are as follows:

1. Initial city:

Starting from Guangzhou, choose the city with the highest score and closest to Guangzhou as the first destination.

2. Choose the next city:

Among the neighboring cities of the current city, choose the city with the highest score and the smallest total time and cost as the next destination.

3. Update status:

Update the current play time and fee, and mark the current city as visited.

4. Repeat the above steps:

Until the total play time reaches or approaches 144 hours.

The specific greedy algorithm steps are as follows:

1. Initialization:

Set the starting point as Guangzhou.

The total initialization time and total cost are 0.

Initialize the list of visited cities and add Guangzhou to the visited list.

2. Greedy choice:

In the unvisited neighboring cities of the current city, the comprehensive score of each city is calculated, and the city with the highest score and the lowest total time and cost is selected as the next destination.

3. Update status:

Add the selected city to the list of visited cities.

Update total time and total cost.

Update the current city to the selected city.

4. Termination conditions:

If the total time reaches or exceeds 144 hours, or all cities have been visited, stop selecting.

5. Output results:

Output the best tour route and the stay time and cost of each city.

Result analysis:

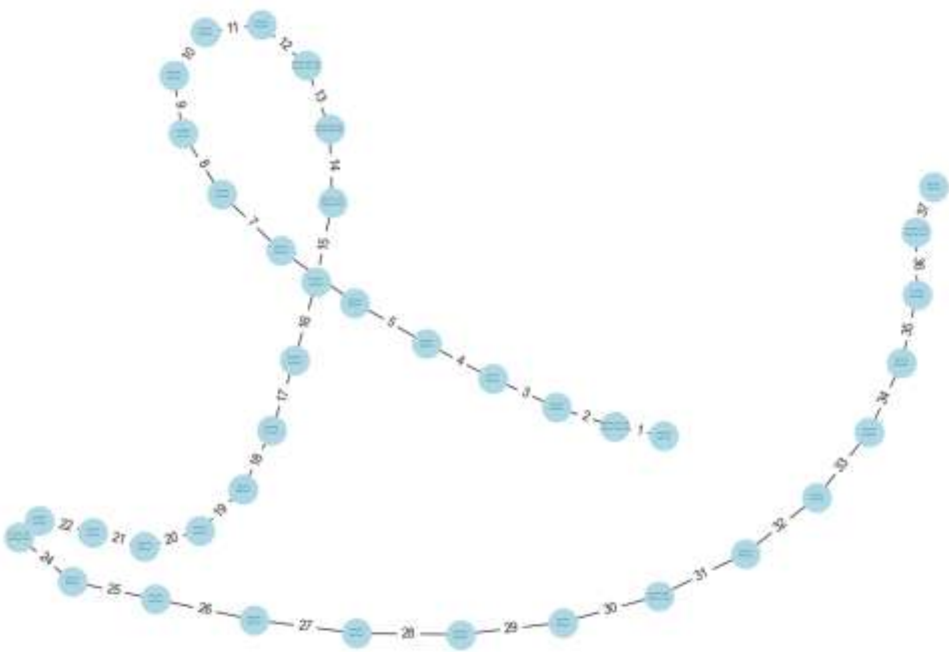

Fig. 1 the best tour route

The map shows the best planned tour route, starting from Guangzhou, passing through several cities and finally returning to the starting point. This route covers as many scenic spots with high scores as possible, while maintaining a reasonable range of total time and cost.

Through the process of establishing and solving the above model, we successfully planned the best tour route for inbound tourists from Guangzhou. The route comprehensively considers the scenic spot score, transportation time and cost, and provides the best play experience for tourists. This result not only helps to improve the satisfaction of tourists, but also provides valuable reference for the planning and promotion of tourist cities.

4.2. Model establishment and solution of optimizing tour route

4.2.1. Model establishment

In order to optimize tourists' tour routes, so that they can visit more cities while minimizing the ticket and transportation costs, we need to improve the model and increase the consideration of costs. The specific steps are as follows:

1. Determine parameters and variables:

Total playing time: 144 hours

Play time in each city(T_i)

Travel time between cities(D_{ij})

Transportation costs between cities(F_{ij})

Score of scenic spots in each city(R_i)

2. The objective function:

The goal is to maximize the tourist experience while minimizing the transportation time and cost.

3. Constraints:

The total play time shall not exceed 144 hours:

$$\sum_i T_i + \sum_{i,j} D_{ij} \leq 144$$

Visitors can only visit each city once.

