Research on Intelligent Route Planning Based on Ant Colony Algorithm

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Abstract. In this paper, we propose a zoning plan for reasonable travel time for self driving travelers. There are 201 5A scenic spots in the country. Travelers who want to visit all scenic spots in the face of many time constraints need to optimize travel routes to ensure maximum travel income. Based on this idea, an optimal path analysis based on ant colony algorithm is proposed. After considering time constraints, the time window constraint is transformed into a target function. Constraint, the hard time constraints which must satisfy the limit of driving time limit and the limit of the opening time of the scenic spots are transformed into soft constraints, and the improved ant colony algorithm is used to iterate. With the help of the improved ant colony algorithm, the optimal path selection satisfying the time constraint is obtained. Taking Jiangsu Province as an example, this article draws a tourist route map of Jiangsu province.

Keywords: Partition optimization; Ant colony algorithm; Hard time constraint; Analytic hierarchy process.

1. Introduction

1.1. Background of the Problem
Tourism is becoming one of the most important driving forces in the global economic development. It accelerates the transfer of international funds and information and technology management, and creates the mode, demand and value of high efficiency consumption behavior. With the rapid development of national economy, people's living standards have been greatly improved. More and more people actively participate in tourism activities beneficial to physical and mental health. With the improvement of people's living standard and the development of tourism, the way of traveling has also become diversified. Self driving travel is especially popular. Self driving tour is a type of self-help tourism, which is different from the traditional group tour. The self driving tour provides the extensible space for the tourists in the selection object, the participation procedure and the freedom of experience. It has the inherent characteristics of freedom and individuation, flexibility and comfort, selectivity and seasonality, and has its own characteristics and charm compared with the traditional way of joining the group. For self driving tourists, tourism is a process of learning and accumulating experience. The attempt to travel starts from the periphery of self driving tourists and gradually radiate far away.

1.2. Description of Problem
Self driving travel is relatively large because of its autonomy, so it is necessary to plan carefully before choosing a scenic spot and route. According to the list of 201 5A level scenic spots announced...
by China's National Tourism Administration, a self driving tour enthusiast intends to make a tourism plan according to the list of scenic spots. The tourists have no more than 30 days of travel time each year, not more than 4 times a year, and no more than 15 days for each tour. Based on personal tourism preference, the least time for each 5A scenic spot is determined. Based on safety considerations, the driving time is limited to between 7:00 and 19:00 per day. The driving time is not more than 8 hours a day. In the daily schedule, if the day is arranged, the driving time is controlled within 3 hours, the half day sightseeing is arranged, the driving time is controlled within 5 hours, and the average speed on the freeway is 90 km/h, the average speed on ordinary roads is 40 km/h. The tourists plan to stay at least 24 hours in each provincial capital city to arrange special time to visit the city's characteristic buildings and experience local customs and customs (no scenic spots). The opening time of the scenic area is from 8:00 to 18:00. In view of the above, we can consider the following problems: the high speed and priority strategy is adopted in the design of the traffic line, that is, to reach the city adjacent to the scenic spot first through the freeway, and then go to the scenic spot. Please design the appropriate method and set up a mathematical model for the tourism enthusiast in Xi'an, for example, to plan and design tourist routes, and to try to decide for at least a few years to travel around 201 5A level scenic spots. Give a specific trip for each tour (the place of departure, the time of driving, the mileage of the driving, the tourist attractions, and if necessary, other more detailed expressions are required).

1.3. Article Hypothesis
There are several assumptions and limitations for the data and processing methods of the study:
1. The traffic time in the city is ignored, and the traffic congestion is not considered. The factors affecting the traffic due to weather and road problems are not analyzed.
It is assumed that one day or two day sightseeing scenic spot can be divided into half day, such as the first day afternoon scenic spot, the second day can continue to visit the half day to meet the requirements.
It is assumed that tourists strictly follow the route schedule and do not leave time for rest alone. If you visit a half day scenic spot A, do not take a rest to drive to the next scenic spot.
When driving on the established route, the tourists are in line with the estimated use of Baidu map, and do not make any extra stops.

