

Research on the Optimal Strategy of "Crossing the Desert" Game Based on Dijkstra Algorithm

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Abstract: This article mainly analyzes the problem of "crossing the desert" game, and transforms the problem of cross-desert game into the shortest path problem in graph theory. Taking the consumable materials and consumable funds as the weights, using Dijkstra's algorithm, path planning, dynamic planning and recursive methods, the model is established in consideration of the weather, and the optimal strategy is given to maximize the remaining funds when the destination is reached.

Keywords: path planning, Dijkstra algorithm, dynamic planning

1. Introduction

The goal of the "Crossing the Desert" game is to save as much funds as possible from the starting point to the end point, and the mission time should not be longer than 30 days. Therefore, we need to analyze the corresponding resource consumption in different motion states (walking/staying), resource consumption corresponding to different weather conditions and material prices corresponding to different locations (starting points/villages), and different strategies are given for different game rules [1]. It is required to formulate the player's best course of action when all weather conditions are known. We assume that the player's final capital composition is initial capital-consumption + mining revenue [2].

2. Model analysis

Firstly, make the following assumptions: (1) Assume that the mining stays in the same area except due to sandstorm days, and does not stay in other situations. (2) Assume that the resources of the village will not be bought out, that is, do not consider how many resources the village has (3) Assumption Ignore the leakage of water on the way and ignore the amount of water evaporated on the way. (4) Assume that the weight of the funds for mining revenue is not considered, and the negative weight only considers water and food. Then define the symbols as shown in Table 1.

Table 1: Symbol description

Symbol	Implication	Unit	Symbol	Implication	Unit
x	Total amount of water	box	E _d	Food consumed	kg
y	Total amount of food	box	A _{w1}	Water supply	box
t ₁	The amount of sunny days	day	A _{d1}	Food supply	box
t ₂	High temperature days	day	a	Total resources consumed	kg
t ₃	Sandstorm days	day	E _{w0}	Initial water volume	box
w	Water consumption	box	E _{d0}	Initial food	box
d	Food consumption	box	k	Mining revenue	yuan
m _w	Water consumption	kg	t	Mining days	yuan
m _d	Food consumption	kg	m	Water and food consumed	kg
Q	Remaining funds	yuan	k ₁	First mining income	yuan
q	Total funds consumed	yuan	k ₂	Second mining income	yuan
S _w	Remaining water	box	Q _n	Remaining funds after the nth mining	yuan
S _d	Remaining food	box			
E _w	Quality of water consumed	kg			

According to the requirements, the optimal strategy to keep as much funds as possible to reach the end within the prescribed 30 days, and the weather conditions within 30 days are known. Based on the weather conditions in Table 2 and the location information of the villages and mines in the map, and the parameter settings in Table 3, the player will not stay in place due to subjective reasons. Whether the

player stays is related to the weather. From this, the relationship between the consumed funds, the remaining funds, the consumed resources, the remaining resources and other variables is established, and the optimal strategy with the most funds at the end is calculated.

Table 2: Weather conditions

Date	1	2	3	4	5	6	7	8	9	10
Weather	H	H	F	S	F	H	S	F	H	H
Date	11	12	13	14	15	16	17	18	19	20
Weather	S	H	F	H	H	H	S	S	H	H
Date	21	22	23	24	25	26	27	28	29	30
Weather	F	F	H	F	S	H	F	F	H	H

Table 3: Parameter setting

Maximum weight		1200kg	Initial capital	10000yuan	
Deadline		30days	Base income	1000yuan	
Resources	Quality (kg/box)	Price (yuan/box)	Basic consumption (box)		
			High temperature	Sunny	Sandstorm
Water	3	5	8	5	10
Food	2	10	6	7	10

To maximize the benefits when reaching the end, then: (1) Must go to mining; (2) Since the price of goods in the village is twice the starting price, it is necessary to carry as many resources as possible at the starting point; (3) Food price Compared with water, water and food at the same price are more expensive, water is 3 times heavier than food, and the player’s load has an upper limit, so you should buy more food and less water at the starting point to reduce the consumption of funds for replenishing resources in the village; (4) The remaining resources that reach the end can only be returned to half of the benchmark price, and there should be no resources left when the end is reached. Only by satisfying the above conditions as much as possible can the funds be maximized [3].

3. Modeling

According to the conditions given in the title, using the shortest path analysis method, the consumption of materials and consumption of funds m yuan are used as weights, and the constraints and assumptions are considered, and the path selected when the weight is the smallest is the optimal path [4].

According to the conditions and weather conditions and parameters given in the topic, the fund consumption under different conditions and the consumption resources under different conditions are calculated as shown in Table 4 and Table 5.

