ISSN : 0974 - 7435 Volume 10 Issue 2

BioTechnology
An Indian Journal

FULL PAPER

BTAIJ, 10(2), 2014 [286-291]

# Tour schedule model and simulation

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## ABSTRACT

To meet the requirements of the Big Long River tourists, we calculate the camp site number, set the rafting tour plan, determine the corresponding tour schedule and explain the carrying capacity of the river.


## KEYWORDS

Computer simulation;
Line-up competition algorithm;
Analytic hierarchy process.

## INTRODUCTION

With the rapid development of economic society, people's tourism consumption level is increasing all the time, emphasizing autonomy independence, individuation, purposiveness, which makes the special tour highlighting spirit and strength become the consumption hotspot. Taking the characteristics of getting close to nature, conquering nature, being novel and exciting, rafting sports has taken the fancy of tourists. According to a survey on American canoeing conducted by American Outdoor Foundation and American Outdoor Industry Association, there are 17.8 million Americans aged six and above taking part in canoe, kayak and rafting, which has increased by 3.6% compared with that in 2006[2]. More and more people are willing to take part in rafting sports, so the managers need to better arrange the trip, making more people engage in this activity. Based on the motor process of computer simulation training for boats, we schedule an optimal mix of trips to better serve tourists.

## PROBLEM ANALYSIS

The trips range from 6 to 18 nights of camping on the river, start to finish, making thirteen tour schedules of six-day tour, seven-day tour, and eight-day tour, etc possible. There are Y camp sites on the Big Long River, distributed fairly uniformly throughout the river corridor. The tourists need to have a rest at the camp sites at night. The camp site distributed to each tour schedule is fixed while the number and position of camp sites are different. Taking the six-day tour schedule for example, we need six camp sites distributed fairly uniformly throughout the river corridor. To differentiate the schedules, we define the needed camp sites of a certain tour schedule as R point.

The operating rate of camp sites (the ratio of the total number of R points and the number of camp sites), the repeating number (the number of R points occupied by two or more groups),the different number of tour schedules are taken as three targets to construct a multi-target optimization model. The spacing distance between two camp sites according to the model can be used to determine the total camp site number Y and the position of different camp sites so as to make applicable tour schedules.

Simulating the different camp sites defined by the optimization model as cellular, applying computer simulation technology, and considering the occupying changes of camp sites by the use of cellar automaton, we aims to make the best use of camp sites and make an optimal mixed tour schedule.

Taking the restricting factors of environment into account, we cannot set too many camp sites, making the ecological system of the Big Long River destroyed. Therefore, some points for attention are put forward for tourists in order to guarantee the better development of the Big Long River.

(1) The Big Long River is 225 miles with no narrow reaches preventing the passing and overtaking of boats. There are obstacles in the river during the tour.
(2) Only two kinds of boats can be used, which travel on average 4 mph and 8 mph respectively.
(3) The tour schedule is not affected by the weather, river conditions and the other factors.
(4) The tour schedule will not be postponed or interrupted by unexpected accident of drafting.
(5) Tourists are taking the raft according to the rule strictly and there is no phenomenon of violating the rules.
(6) The camp sites are only set on one side of the river.
(7) The camp sites will be set with no influence of different topography.
(8) Each camp site can meet tourists' needs for staying over sleep at night.

## MODEL CONSTRUCTION AND SOLUTION

### Determine the camp sites number and tour schedule

Taking the Big Long River as an idealized river with the known length, together with the fairly distributed camp sites, we only need to calculate the reasonable standoff distance and then make simulation training of the motor process of boats to get the optimal tour schedule[3].

The Big Long River's $Y$ tour sites are distributed fairly and the standoff distance is $l$ miles. Based on the principle of setting the tour length from the last R point to the final point within one day, the managers make several tour schedules. Point R refers to the different camp sites in the thirteen tour schedules from six-day tour to eighteen-day tour. The total sum of point R is $n_s$. As for the $i$-day tour schedule, the managers provide $i(i = 6,7,8,\cdots,18)$ point R distributed fairly in the river.

To achieve the following goals:

① To best meet tourists' requirements, the managers can provide the most tour schedule, that is $\max N$, and the weight number is 0.2;

② To make full use of camp sites, the operating factor reaches to the maximum, that is $\max\varphi$, and the weight number is 0.5;

③ The ratio of four boats reaching the same camp site is the minimum, that is $\min\omega$ and the weight number is -0.3.

