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Research on the Game of Crossing Desert based on Dijkstra algorithm and dynamic programming algorithm

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Abstract: In this paper, we take the optimal strategy of the game "Crossing the Desert" as the research object. First of all, we regularize the graph of the first level, draw an undirected graph according to the knowledge of graph theory, and mark 27 points and 53 edges. Since this is a regional path, you only need to consider whether it is crossing the border. According to the graph, let the weight between each adjacent graph (the adjacent condition in the topic) be 1, and the weather condition is known. According to the rules of the game, we regard the starting point, village, mine and destination at four important points. The desert area of the way only needs to add up the weight, which can be deleted after the addition, leaving the weight behind. As a result, we know that only through the village can the mine maximizes the number of days and assets, as well as the second level. Through the modeling operation, we get that the first pass reaches the end point in the 23rd day, and the maximum value when the capital is 10430, and the second level reaches the end point on the 30th day, with a capital of 12590 yuan.

1. Introduction

At present, it has become a hot spot to protect nature and pay attention to the desert.

In order to attract more people's attention, combined with the characteristics of easy spread and wide divergence in today's Internet era. It has become a development trend to integrate desert elements into the game. Among them, "Crossing the Desert" is a representative and excellent competitive game [1]. In the game, each player has the same initial capital, and players can buy drinking water and food at the starting point and make choices in different weather. At the same time, players can also obtain resources and funds in specific locations such as villages and mines. In the end, players need to carry the most money to the finish line within a specified period of time. In addition, players also need to consider the impact of factors such as material prices and load limits and weather decision-making. We need to establish a decision-making model to maximize benefits when the relevant conditions are given. In this paper, we get the optimal strategy of the game when there is only one player and the weather conditions are known.

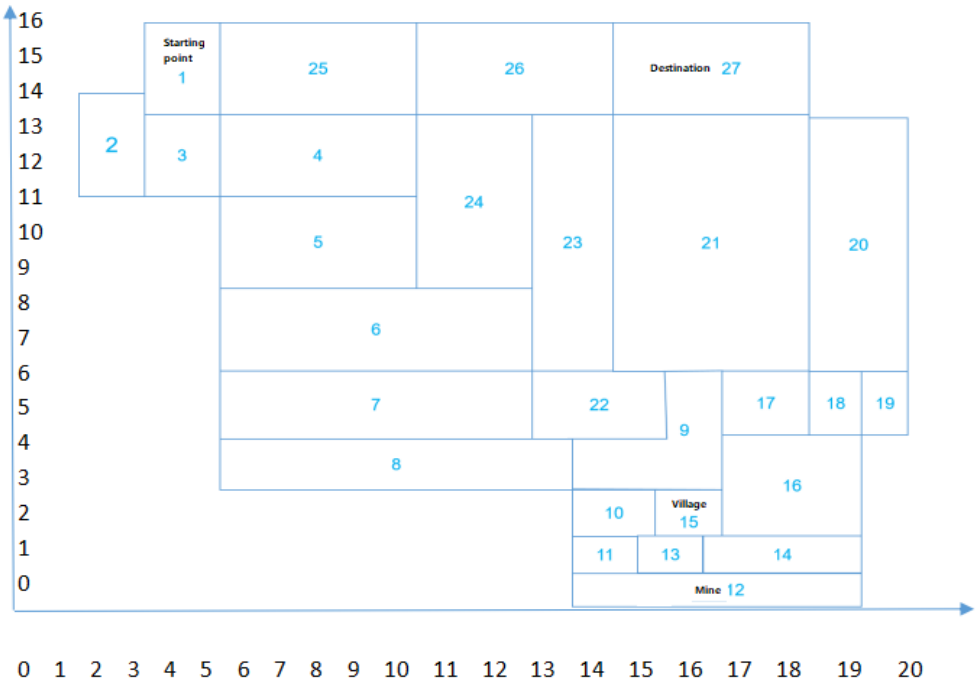

Figure 1: The simplified map of the first level

2. Modeling and solving of the first pass of the game

According to the analysis of the problem, we first sort out the irregular map and regularize each area of it. After that, we list all the adjacent regions with the classical Dijkstra algorithm [2] in graph theory, where an and b represent every two adjacent regions: a, $=\{1,2,3,4\ 27\}$. C indicates that it will cross the border at least a few times, and e indicates the amount of money spent.