2. Travel through 201 5A Scenic Spots

2.1. Model Thought
Under the constraint conditions, this article needs to classify the disorderly and disordered scenic spots in the country. There are two levels of classified thinking. According to these two levels, there are two kinds of optimization ideas to be chosen: the first level is to classify the scenic spots with the administrative province as a unit, and to optimize the path of the scenic spots in the administrative province. After seeing the time needed to visit the scenic spots in the entire administrative province, the administrative provinces are taken as a big node, and finally the path of these big nodes is optimized by the Xi’an as the starting point. The traveler's final travel time is obtained. The second level is classified by distance to the scenic spots (for example, the area of the classified area is 2 small distances. "At the time, the distance is the radius, the near center scenic spot of the scenic spot is taken as the center. The path is optimized to solve the path in the area. After calculating the time needed for the tour of the whole area, they are also used as a big node. Finally, the path of these big nodes is optimized by the Xi’an as the starting point. Find out the traveler's final travel time.
In comparison, the first path optimization solution is based on the province as a unit, the number of scenic spots is certain, the optimization goal is relatively clear, but the concentration of scenic spots in the province is weak and strong. If the province is set to optimize the solution, some scenic spots are bound to be far away from the scenic spots in the province, but it is close to the scenic spots in the provinces outside the province. The occurrence of this situation is bound to lead to longer travel time. Based on this reason, this paper puts forward second optimization ideas, namely, cross provincial selection, select the scenic spot as a set, and optimize the path to get a certain number of large nodes,
and then optimize the path of these large nodes, and finally solve the travel time. Theoretically, the travel time calculated by the second ideas is less than the travel time under the first thought.

2.2. Optimize the Solution to the Collection of Administrative Province

Through observation, we can find that some of the 2015A scenic spots in the country are located in the same urban area. In order to facilitate the follow-up analysis, we first merge these scenic spots and get 131 nodes. At the same time, on this basis, this paper first needs to locate the latitude and longitude of these nodes with the aid of GOOGLE map, and then use the computer technology to deal with the latitude and longitude.

Taking Jiangsu Province as an example, there are 19 5A scenic spots in Jiangsu Province, which can be merged into 9 nodes, including Suzhou node (Suzhou garden, Suzhou Kunshan Zhouzhuang, Wujiang Tongli ancient town in Suzhou, Suzhou Jin chicken lake, Suzhou Wu middle Taihu and Shang Yu Shan Shang Lake). Nodes (Wuxi Grand Buddha at Lingshan, Wuxi Turtle Head Islet scenic area, Wuxi film and television base), Changzhou node (Changzhou global dinosaur City, Changzhou Liyang city Tianmu Lake), Zhenjiang node (Zhenjiang San Shan Scenic Area, Zhenjiang Jurong Maoshan scenic area), Yangzhou node (Changzhou scenic area), Thai node State node (Qin Lake National Wetland in Jiangyan District of Taizhou) and Huaian node (Huaian Zhou Enlai hometown scenic area). With the help of Google map, the latitude and longitude of these nodes can be located in Table 1.

Table 1. Summary of the coordinates of each node in Jiangsu.

| Serial number | Node name     | Latitude and longitude coordinates [north latitude, Dongjing] | Coordinates in a simulated map |
|---------------|---------------|----------------------------------------------------------------|--------------------------------|
| 1             | Suzhou node   | [31.2983,120.5832]                                               | [3.57,1.19]                    |
| 2             | Nanjing node  | [32.0584,118.7965]                                               | [0,0]                          |
| 3             | Wuxi node     | [31.4910,120.3124]                                               | [3.03,-2.84]                   |
| 4             | Changzhou node| [31.8107,119.9736]                                               | [2.35,-1.24]                   |
| 5             | Zhenjiang node| [32.1896,119.4250]                                               | [1.26,0.66]                    |
| 6             | Yangzhou node | [32.3936,119.4127]                                               | [1.23,1.68]                    |
| 7             | Nantong node  | [31.9796,120.8937]                                               | [4.19,-0.39]                   |
| 8             | Taizhou node  | [32.4554,119.9255]                                               | [2.26,1.99]                    |
| 9             | Huaian node   | [33.6102,119.0159]                                               | [0.44,7.76]                    |

On the basis of obtaining the latitude and longitude coordinates of each node of Jiangsu Province, it is necessary to optimize the path of these nodes first. This is a typical TSP (Traveling salesman problem) problem. The ant colony algorithm is generally used to calculate the TSP problem. However, some time constraints need to be considered in this paper, so the model is designed and calculated. A certain revision is made in the rules.