Combining the above three factors, we convert the multi-target optimal problem into a single target $A$ optimization: $\max A = 0.2N + 0.5\varphi - 0.3\omega$ When $A$ reaches the maximum, the corresponding $l$ is the reasonable standoff distance between two camp sites. Then solve the problem by line-up competition algorithm[5,8]:

Step One:The distance between two point R is $L_i = 225/(i+1)$ miles. When $l = a,(a \in N^*)$ miles,the corresponding point R standoff distance is $L_{ia}$.

First, determine the minimum miles $x$,making $L_{ia}$ can be divided exactly by $a$, as shown in the following: $(L_i + x) \bmod a = 0$,Then: $L_{ia} = L_i + \min x$.

Step Two:If $0 < 225/L_{ia} - i < 1$,then reserve the corresponding tour schedule,taking it as $j$ nights tour schedule. The number of point R of $N$ tour schedules is calculated in the equation $n = \sum j$.

Step Three:The number of camp sites $Y = [y], y = (225/a) - 1$,The operating factor of camp sites is $\varphi = n/Y$.

Step Four:Take $a$ as superposition unit and calculate the repeating number of each camp site of the $N$ tour schedules. Select $m$ camp sites with the repeating number of 4,and calculate the percentage it takes in the total camp sites number: $\omega = m / Y$.

Step Five:Calculate $A = 0.2N + 0.5\varphi - 0.3\omega$. When there is only one camp site in the river bank, $a$ reaches the maximum $\max a = 225 / 2 = 112.5$.

Therefore, we only need to 112 times loop of the previous steps to get $\max A$. Then $a$ is the standoff distance of two camp sites.

When the standoff distance between two camp sites reaches $a$,we can get $N$ kinds of tour schedules matching condition. Calculate the position of point R in $N$ times of tour schedules,and filter the same position R of $N$ tour schedules. Make statistics of the repeating number of the same position R. As shown in Figure 1,when $a = 1$,there is no R point occupied by more than four groups of tourists, $\omega_1 = 0$. When $a = 2$,there is 3 R points occupied by more than four groups of tourists, $\omega_2 = 3/111 = 0.0270$. When $a = 3$,there is 1 R point occupied by more than four groups of tourists, $\omega_3 = 1/74 = 0.1351$. When $a = 4$,there is 2 R points occupied by more than four groups of tourists, $\omega_4 = 2/55 = 0.0364$.

According to the above algorithm,we make a comparison of the calculating results

When

$a = 1, A = 0.2\times 12 + 0.5\times 0.7 - 0.3\times 0 = 5.9000$;

When

$a = 2, A = 0.2\times 10 + 0.5\times 0.9 - 0.3\times 0.0270 = 6.4919$;

When

$a = 3, A = 0.2\times 10 + 0.5\times 0.9 - 0.3\times 0.1351 = 6.4595$;

When

$a = 4, A = 0.2\times 7 + 0.5\times 0.9 - 0.3\times 0.0364 = 5.8890$.

Therefore, when we choose $a = 2$,the number of camp sites $Y$ reaches the optimal point,it is 111. Figure 1 shows the position of all camp sites when the standoff distance of two camp sites is 2 miles (Due to the space limit,Figure 2 just shows the first 10 camp sites of the river).

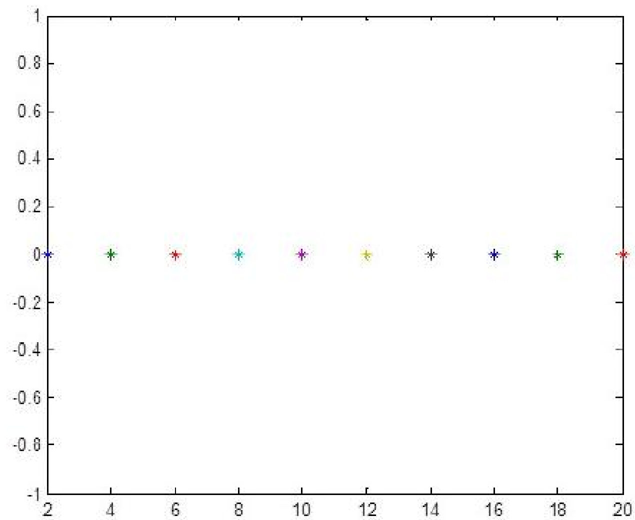



**Figure 1**

**TABLE 1 : lists the twenty tour schedules**

| | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| oar- powered rubber raft | * | * | * | * | * | * | * | | * | | * | | * |
| motorized boat | * | * | * | * | * | * | * | | * | | * | | * |

Based on the principle of setting the tour length from the last R point to the final point within one day, the managers make 10 tour schedules:6,7,8,9,10,11,12,14,16,18-day. Each day number has two kinds of boats with different speed. Thus tourists can choose from 20 tour schedules.