At the same time, we also use the known conditions to establish a linear programming [3] model to discuss the relationship between itinerary distance and income, then we can list the following objective function, where r_i is the average rate of return and p_i is the loss costs.

In the case of this question, the player only knows the climate of the day and needs to decide the itinerary of the day, with uncertainty about the conditions of the sandstorm.

We need to discuss the results in different situations according to the actual situation, as well as the best strategy at this level.

$$\begin{cases} \max \sum_{i=0}^{n} (r_i - p_i) x_i \\ \min \left\{ \max \left\{ q_i, x_i \right\} \right\} \\ 5x_1 + 10x_2 < 10000 \\ 3x_1 + 2x_2 < 1200 \\ x1 > 0 \\ x2 > 0 \end{cases}$$

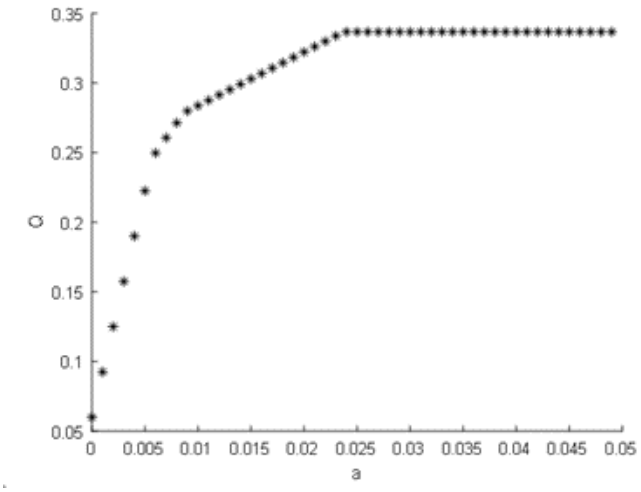

Figure 2: Linear programming simulation results

By establishing the undirected graph between the points, we can clearly find the existence of the path between the points, which are beneficial in the follow-up program practice.

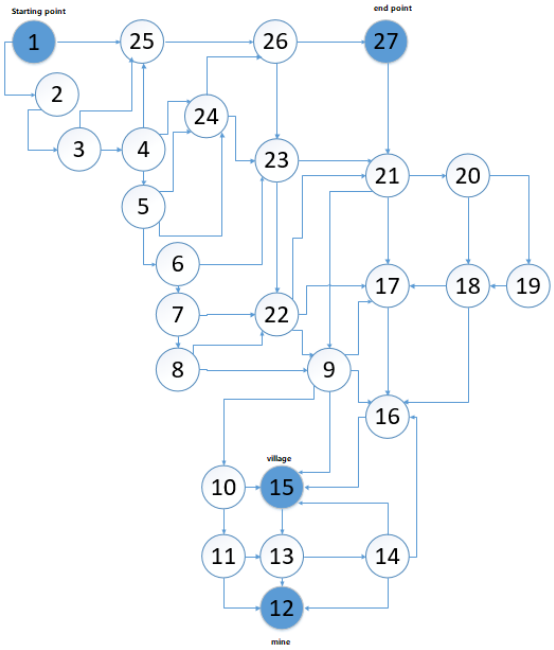

Figure 3: Vertex undirected graph

Through the simulation, we can draw a conclusion: in order to maximize the amount of money left. We must take the fastest way to reach the village. After that, there will be two situations: one is to go to the mine through the village. Dig the mine for another seven days to return to the village, and then return to the mine. The second situation is to stay for one day, dig the mine for seven days, and then go to the village to reshuffle.

The following examples are given in turn:

We set up the coordinate system as shown in figure 4, write out the coordinates, and then use MATLAB2018b to draw a simplified version of the map.

