Intelligent Filter Attractions based on Multi-objective Programming

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***Abstract*—Family summer travel packages designing should consider the demands of different families, such as the number of people, the cost, the time and the other factors. It is important to decide how to choose the scenic spot in order to make the trip to scenic spots as much as possible, as far as possible. This problem can be abstracted as a multi-objective programming problem. Therefore, we can make use of multi-objective optimization model to filter scenic spots.**

Keywords-intelligent filter; multi-objective programming model; traveling salesman problem; genetic algorithm

This is a classical traveling salesman problem, and we can make use of Genetic Algorithm and other algorithms to solve a specific line of travel.

In view of a tourist city, Shanghai for example, there is numerous of scenic spots and several of choices of completing the tour. We can calculate the attractions of some districts in Shanghai and put forward a concept of degree dense according to the Shanghai attractions to partition scenic spots, and then filtered each partition attractions. In this way, we can save calculate and make the calculation to be more operability and practicability. We use Genetic Algorithm to find the optimal route. This method can greatly reduce the amount of calculation, and our solutions are more comprehensive. It can meet the demands of various customers.

Different level demands of different family can be divided respectively: (1) there is no cost constraint, but time limitation; (2) there is cost limitation, and a time limitation; (3) there is cost limitation, but no cost restriction. The first and the third are two special circumstances, and the second is a common condition. In this case, different levels of requirement should have different optimal routes.

In view of different levels of demand analysis, such as different scenic spot category, natural folk, entertainment and leisure, cultural sports class, we can plan the daily schemes.

I. INTRODUCTION

When summer vacation comes, many parents will choose this time to take children to have a travel to a certain city. But different family has different requirements (population, cost constraints, time constraints, etc.). When family choose any one tourist city (such as your city), they should consider travel routes, cost, time, and other factors (other more important elements) for families with different demand of designing a best navigator.

II. BACKGROUND

Family summer package designed should consider the needs of different families, such as family member number, cost, time and other issues to plan a rout of scenic spots as much as possible, as far as possible to the scenic spot which quality is higher. That can be considered as the objective function of package design. Thus, the problem is a multi-objective programming model. In view of a tourist city, Shanghai, for example, spots is numerous. The computational complexity of the attractions is too heavy to be practical and operational. Therefore, We need to divided the scenic area into different scenic spots in Shanghai, and then filter to each partition attractions. Finally, we used the Genetic Algorithm to find an optimal route.

The paper discusses about how to make various demands of various families to be more clearly. Different levels of demands can be divided into three scenarios to the problem:

1. There is no cost constraint, but there is time limitation;
2. There is cost constraint, time limitation;
3. There is cost constraint, but no time constraint.

The first and the third are two special circumstances, and the second is a common condition. In different cases, the tourist needs to choose different partition type for route planning.

III. MODELING

Shanghai is one of the important economic center cities in China. In view of economic, it can reflect the modern development level of China; in view of culture, it is a national famous historical and cultural city. There are more and more people choose to travel Shanghai.

However, there are numerous attractions in Shanghai for the tourists, then how to choose a most suited line quickly from so many scenic spots becomes the most concerned question for them. Through the studies of classification of tourist attractions, people can be more targeted to develop a new tourist route, greatly shorten the time from various and huge amounts of tourist routes. This way can meet the travel demand of different families.

Firstly, according to the attractions intensive tourist in Shanghai, this paper collected above 3A grade scenic spots of Shanghai. After separating listed tourist area into each scenic area, we specifically gather information of each scenic spot. These scenic spots are a bigger place, visitors willing to visit with strong appeal. This paper collected these attractions on the map of longitude and latitude, collected tickets price of these attractions, as well as the

open time of these attractions. We also grade these attractions by evaluation from tourists on the Internet, lodging information, and thus grade the scenic spot. All the information will be used to the screening of multi-objective planning tourist attractions and the optimal solution of the route.

With numerous tourist attractions in Shanghai, the scenic spots are different. In order to facilitate research, we firstly choose 3A and the above attractions to analyze. The basic information collected can be divided into the humanities education, theme parks and natural leisure. Table 3.1 is for 3A and above attractions in Shanghai.

