Dynamic Optimization of "crossing the desert" Game Path based on 0-1 Planning

Zhang Wei

Business School of Dalian University of Technology, Panjin, Liaoning, 124000

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Abstract: According to the game rules given by the title and the parameters given by the system, this article studies the problem of the optimal strategy for players to reach the end within the specified time from the perspective of planning and the game map, and seek the optimal strategy for the final retained funds. First, analyze the game conditions. The player will be given an initial fund of 10,000 yuan to purchase the two necessities of food and water within the specified 30 days. At the same time, in the line, the player can rely on mining in the mine to obtain income And in the villages in the picture, food and water are supplied to make oneself return to the end within the specified time. Considering that there are many classifications and a large amount of calculation to solve the optimization problem, the multi-stage decision model is used to solve the problem, that is, the maximum profit is solved according to different schemes, and the optimal state optimization principle is compared by comparing the results. Combining the clear optimization criteria to construct decision-making schemes at various stages, so as to complete the solution of the optimal problem. Finally, this article analyzes the advantages and disadvantages of the model, and on this basis, discusses the improvement direction of the model and simply promotes the model.

1. Background

"Crossing the Desert" is a single player game project that seeks the optimal solution of the route. The game's props include a map and an initial capital of 10,000 yuan. Players can use the initial capital to purchase a certain amount of water and food (including food and other daily necessities) for daily consumption. When the game starts, the player starts from the starting point and walks in the desert. On the way from the starting point to the ending point, players will encounter different weather, and they can also replenish funds or resources in mines and villages. Within the specified system parameters, the sum of the quality of water and food owned by the player every day cannot exceed the upper limit of load. If the end is not reached and the water or food is exhausted, the game is deemed to have failed. The goal of the game is to reach the end within the specified time and keep as much money as possible.

Assuming that there is only one player and it is required that all the weather conditions are known in advance during the entire game period, this article gives the optimal strategy for the player under normal circumstances.

2. Problem analysis

Based on the TSP algorithm, LINGO and MATLAB are used to calculate the optimal path, establish an optimal strategy model based on the weather conditions and the given system parameters, and pass the "first pass" and "second pass" to the player. The case of “closed” is solved. The evaluation of the selected model by this algorithm is to test whether the establishment of the model has a scientific basis, and whether the result of the model has a good fitting effect is extremely reasonable. At the same time, carry out practical evaluation and check whether the model can simulate real conditions, whether it has practical significance and can provide guiding suggestions for real results.

3. Model establishment and solution

3.1 Data preprocessing

All requirements are within a certain period of time, requiring players to use the prescribed time and initial funds to mine and go to the village to supply supplies from the starting point to the end point. However, the problem gives different conditions, which need to be analyzed and solved separately under different circumstances. That is, the optimal plan for the player's route from the starting point to the end point may be when the weather conditions for 30 days are all known, only the day is known, or all are unknown. Plan. Using the path evaluation algorithm, through the analysis and estimation of the player's available paths in different weather (clear, high temperature, sandstorms), and then combined with relevant and determined information (the distance to the available path, the length of the available path, the degree of congestion in the available path and Available exit capacity) influence on planning pedestrian evacuation paths, and analyze the influence of each information on path planning by adjusting the weight of each information in the evaluation path.

3.1.1 Model overview

The knapsack problem is a NP-complete problem of combinatorial optimization. This question was raised by Merkel and Hellman in 1978. The problem given in this question can be described as: Given a set of items at the beginning of the game, each item has a different weight and price in sunny, high temperature, and sandstorm weather. How do players make choices within a limited total load and total budget? , In order to make the total value remaining at the end the highest. The knapsack problem can be described as a decisive problem, that is, on the premise that the total quality of the items purchased at the starting point does not exceed the total weight that the player can accept, whether the total revenue can reach the maximum at the end.

3.1.2 Analysis of the rationality of the model

After consulting relevant information, we analyzed the basic form of the model, model parameter settings, model prediction accuracy, etc., and obtained:

1) The advantages of this model are that it is simple in form, easy to understand, easy to operate, data processing fits the reality, and the modeling process is convenient and efficient;

2) This model visualizes the final result, making it easier to compare and analyze. Players' choices in different schemes are presented one by one, which is convenient for vertical comparison of the feasibility of each scheme. However, in this article, the hypothetical situation is too ideal, and the actual problem is not considered. The single conditional design limits the scope of the solution, and the practicability needs to be improved.

3.2 Model building and solving

Regret Minimization is the predecessor of Counterfactual Regret Minimization (CFR). The role of regret in game games is to predict future action choices based on the degree of regret for actions in the past. For a given series of strategies δ1, δ2,..., δT, the minimum regret value of player i is calculated as follows:

$$R_i^t = \max_{\sigma_i^{'} \in \varepsilon_i} \sum_{t=1}^{T} (\mu_i(\sigma_i^{'}, \sigma_{-i}^{t}) - \mu_i(\sigma^t)).$$

R corresponds to player i recalling the profit under the optimal strategy at all time steps t=1, ..., T. If a player’s strategy is generated

$$R_i^{T,+} / T \to 0\,(\mathrm{x}^+ = \max\{\mathrm{x},0\})$$

We say that this algorithm is the least regrettable.