Table 4: Consumption of funds under different circumstances (unit: yuan)

The weather	After one day	Mining	No mining	Stay in one place
Sunny	190	570	0	95
High temperature	200	600	0	100
Sandstorm	0	450	150	150

Table 5: Consumption of resources under different circumstances (unit: box)

The weather	Resources	After one day	Mining	Stay in one place
Sunny	water	10	15	5
	food	14	21	7
High temperature	water	16	24	8
	food	12	18	6
Sandstorm	water	0	30	10
	food	0	30	10

Suppose there are x boxes of water and y boxes of food, then

$$\begin{cases} 3x + 2y \leq 1200 \\ 5x + 10y \leq 10000 \end{cases} \quad (1)$$

The total consumption of fund m is

$$m = 190t_1 + 200t_2 \quad (2)$$

The final remaining fund M is

$$M = 10000 - m + k \tag{3}$$

The mining revenue k is

$$k = 1000t \tag{4}$$

Number of boxes of water and food consumed while walking are

$$w_1 = 10t_1 + 16t_2 \tag{5}$$

$$d_1 = 14t_1 + 12t_2 \tag{6}$$

Number of boxes of water and food consumed while staying in one place are

$$w_2 = 10t_3 \tag{7}$$

$$d_2 = 10t_3 \tag{8}$$

Number of boxes of water and food consumed while mining are

$$w_3 = 15t_1 + 24t_2 + 30t_3 \tag{9}$$

$$d_3 = 21t_1 + 18t_2 + 30t_3 \tag{10}$$

4. Solution

The player arrives at the village from the starting point. After supplying the corresponding materials in the village, the player goes to the mine for digging for a few days, and then goes to the village to supply materials and then returns to the mine for digging for a few days and heads directly to the end point. Using Python software, using Dijkstra's algorithm, the path of strategy 2 is: $1 \rightarrow 25 \rightarrow 24 \rightarrow 23 \rightarrow 22 \rightarrow 9 \rightarrow 15 \rightarrow 14 \rightarrow 12 \rightarrow 14 \rightarrow 15 \rightarrow 9 \rightarrow 21 \rightarrow 27$. As shown in Figure 1, from the parameter settings in Table 3, the price of food is more expensive than water. If it is supplied in the village, it will cost more money. Therefore, when we buy materials at the starting point, we are burdened under the constraints of capital and capital, only the number of boxes of water that can reach the village is purchased. The water needed to reach the mine from the village and when mining and from the mine to the end is replenished in the village. According to the shortest path algorithm and the need to stay in a sandstorm, the shortest path from the starting point to the village is obtained, which takes 8 days. Among them, sunny $t_1=3$ days, high temperature $t_2=3$ days, sandstorm $t_3=2$ days.

The number of boxes available to buy water: $x = 98$. The number of boxes to buy food: $y = 453$. According to the formula, the remaining water is 0 tanks, the food is 7 tanks, and the fund is 10255 yuan.

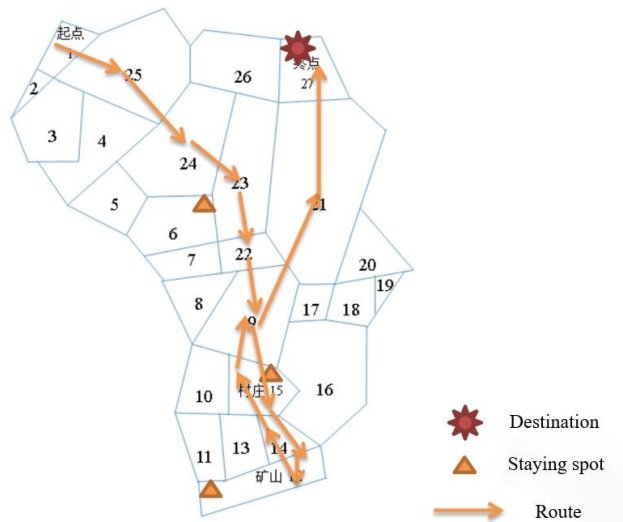


Figure 1: The map of the game

Note that there are still 7 boxes of food left after reaching the end point, and there is no food supply in the village from the starting point, then the path remains the same. First of all, buy 7 boxes of food

less at the starting point, then you can buy more $7 \times \frac{2}{3} = 4$ boxes of water. Then at the starting point:
Number of boxes of water purchased:

$x = 102$. Number of boxes of food purchased: $y = 446$.

At this time, the player reaches the end on the 30th day, and the fund is 10310 yuan.

5. Conclusion

This question takes game players in the desert as the research object, uses Dijkstra's shortest path analysis method, according to the changes in materials and funds corresponding to different weather, and considers the player's maximum load, and generates the shortest path to complete the task through the map. The route provides players who travel through the desert with the maximum funds to survive in the desert and retain when they reach the destination. But in this question, it is assumed that the player can reach another area adjacent to it from a certain area every day, which reduces the factors that the player needs to consider in the game. The model has feasibility, reliability and high efficiency.

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