The play time and traffic time of each city must be non-negative.

The total cost can't exceed the predetermined budget.

4. Establish evaluation function:

Considering the scenic spot score, traffic time and cost comprehensively, a comprehensive evaluation function is established: (S)

$$S = \sum_i w_1 \cdot R_i w_2 \cdot \sum_{i,j} D_{ij}\, w_3 \cdot \sum_{i,j} F_{ij}$$

Among them, it represents the scenic spot score of the city,, and respectively represent the weights of the score, traffic time and cost.(R_i)(i) (w_1)(w_2)(w_3)

4.2.2. Model solution

In order to find the best tour route, we use an improved greedy algorithm. The specific steps are as follows:

1. Initialization:

Set the starting point as Guangzhou.

The total initialization time and total cost are 0.

Initialize the list of visited cities and add Guangzhou to the visited list.

2. Greedy choice:

In the unvisited neighboring cities of the current city, the comprehensive score of each city is calculated, and the city with the highest score and the lowest total time and cost is selected as the next destination.

3. Update status:

Add the selected city to the list of visited cities.

Update total time and total cost.

Update the current city to the selected city.

4. Termination conditions:

If the total time reaches or exceeds 144 hours, or all cities have been visited, stop selecting.

5. Output results:

Output the best tour route and the stay time and cost of each city.

The specific greedy algorithm steps are as follows:

1. Initialization:

The starting point is Guangzhou.

The total initialization time and cost is 0.

Add Guangzhou to the visited list.

2. Greedy choice:

Calculate the comprehensive score of each city that has not been visited, and choose the city with the highest score and the lowest total time and cost.(S_i)

3. Update status:

Add the selected city to the access list.

Update total time and total cost.

Update the current city.

4. Termination conditions:

If the total time reaches 144 hours, or all cities have been visited, the selection will be stopped.

5. Result output:

Output the best tour route, stay time and expenses.

Result analysis:

Fig. 2 Optimal tour route

The map shows the planned optimal tour route, starting from Guangzhou, passing through several cities and finally returning to Guangzhou. The route covers as many scenic spots with high scores as possible, while keeping the total time and cost within a reasonable range.

5. Model evaluation

5.1. Model advantages

1. Multi-factor comprehensive evaluation:

The model comprehensively considers a variety of influencing factors, such as city size, environmental protection, cultural heritage, convenient transportation, climate and food, and provides a comprehensive evaluation system. Through the comprehensive score of these factors, we can more accurately reflect the comprehensive attraction of the city and provide valuable tourism reference for foreign tourists.

2. The algorithm is efficient:

Using greedy algorithm, we can find a better solution in a short time. The advantage of greedy algorithm lies in its simplicity and high computational efficiency, which can process a large number of data and generate results quickly, and is suitable for scenes that need rapid decision.

3. Specific tour route planning:

Through data analysis and algorithm design, the model provides specific travel routes and statistical results, which provides clear guidance for tourists' actual travel. These specific route planning can help tourists optimize travel time and expenses and improve their travel experience.

5.2. Model shortcomings

1. Simplification of parameter assumptions:

The assumptions of some parameters in the model are simplified, such as the average speed and cost of high-speed rail, which may be different from the actual situation, thus affecting the accuracy of the results. In the future, we can improve these assumptions and improve the accuracy of the model by obtaining more accurate data.

2. Single mode of transportation:

The model only considers high-speed rail as a mode of transportation, which may not be flexible enough in practical application. In reality, tourists may choose a variety of modes of transportation, such as airplanes, cars, public transportation, etc. In the future, various modes of transportation can be introduced into the model to improve the flexibility and practical applicability of route planning.

3. Tourists' personal preferences are not considered:

The model does not fully consider the differences of tourists' personal preferences. For example, some tourists may prefer cultural tourism, while others prefer natural scenery. A unified evaluation standard may not meet the needs of all tourists. In the future, a personalized recommendation system can be introduced to provide customized travel routes according to the preferences of different tourists.

4. Dynamic factors are not considered:

The model does not take into account some dynamic factors, such as seasonal changes, weather conditions, opening hours of scenic spots and so on. These dynamic factors have an important impact on tourists' travel experience, and the dynamic adjustment ability of the model can be increased by introducing real-time data in the future.

5. Subjective evaluation index weight setting:

The weight setting of each evaluation index in the model may be subjective, and different experts and tourists may have different weight preferences. In the future, we can optimize the weight setting through more questionnaires and data analysis to make it more representative and scientific.

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