3.2.1 Modeling ideas

In the process of traversing the desert, the player needs two resources, water and food, and the smallest unit of measurement for both is a box. The sum of the quality of water and food that each player can have each day cannot exceed the maximum weight given. Ignoring the impact of the area of the map on the player, considering that only one square per day can be moved to the adjacent area. After data comparison and fitting, the player moving one square is more helpful to the solution of the optimal strategy than stagnation. In the same way, choosing to go through the mine makes more money than not going through the mine. Ensure that the path to the mine is the shortest, and at the same time, the time of mining in the mine is long enough to get more revenue at the end. The itinerary of the players in the first level is shown in Table 1.

After data analysis and comparison, the optimal path for players in the first level should be:

1 (starting point) → 25 → 24 → 23 → 22 → 9 → 15 (village) → 14 → 12 (mine) → 14 → 15 (village) → 14 → 12 (mine) → 16 → 17 → 21 → 27 (end point)

Table 1 Player's first stage schedule

Serial number	date	stroke
1	1—8	Supply from the starting point to the village
2	9—10	From the village to the mine
3	11—17	Mining in the mine
4	18	The sandstorm is stagnant
5	19—22	Replenish from the mine to the village and then return to the mine
6	23—25	Mining in the mine
7	26—30	From the mine to the end

In the second level, the sum of the quality of water and food that the player can have still cannot exceed the maximum weight given. Using the ideas and methods of the first level, ignoring the impact of the area of the map on the player (at this time the area of each area is equal), considering that only one grid can be moved to the adjacent area per day, after data comparison and fitting, The player moving one square is more helpful to the solution of the optimal strategy than stagnation. Similarly, choosing to pass through the mine makes more money than not passing through the mine. Ensure that the path to the mine is the shortest, and at the same time, the time of mining in the mine is long enough to get more revenue at the end. The itinerary of the player in the second level is shown in Table 2.

After data analysis and comparison, the optimal path for players in the second level should be:

1 (starting point) → 2 → 10 → 11 → 20 → 21 → 29 → 30 (mine) → 39 (village) → 30 (mine) → 39 (village) → 46 → 55 (mine) → 63 → 64 (end point)

Table 2 Players' second stage schedule

Serial number	date	stroke
1	1—9	From the starting point to mine 30
2	10—14	Mining in mine 30
3	15	Supply from mine 30 to village 39
4	16	From Village No. 39 to Mine No. 30
5	17—21	Mining in mine 30
6	22—24	From Mine No. 30 to Mine No. 55, supply supplies in Village No. 39 along the way
7	25—28	Mining in mine 55
8	29—30	From mine 55 to the end

3.2.2 Model establishment

(1) In order to find the optimal strategy, it is necessary to make the player's path from the starting

point to the mine the shortest. Taking into account the weather, this journey takes at least 8 days, of which the 4th and 7th are sandstorms and the player cannot move forward. , After the player arrives at the mine on the 10th day, they cannot mine on that day, so the mining starts on the 11th. At this time, we found that it takes at least five days from the mine to the end. In order to obtain the optimal strategy and obtain more benefits, it is necessary to ensure that the players are on the road for five days. Suppose the player is on the road from 26 to 30 days. Taking into account the supply and demand of supplies, after calculation, the player needs to make a supply on the way to the mine, and also needs to go to the village to make a supply on the way to the mine, and then return to the mine for mining. The 17th and 18th are sandstorms and cannot be moved. On the 19th, leaving to the village for supply will not be enough to support the player to continue the game. Therefore, it can be determined that the player will stay in the mine without mining on the 18th, and then leave for the village on the 19th to buy supplies. Water and food will be returned to the mine on the 22nd, mining will be carried out on the 23rd-25th to obtain sufficient profits, and on the 26th, it will start to the end.

The conditions given in this question are that the price of replenishment in the village is twice the initial purchase price, food is 10 yuan/box, water is 5 yuan/box, and the price of food and water is quite different. Under the condition of ensuring sufficient water supply, in order to obtain the maximum benefit at the end point, you should buy as much food as possible at the starting point, calculate the quality of water and food in the first eight days, hurry on 9-10 days and mine on 11-17, 18th Stop, the amount of water consumed for driving on 19-22 is 245 boxes. According to the 1200 kg replenishment limit given in the subject, there are two options for discussion at this time:

Solution 1: It is calculated that the maximum amount of food is 232 boxes at this time, plus 98 boxes of food consumed in the first eight days on the road, that is, players need to buy 330 boxes of food at the beginning. According to the weight limit, 180 boxes of water are purchased at this time. At the same time, there is 1 kilogram of weight left, and retaining this kilogram of surplus at this time is more beneficial than replacing a box of food with a box of water. It is calculated that 500 boxes of water and 470 boxes of food were consumed. The player spent 10 days of mining on the way (11-17 and 23-25), earning a total of 10,000. Replenishing 320 boxes of water and 146 boxes of food in the village cost 3200 yuan for water and 2800 yuan for food, plus 900 yuan for water and 3,300 yuan for food at the starting point. The total cost is 10,200 yuan. The game provides players with 10,000 yuan initial funding. Players have a net profit of 9,800 yuan under this program.