2.3. TSP Solution Based on Common Ant Colony Algorithm

The ant colony algorithm was proposed by the Italy scientist M.Dorigo and others in the early 1990s. M.Dorigo et al. Found that ants find the shortest path between the nest and the food when looking at the foraging habits of the ants. Firstly, ant colony algorithm is successfully applied to traveling salesman problem (TSP). For the sake of expression, this paper gives the collection of n cities \{0,1,..., N-1\} and the cost of traveling around the city. The TSP problem is to find a minimum cost round trip through each city and return to the starting point. If each vertex is seen on the coordinates of the coordinate graph, TSP problem is to find a Hamilton loop with the least cost on a complete graph with N nodes.

Assuming that M self driving travelers travel from Xi'an to Jiangsu, each traveler has a certain memory function, which has the following characteristics:
(1) In the course of the traveler's movement from the city I to the city J, the I (J) will retain a certain memory. The traveler selects the next city with the corresponding transfer probability according to the memory intensity and the heuristic information.

(2) Put the cities that have already been in the taboo list, and taboo cities will no longer be chosen as the next city.

(3) After the completion of a cycle, recollection of the previous journey based on the length of the entire path (similar to the ant releasing the corresponding pheromone) and updating the corresponding memory on the path passed.

At the beginning, travellers have the same memory for each path, set \( C \) is constant. In the course of travel, the traveler determines the direction of transfer according to the memory of each path. The transfer probability used under this system is a pseudo random proportion rule. At \( t \) time, the probability of traveler \( K \) to select J in city I is:

\[
P^k_I (t) = \begin{cases} 
\frac{[A_i(t)]^\alpha [\zeta_{ij}]^\beta}{\sum_{j \in allowed_k} [A_i(t)]^\alpha [\zeta_{ij}]^\beta} & \text{if } j \in allowed_k \\
0 & \text{otherwise}
\end{cases}
\]  

(1)

It represents the set of nodes that travellers have not yet visited, and each cycle passes the nodes that have been accessed from the list, and the parameters represent the importance of the residual memory, indicating the relative importance of visibility. To avoid repeated visits to the same city, each traveler holds a list of tabu \( (K) \) to record a collection of cities that have been visited by the traveller so far.

At the same time, with the increase of travellers' memory, the old information stored in the brain gradually fade and forget. Thus we get the memory of \( t+n \) on the \((I, J)\) path as follows:

\[
\psi_{ij}(t+n) = (1 - \rho)\psi_{ij}(t) + \Delta \psi_{ij}(t)
\]  

(2)

\[
\Delta \psi_{ij}(t) = \sum_{k=1}^{m} \Delta \psi_{ij}^k(t)
\]  

(3)

In this case, \( \rho \) represents the retention rate of traffic memory, and \( 1 - \rho \) represents the volatilization factor of the driving memory. In order to prevent the infinite accumulation of information, the range of value of \( \rho \) is limited to \((0,1)\). It represents the process of traveller's \( t \) to \( t+n \) in the time interval, and the remnant memory left on the path from I to J.

Based on this idea, we need to deal with the longitude and latitude of each node in Table 1, where travelers take Nanjing as the initial node in Jiangsu province. In the coordinate axis, the coordinate point of Nanjing city is \((0,0)\), and the latitude and longitude coordinates are converted into 1 dimension =100 and 1 longitude =100.