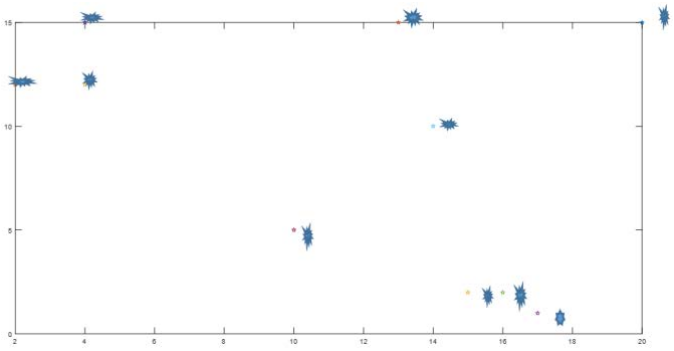

Figure 4: The position relationship between the key points and other individual points in the simplified version of the map

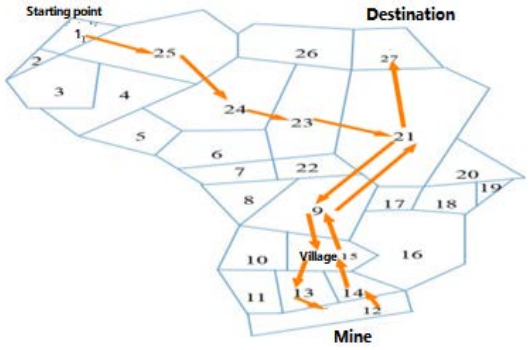

Figure 5: The first level is the road map.

Therefore, the maximum value can be obtained by using the following scheme:

Plan 1: from the starting point, buy 540kg of water and 660kg of food.

Spend 900-3300-4200 yuan carrying 1200 kilograms.

Plan 2: arrive at the village eight days later and still have 464kg of food and 246kg of water left.

After replenishing 489 kilograms of water, the expenditure is 1630 yuan, and the load after replenishment reaches 1199 kilograms.

Plan 3: arrive at the mine after two days, stay for one day, dig the mine for seven days, and then go to the village for repurchase. The journey takes two days, with a total loss of 422kg of food, 735kg of water and 42kg of water.

Plan 4: arrive at the village and start replenishing again, purchasing 38kg of food and 108kg of water. Expenditure of 380,360,740 yuan.

Plan 5: after three days to return to the finish line, food and water are just consumed.

Summary: the total amount of mining is 7 days, the income is 7000 yuan, the expenditure is 6570 yuan, and the balance is 10,000,7000,6570,0430 yuan.

3. Modeling and solving of the second pass of the game

The thought of the second level is similar to that of the first level. This pass map is hexagonal honeycomb, walking along the positive direction of the path. The distance is fixed. And because the players at this level have made it clear about the weather every day, in order to maximize the benefits, players should choose to stay in the mine for as long as possible, especially the sandstorm weather. When the sandstorm weather comes, it can not move forward, if it is in the mine, it can continue to excavate normally. Therefore, this pass can be simplified to a mathematical model of "judging whether it is a sandstorm weather, checking whether resources are sufficient, and whether to continue to mine". By using depth-first traversal [4] and route planning, the following results can be obtained:

Step 1: from the starting point, buy 552kg of water and 648kg of food, cost 4160 yuan, the remaining 5840 yuan, full load at this time.

Step 2: arrive at the mine 30 after 9 days, start digging after a rest, and then go to village 39 after digging for two days.

Step 3: 48 kilograms of remaining water, 332 kilograms of food, 891 kilograms of water, the remaining 4870 yuan.

Step 4: arrive at the mine 55 two days later, start digging every other day, and go to the village for four days to replenish, remaining water 489kg, food 64kg, supplementary water 162kg, food 374kg, surplus 4590, load 1089 kg.

Step 5: go back to the mine to 55, start digging every other day, dig for eight days, and stay for

one day. The capital is 12590. The water surplus is 96kg, and the food surplus is 48kg.

Step 6: after two days back to the finish line, food and water are used up.

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