Solution 2: At this time, the player can exchange a box of food for a box of water to obtain greater benefits. It is calculated that the maximum amount of food at this time is 231 boxes, plus 98 boxes of food consumed in the previous eight days, that is, the player needs a total of At the beginning, 329 boxes of food were purchased. According to the weight limit, 181 boxes of water were purchased at this time. At the same time, there is 1 kg of weight left, and as mentioned earlier, the benefits of replacing a box of food with a box of water are greater. In the same way, the player spends 3190 yuan to replenish water in the village and 2820 yuan for food. At the beginning, water costs 905 yuan, and food costs 3290 yuan. The total cost is 10205 yuan. The game provides players with an initial capital of 10,000 yuan. The net profit was 9795 yuan.

After comparison, the players finally get more profits from implementing the first plan.

(2) In the second level, it takes 9 days for the player to get from the starting point to the mine. We must mine as much as possible while ensuring sufficient supplies. Therefore, we choose to mine on the 10th to 14th and arrive at Village 39 on the 15th. Supply, so that the player's itinerary on the 16th can be discussed in two situations:

Option 1: Return to Mine No. 30 on the 16th, stay for one day, and dig in the mine on the 17th.

Option 2: Starting from Village 39 on the 16th to mine at Mine 55. At this time, due to sandstorms on the 17th and 18th, it is necessary to stay on the 47th for two days.

It is calculated that the profit of Option 1 is high, that is, after the replenishment is over, return to mine 30 for mining, set off on the 22nd, hurry on the 22-24, reach the 55 mine on the 24, and mine for 4 days on the 25-28, 29 On the 30th, rush to the end in two days.

It should be noted that unlike the first question, we do not need to consider the ratio of water to food at this time, because before the 15th replenishment, the player has consumed 247 boxes of water and 227 boxes of food, which need to be purchased at the beginning Sufficient. At this time, the distance to the maximum load is still 2 kg. We choose to buy food, so there are 229 boxes of food and 247 boxes of water. Considering that similar to the first level, the profit of the remaining one kilogram is greater than that of replacing a box of food with a box of water. Therefore, at the beginning, the remaining 1 kilogram of the weight was carried, which consumed 538 boxes of water and 500 boxes of food, which was replenished in the village. After 291 boxes of water and 271 boxes of food, water costs 2910 yuan and food costs 5420 yuan, plus 2290 yuan for water at the starting point and 1235 yuan for food. The calculated cost is 11,855 yuan, and a total of 14,000 are earned in 14 days of mining. Yuan, the final player netted 12145 Yuan.

3.2.3 Model solution and result analysis

Set up n1 round trips between the village and the mine to supply water and food, the time used t1, the round trip between the starting point to the village and the mine to the end point n2 times, the time used t2, that is, the water carried each time is a=5kg/ Box, food b=10kg/box, water and food consumed in sunny weather d1=12kg, water and food consumed in high temperature d2=14kg, water and food consumed in sandstorms d3=20kg, total water consumption is c, The total consumption of food is d, then the objective function is

$$min\ f1=1/2n1(2d3+4d2+d1)+d3+1/2n1*3(d1+d2)+d3$$

$$min\ f2=1/2n2[(2d1+3d2)+ 2d3+3(d1+d2)+2d2]$$

$$w=5c+10d$$

From this to get the model

$$\begin{cases} \min f=f1+f2 \\ \text{s.t.} \quad f_1+f_2\leqslant 1200 \\ \qquad t_1+t_2\leqslant 30 \\ \qquad w\leqslant 10000 \end{cases}$$

4. Evaluation and promotion of three models

4.1 Model advantages analysis

1) The algorithm idea is simple and easy to understand, the operation efficiency is high, the data is easy to organize and the popularity is wide.

2) The model adopts the idea from the part to the whole, sees the micro-knowledge, progressively hierarchically, and clearly organized, making the optimal solution more reasonable and visible.

3) In the process of solving the problem, the model can be adjusted step by step to increase the accuracy of the final result.

4.2 Analysis of model shortcomings

1) For the compiled code mentioned in the article, the code for reading information from the given document is not fully realized during the problem-solving process, and the operator needs to manually enter the data.

2) Due to time constraints, the code for the optimal algorithm for writing the title is not perfect, and there will be certain errors. I hope someone can do it.

3) The model used in this question can only process the known data of the question, the results obtained have certain limitations, and the optimal solution can be solved based on more data.

4.3 Promotion of the model

The model in this paper has a wide range of applications, clear organization, simple operation, and easy-to-understand results. It realizes the planning and analysis of the optimal solution under the conditions of different data attributes, diverse requirements, and restriction conditions. Practical issues such as the comparison and selection of optimal strategies play a positive role in improving the utilization of existing resources and obtaining higher economic benefits, and have certain reference and practical significance.

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