TABLE 3.1 ABOVE 3A GRADE SCENIC SPOT OF SHANGHAI

No	Names of scenic spots	Level of attraction	Attraction types
1	Oriental Pearl Tower(OPT)	5A	Humanistic Education
2	Shanghai Science and Technology Museum(SSTM)	5A	Humanistic Education (HE)
3	Shanghai Wildlife Park(SWP)	5A	Theme Park(TP)
4	Shanghai Century Park(SCP)	4A	Natural Leisure(NL)
5	The Shanghai Zoo(SZ)	4A	Humanistic Education
6	Shanghai Film Park(SFP)	3A	Theme Park
7	Shanghai Shooting Club(SSC)	3A	Humanistic Education

We use Google map to search the corresponding latitude and longitude of the scenic spots. And the spatial distribution of the scenic spot is obtained by Badu map. All the information is shown in figure 3.1 for 3A and above attractions of Shanghai space distribution.

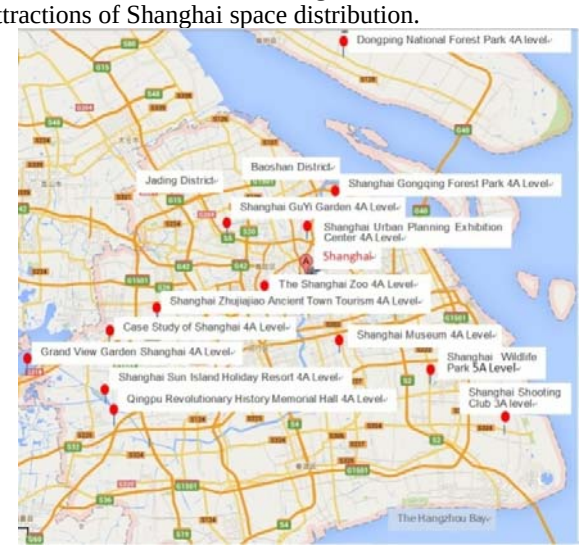

Figure 3.1 Shanghai 3A or more attractions space distribution

According to the spatial distribution of the 3A and above level attractions in Shanghai, we can find that Shanghai attractions distributions are obvious regional. Therefore, according to the intensity of scenic spots in Shanghai for tourism partitions, we can deal with accuracy and convenience. Then based on the partition of travel route development, we can get the whole comprehensive tourism routes finally.

Shanghai tourism partition consists of A, B, C, D and E five areas. Shanghai science and technology museum is as the center of the area A, Shanghai Sheshan National Forest Park is as the center of area B, Shanghai Guyi park is as the center of the area C, Shooting Clubs in Shanghai is as the center of the region D, and Dongping National Forest Park is as the center of E area. There are nine are as for Agrade attractions, eight are as for B grade area attractions, three areas for C grade area attractions, one are for D grade area attractions, and two for E grade area attractions. Here we add the corresponding latitude, longitude and partition information into 3A grade scenic spot of Shanghai information table, as shown in the table 3.2.

TABLE 3.2 ABOVE 3A-CLASS SCENIC SPOT IN SHANGHAI

No	Names of scenic spots	Longitude	Latitude	Level of attraction	Attractions types	Partition type
1	OPT	31.24055	121.4998	5A	HE	A
2	SSTM	31.2225	121.5379	5A	HE	A
3	SWP	31.05525	121.7243	5A	TP	A
4	SCP	31.2145	121.55	4A	NL	A
5	SZ	31.19338	121.36	4A	HE	A
6	SFP	31.0178	121.31	3A	TP	B
7	SSC	31.026	121.89	3A	HE	C

A. Partition information

We can distinguish area situation according to the Shanghai star attractions. The area usually been visited is a star attraction which as higher value. In fact, not all visitors will choose the star attractions. To increase the diversity of choice, we make the data more close to the real situation. Some attraction shaving no rating but still need to be added, such as some famous scenic spots through the travel guides, tourism, public comments on web sites. For example, tourists can use Badu resources to find the best time and ticket information of tourist attractions. At the same time, Google maps are used to get the scenic spots in latitude and longitude. Supplement information of five partitions A grade, B grade, C grade, D grade, and E grade of the main attractions is shown in the table 3.3 ~ 3.5.

TABLE 3.3 THE TIME AND THE TICKET MAIN ATTRACTION

No	Names of scenic spots	Time	Ticket
1	OPT	2h	80yuan
2	SSTM	4h	60yuan
3	SWP	4h	40yuan
4	SCP	3h	10yuan
5	SZ	2h	10yuan
6	SFP	2h	80yuan
7	SSC	1h	99yuan