## Determine the tour schedule

Simulating a camp site into a cellular[6], we set the first camp site at the place two miles away from the

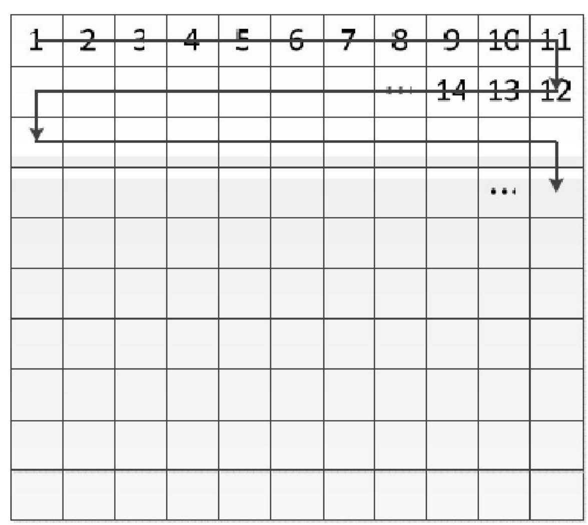



**Figure 2**

starting point. No boats will stay there so the cellular standing for the first camp site can be eliminated. Then the remaining 110 cellular can be divided into 10 parts, transferring into the area of $11 \times 10$ [7], as demonstrated in Figure 2.

The cellular has three states. In some moment at night, if there is one boat,then the cellular state is 1; if there are two boats, the cellular state is 2; if there is no boat, the cellular state is 0[9].

On the first day, put 10 boats belonging to different tour schedules to 111 cellular. On the first evening, each boat can occupy its own camp site, the state becomes 1 and the other is 0.

On the second day, put another 10 boats of different tour schedules into the cellular. Boats of the first day move forward toward the next camp site, which inevitably makes the double cover with one cellular due to different arrangements of tour days. Then the cellular state under double cover becomes 2[10]. The state 2 cellular needs to make partition according the real condition, putting state 2 cellular into adjacent cellular, to make the cellular state return to one and meet the full-sale condition.

### Rule

The fist day boat trip arrangement is the initial state. Each cellular has two neighbors. The two neighbors of the state 2 cellular have the following six conditions:

- when the states of two neighbor cellular are 0, the cellular state after partition is (101),
- when the states of two neighbor cellular are 1 and 0 respectively, the cellular state after partition is (111),
- when the states of two neighbor cellular are both 1, the cellular state after partition is (202),
- when the states of two neighbor cellular are 1 and 2 respectively, the cellular state after partition is (212),
- when the states of two neighbor cellular are 0 and 2 respectively, the cellular state after partition is (112),
- when the states of two neighbor cellular are both 2, the cellular state after partition is (111),

The specific rule is listed in the following figure:

To make the minimal contacts among boats, we let 10 boats with different tour schedules sail at a given time interval on the first day. On the second day another 10 boats sail in the same way. If two boats sharing one camp site happen, we make partition of the two boats according to the previous cellular partition rule, making two boats occupy one complete camp site. Boats with short rafting period only occupy the upriver camp sites while boats with long rafting period take the downriver camp sites. On the third day, all boats search for their own camp sites according to the set tour schedule. The rules are carried out in the same way in the following days. If we fail to distribute the camp site of two boats, we suspend the departure of the boat sail on the day and let the early sailed boat occupy the camp site.

We adopt computer simulation technology to simulate the camp sites occupying changes of the Big Long River in six months[11]. When operating rate of camp sites reaches the maximum, repeat the previous tour schedule, namely choosing the tour schedule arranging the largest number of tourists.