**Figure 1.** Simulation coordinates of urban coordinates in Jiangsu Province.
Finally, the coordinates of each city node are converted to table 1 and figure 1. On the basis of the above map, based on the algorithm of ant colony algorithm, the MATLAB program is compiled to optimize the path of nine nodes in Jiangsu province. The results show that:

1. In Jiangsu, the most provincial travel time travel routes are: Nanjing (2) Zhenjiang (5), Changzhou (4) Suzhou (1) Nantong (7) Wuxi (3) Taizhou (8) Yangzhou (6) Huaian (9).
2. Under this travel strategy, the shortest travel path of travellers is equal to 24.9707, which should be noted: This is the result of simulation, not the actual total distance.
3. According to the optimal driving strategy solved above and considering the time constraints of this article, the traveler wants to complete a complete tour of Jiangsu Province in Jiangsu province. The time required is 15 hours (about 2 days) for the total travel time, that is, the time required for the traveler to drive between 9 nodes; the time of tourist attraction takes 10 days. This time includes a traveler's trip in the scenic area (4 hours for a half day tour, 8 hours for a tour of the day), a 1 - day stay in the provincial capital city of Nanjing, and the travel time from the nodes to the node.

3. Conclusion
According to the requirements of the topic, according to the optimal route planning, we can give the specific itinerary of Jiangsu province.
First day: the capital city of Nanjing, stay for 24 hours, arrange special time to browse the characteristic buildings and experience the local customs.
The second day: morning tour of Nanjing Confucius temple - the Qinhuai River scenery belt, afternoon visit Zijin Mountain - Dr. Sun Yat-sen's Mausoleum scenic area.
The third day: starting from 7:00 a.m. in Nanjing, and exercising 8:14 to Zhenjiang. After visiting Zhenjiang three mountain scenic area for 4 hours, then travel for an hour to reach Jurong Maoshan scenic spot in Zhenjiang for half a day (stay in the scenic area in the evening).
The fourth day: in the morning in the scenic area to continue to visit the half day to 12:00, and then return to the city, in the afternoon driving to Nantong to use 2 hours and 25 minutes, because of more than the scenic time arrangement to stay.
The fifth day: at 8:00 in the morning, visit the Hao River scenic area of Nantong, leave at 12:00 noon and arrive in Suzhou. In the afternoon, we began to visit the gardens in Suzhou and rest in Suzhou city in the evening.
The sixth day: 8:00 am at 8:00 in the morning to visit the national commercial tourism demonstration area of Suzhou Jinji Lake. 12:00 out of the issue makes about an hour to reach the Zhouzhuang scenic spot in Suzhou, Kunshan, and return to Suzhou city accommodation after 4 hours of sightseeing.
Seventh days: 7:00 a.m. set out for about an hour to reach the ancient town of Tongli, Wujiang, Suzhou, after 4 hours, returning to Suzhou City, and 13:00 began to visit the Suzhou Changshu Sha Jia Bang - Yushan Shang Lake tourist area, and stay in the scenic area.

Eighth days: at 8:00 in the morning at 8:00 in the scenic area to continue to visit 4 hours, at 12:00 noon to go to Wuxi, to reach the time about, the afternoon to visit the Wuxi Turtle Head Islet scenic spot, night in the Wuxi downtown.

The ninth day: starting at 7:00 in the morning, driving for about 1 hours to reach the Grand Buddha at Lingshan scenic spot in Wuxi, and tour for about 4 hours. Return to the downtown area in the afternoon, drive 54 minutes to Changzhou, and visit the Changzhou global dinosaur city scenic area in the afternoon. There is plenty of time for tourists to relax or arrange other tours.

The tenth day: at 8:00 in the morning, we began to visit the Tianmu Lake scenic spot in Liyang, Changzhou, one day, and stayed in Suzhou.

Eleventh days: starting at 7:00 in the morning, arriving at Taizhou at 8:22, visiting Taizhou Jiangyan District Qin Lake National Wetland Park for about 4 hours, leaving for about 1 hours and 11 minutes to arrive in Yangzhou, visit the scenic area of the Yangzhou Slender West Lake, and stay in the downtown of Yangzhou at night.

The twelfth day: starting at 7:00 in the morning, arriving at Huaian about 9:27, and visiting the scenic spot of Zhou Enlai's hometown in Huaian for about 4 hours. Return to Nanjing in the afternoon. The tour of Jiangsu is over.

Nowadays, China's tourism is undergoing a lot of changes, including tourists, tourism mode, tourism demand, tourism channels and industrial chain. According to the current situation, it is an inevitable trend to develop characteristic tourism projects and increase competitiveness.

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