TABLE 3.4 THE COST OF A& B DISTRICT

District	Restaurant	(RMB/per person)	Total cost (RMB/meal) per capita
A district	Xia Li Restaurant in Xinjiang	79	77
	State Sand Pot of Porridge	99	
	Hot Is Addiction	49	
	Old Factory of Chongqing Hot Pot	91	
	57Degree of Hunan	95	
	Secret Recipe	26	
	Uncle Tea Restaurant at Sea	106	
	Pankoop	86	
	Xiang Yuehui (appropriate hill shop)	62	
	Righteous Side House (Xujiahui)	74	
B district	Hutchison Dishes (Songjiang)	93	64
	Chen Yang Crab Roe Soup Package (PinhuiRoad Shop)	19	
	Small Fat Private Kitchens	37	
	Hole 2 Baba Sichuan Hot Pot JiutingShop	92	
	Sha Long Restaurant	66	
	Qiao Thai Restaurant	79	
	LesvilathemedRestaurant	47	
	Olive Manor (Kaiyuan Mediterranean Restaurant)	79	
	Hunan Garden (Kaiyuan Mediterranean Shop)	74	
	Weston (PinehuiRoad Shop)	54	

TABLE 3.5 THE COST OF CDISTRICT

district	Restaurant	(RMB/per person)	Total cost (RMB/meal) per capita
C district	JinjiangChef (LingangTown Shop)	70	84
	Thousand Island Lake Chun Fresh Mud City Shop	70	
	Mr Cameron Fire Barbecue (PudongTheme Shop)	62	
	Store Seafood Restaurant (JinqiaoStore)	130	
	Incense Pot (PudongNew Stores)	98	
	Righteous Side House (Thumb Plaza)	78	
	My Grandma's Era (CRC)	58	
	KwaiGarden Organic	86	
	Shenyang Garden (NanhuiShop)	122	
	Su Wu Sheep (NanhuiShop)	64	

B. Main scenic spots of Shanghai scores

The tourist satisfaction will be different in different scenic spots. This paper will let visitors judge and evaluate comfortableness by themselves, and we make evaluation to the scenic spots. According to that, we put forward the grading standard and criteria for specific scenic spot. The corresponding scoring criteria as shown in table 3.6.

TABLE3.6 SCORING CRITERIA

	5A	4A	3A	No rating
Grade	5	4	3	2

For 3A, 4A and 5A grade scenic spots are 3, 4, 5 scores accordingly. The no rating of attractions is 2 score. Combined with the public comments on the net of the masses and the Badu tourism online scoring, the conversion formula is as follows:

$$P_i' = \frac{2 \times P_i}{P} \tag{1}$$

Here P_i' is the final score, and P_i is online score for the populace. Here P is the full mark. Public comments on the net of Badu travel generally take 5 scores.

Combination level of each area attractions with scenic spots and the masses online score calculation, we can get the final score of 70 sites in Shanghai. The main attractions of Shanghai grading are shown in table 3.9.

C. *Cost of accommodation and the busin different Partition of Shanghai*

Considering the cost and time limit of the model with the influence of the need, on the basis of all the cost of accommodation and tourism travel by car, the thesis analyzes statistical data of each partition in Shanghai getting all cost of accommodation and the bus. The detail data are shown in table 3.7.

TABLE 3.7 SHANGHAI KING LONG BUS BASIC FEE (DATA SOURCE) HTTP://WWW.DEQINZUCHE.COM/

Basic feeAverage cost (RMB/day)(RMB/person)	Total average (RMB /person)
Kinglong120022.64 53 seats bus	23
Kinglong800 24.24 33 seats bus	
Kinglong1100 22.44 49 seats bus	
Kinglong1000 22.22 45 seats bus	

IV. MODELING AND SOLVING

It should be considered when designing family summer Vacation Navigation to meet the requirements of different families (people, cost, time, etc.) to make a trip to scenic spots as much as possible, as higher as possible. This question is a multi-objective programming problem on the basis of meeting the constraint condition. It can meet the requirements of routes selection. Then, we can use the method of the shortest path to find out the suitable route for travel. And the optimal path problem can be disposed as a traveling salesman problem. Thus, the plan can satisfy different needs of different family's travel.

To discuss various families' needs more clearly, the different levels of demand can be divided into three scenarios to the problem: there are not cost constraints, under time limitation; there are cost constraints, and time is limited; there are no cost limitations, and no cost restriction conditions. The first and third situations are two special cases, and the second case is a general situation. In the statement of the model which embodies the process from special to general mathematical thinking. The following is the total flow chart of solve the problem.

The third case is a special case, so there can be route based on the second case to be discussed. In the second case, according to a day of travel consumption standards, we can get various line consumption level report table.