The initial state and final state of simulation are listed in the above figures. As is shown in Figure 5, the final state of 18 cellular is 0, representing there are no tourists arriving there. At that time the camp sites have reached saturation state. In other words, we have made full use of the camp sites.

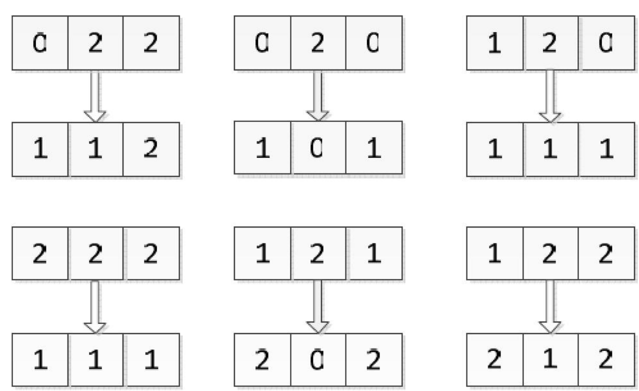
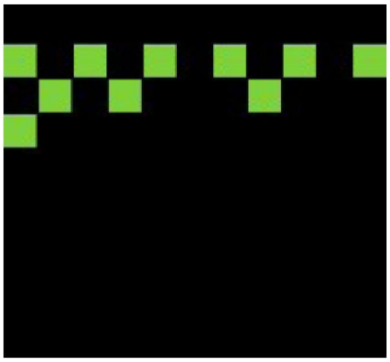


Figure 3

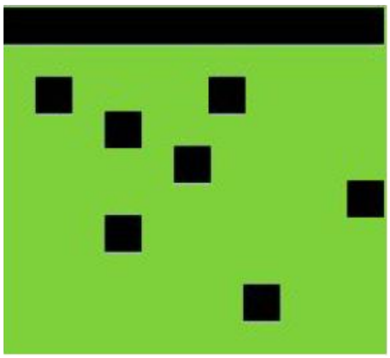
## CONCLUSION AND PROSPECT

Based on the analysis and research of river tourism, on the condition of uniform distribution of campsites and passengers unsharing the same campsite, we organically bring in the Enumeration model and Genetic Algorithm model based on multilayer coding technol-



**Nitial state**

**Figure 4**



**Final state**

**Figure 5**

ogy to build a simulating fusion mathematical model combined by Genetic Algorithm after Enumeration, and present the fixed camping trip in stages mode, which solves trip scheduling problem theoretically. By the contrast of the computing simulation and practical examples, the efficiency and reliability of the model can be proved, which provides a best trip schedule to the managers.

Because of the ambiguity of $Y$ (the value of distribution of campsites) and uncertainty of $X$ (the value of hypothetical boat trips), the model above could be widely promoted. However, it is not almighty owing to its own limitation. Therefore, during the operating of actual park, we can also build different models in different areas to enhance accuracy rating in specific area by considering the following points:

On condition of ensuring every passenger having their own campsite, the carrying capacity of the Big Long River should be in two aspects: one aspect is the passengers' carrying capacity, and the other is the environmental carrying capacity. When the passengers' carrying capacity reaches to maximum in the schedule, whether the natural environment can clean itself should be considered. Therefore the environmental carrying capacity should be the restrictive factor for the passengers' carrying capacity. On the basis of less considering the environment, after implementing the best schedule for a period, the park would be closed for several days so that the environment can have self-cleaning. Owing to the different environment framework, the models built will vary in line with the environment, which shows the regional characteristics. Besides, it becomes particularly important to keep ecological balance in the case of constantly aggravated global environment.

The income is from entrance tickets which can be divided into two parts: one is rental income of boats, and the other is rental income of occupying campsites. When setting the optimal schedule, these two parts will vary in great degree with different environments, which represented strong regionalism. Meanwhile, there are mainly two aspects affect the price positioning: one is from the competition of same kind of parks in the same area, and the other is from the different consumption level of customers. While handling this strong regionalism, the NASH model and The Unbalanced Cobweb model in Game Theory can balance the multiparty interests. Because of the different environment of locations, the weight of these two parts will be different, so we should build different regional models according to different environment.

To sum up, in the research of program design of river tourism and problem of trip scheduling, the carrying capacity of the Big Long River, the primary income for managers and the preservation of ecological environment should be the most important factors that considered, which is also the main direction the author making deep research in.

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