The third case is to be discussed if the capital is limited at various time package designs. The package designs can be m_1Yuan one-day, m_2 Yuan two-days, m_3 Yuan three-days, m_4Yuanfour-days, m5 Yuan five-days, m6 Yuan six-day's tour, and so on.

A. *Modeling*

1) No cost constraints, under time limitation, the mathematical model of case

(1) Screening scenic spots with multi-objective optimization model

$$\text{Max} \quad \sum_{i=1}^{n}\sum_{j=1}^{n} x_{ij} \tag{2}$$

$$\text{Max} \quad \sum_{i=1}^{n}\sum_{j=1}^{n} p_j x_{ij} \tag{3}$$

$$\text{s.t.} \quad \sum_{i=1}^{n}\sum_{j=1}^{n} t_j x_{ij} + T_0 \le T_l \tag{4}$$

$$\sum_{i=1}^{n} x_{ij} \le 1 \qquad j = 1,2,\cdots,n \tag{5}$$

$$\sum_{j=1}^{n} x_{ij} \le 1 \qquad i = 1,2,\cdots,n \tag{6}$$

$$x_{ij} = 0 or 1 \qquad i, j = 1,2,\cdots,n \tag{7}$$

There are many methods can be used to solve the multi-objective programming. Here, we seek help with the using of linear programming, nonlinear programming, stochastic programming and numerical calculation methods and skills. We use" linear weighting method" to translate double goal programming model into single objective programming problem, namely the decision goal is:

$$\text{Max} \quad \alpha\sum_{i=1}^{n}\sum_{j=1}^{n} x_{ij} + (1-\alpha)\sum_{i=1}^{n}\sum_{j=1}^{n} p_j x_{ij} \tag{8}$$

The α is any numerical in [0,1],and it reflects the decision maker's degree to each objective value, here

$\alpha = \frac{1}{2}$ .At the same time, considering the number as much as possible to attractions, and the quality of scenic spot more higher.

$$\text{Max} \quad \frac{1}{2}\sum_{i=1}^{n}\sum_{j=1}^{n} x_{ij} + \frac{1}{2}\sum_{i=1}^{n}\sum_{j=1}^{n} p_j x_{ij} \tag{9}$$

$$\text{s.t.} \quad \sum_{i=1}^{n}\sum_{j=1}^{n} t_j x_{ij} + T_0 \le T_l \tag{10}$$

$$\sum_{i=1}^{n} x_{ij} \le 1 \quad j = 1,2,\cdots,n \tag{11}$$

$$\sum_{j=1}^{n} x_{ij} \le 1 \quad i = 1,2,\cdots,n \tag{12}$$

$$x_{ij} = 0 or 1 \qquad i, j = 1,2,\cdots,n \tag{13}$$

(2) Traveling route model of the traveling salesman problem

Tourists in a scenic spot would walk along with a way from every perhaps spots as a starting spot. They need to determine which route is the shortest route. This problem is a traveling salesman problem (TSP). Analysis from the perspective of graph theory, it is in a complete graph of empowerment in which we can find out a Hamilton loop. The graph has the smallest weight C, namely the optimal circle.

Traveling salesman problem of the mathematical model of expression as follows:

$$\min \sum_{i \ne j} d_{ij} x_{ij} \tag{14}$$

$$\sum_{j=1}^{n} x_{ij} = 1, i = 1,2 \cdots n \tag{15}$$

$$\sum_{i=1}^{n} x_{ij} = 1, \ j = 1,2 \cdots n \tag{16}$$

$$\sum_{i,j \in s} x_{ij} \le |s| - 1, 2 \le |s| \le n-1, s \subset \{1,2,\cdots,n\} \tag{17}$$

Three constraints respectively: each point out there is only one edge; each starting point and end point does not constitute a circle.

B. A Mathematical Model, Under Time Limitation and Cost Limitation

(1) Screening attractions multi-objective optimization model

$$\text{Max} \quad \sum_{i=1}^{n}\sum_{j=1}^{n} x_{ij} \tag{18}$$

$$\text{Max} \quad \sum_{i=1}^{n}\sum_{j=1}^{n} p_j x_{ij} \tag{19}$$

$$\text{s.t.} \quad \sum_{i=1}^{n}\sum_{j=1}^{n} t_j x_{ij} + T_0 \le T_l \tag{20}$$

$$\sum_{i=1}^{n}\sum_{j=}^{n} f_j x_{ij} + C \le M \tag{21}$$

$$\sum_{i=1}^{n} x_{ij} \le 1 \ j = 1,2,\cdots,n \tag{22}$$

$$\sum_{j=1}^{n} x_{ij} \le 1 \ i = 1,2,\cdots,n \tag{23}$$

$$x_{ij} = 0 or 1 i, j = 1,2,\cdots,n \tag{24}$$

So the "linear weighting method" will be used to change double goal programming model into single objective programming model:

$$\text{Max} \quad \frac{1}{2}\sum_{i=1}^{n}\sum_{j=1}^{n} x_{ij} + \frac{1}{2}\sum_{i=1}^{n}\sum_{j=1}^{n} p_j x_{ij} \tag{25}$$

$$\text{s.t.} \quad \sum_{i=1}^{n}\sum_{j=1}^{n} t_j x_{ij} + T_0 \le T_l \tag{26}$$

$$\sum_{i=1}^{n} x_{ij} \le 1 \quad j = 1,2,\cdots,n \tag{27}$$

$$\sum_{j=1}^{n} x_{ij} \le 1 \quad i = 1,2,\cdots,n \tag{28}$$

$$x_{ij} = 0 or 1 \ \ i, j = 1,2,\cdots,n \tag{29}$$

(2) Solution method for model

The feature of attractions of Shanghai tourism partitions is a discrete distribution problem. On each partition, different attractions category would be considered separately. Respectively with the help of attractions screening, multi-objective programming model will be

screened by Genetic Algorithm (GA).The optimal solution of the path is the best travel route plan. The problem is to find the optimal path belonging to the classical traveling salesman problem. So we will use genetic algorithm to solve the optimal path searching.

C. Genetic Algorithm is introduced

Traveling salesman problem is a classical combinatorial optimization problem, which is also a NP problem. The travel planning method of Shanghai scenic sports has the actual help for tourists in this holiday. One of the goals of our research is to find a kind of both the higher quality and also fast convergence properties routs by using the approximate algorithm.

The research of traveling salesman problem has made many achievements in recent years. So far, in the international theses, there are lots of algorithms used, for example, the Dijistra Algorithm, the Binary ree method, the Floyd algorithm, the Neural Network and the Genetic Algorithm method, and so on. Each algorithm has its own characteristics. However the Genetic Algorithm is more suitable for the solving traveling salesman problem in comparison.

Genetic Algorithm referenced for biological natural selection and natural genetic mechanism of the random search algorithm. It simulated genetic selection and natural selection of Darwin's biological evolution process calculation model. The approach is to be used to solve the problem of parameters of the code for chromosome, and can be reused in iterative manner, such as selection, crossover and mutation operation information to the exchange of chromosomes in a population. The results of chromosomes will be conforming to the goal of optimization. Practice has proved that the genetic algorithm for solving combinatorial optimization problems, such as the TSP problem, has better optimization performance.

The Genetic Algorithm to do work mainly focused on:

(1) To adopt appropriate expression method for encoding circuit;

(2) To design available genetic operators that can keep their characteristics;

(3) To prevent premature convergence and a local optimum path.

V. EVALUATION AND IMPROVEMENT DIRECTION OF THE MODEL

A. Summary of the Model

With the method of multi-objective programming and Genetic Algorithm, we can get the optimal travel path in the tourism area of Shanghai, can solve the cost problem based on the popularity of multi-objective programming, also we can define scenic spots in different areas, and in addition to that we can easily make clear what is the best time to visit and how is accommodation consumption condition and other factors. This model has also put forward several kinds of different style, different levels of consumption demands in travel attractions.

Considering different family travel demands, the family travel can be largely satisfied to the largest extent.

By using Genetic Algorithm based on multi-objective programming, the tourist can get the best travel scenic spot, the optimal travel path according to the scenic spots in latitude and longitude data. In this way, the tourist can greatly reduce the time lost on the way. The purpose of getting better tourism can be achieved.

B. Shortcoming of the Model

(1) To deal with multi-objective programming problem, it needs to divide the multiple objectives into single objective problems using the linear weighted method, the weight of each target are 0.5,lack of further theory basis.

(2) In the cost of computation, this paper adopts the average data, which may have some deviation with the actual real data.

VI. CONCLUSIONS AND FUTURE WORK

The paper takes use of multi-objective programming to solve the family member tours problems: as far as they can visit, as low as their fee in a limit time. With the application of these methods, the paper contributes a model to complete above aims. All the methods can help families to make their tour plans by themselves. And the advantages of this model was shown in the 5.1, meaning while, there are some shortcoming in ourmodel which shown in 5.2 part.

There are some work can be done in the next progress. With the method of cloud platform and reinforcement learning, this multi-objective programming problem could be solved accurately and more intelligent.

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