

# Theoretical Analysis and Strategy Research of Desert Travel Model

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**Abstract.** In this paper, aiming at the decision-making problem of players' walking scheme in the game, according to graph theory, benefit and cost game, the optimal path model is established, which provides the choice scheme for players to complete the game, gives the walking scheme with the most remaining funds under the condition of completing the game, and solves the problem of finding the optimal scheme under the influence of other players' actions.

**Keywords:** Desert Nuggets Optimization Method Graph Theory Game Theory

## 1. Introduction

Crossing the desert requires players to purchase a certain amount of water and food with the initial subsidy within the specified time. When they arrive at the destination from the starting point, they will encounter different weather on the way, and they can also supplement funds or resources in mines and villages. The ultimate goal is to arrive within the specified time and keep as much funds as possible.

There are various and ever-changing routes for decision-making in desert. Correctly planning the proportion of water and food and daily action strategies will provide theoretical basis for the shortest time, the maximum capital gains and the optimization scheme.

## 2. Problem analysis

Under the influence of three kinds of weather affecting players' travel strategies and material consumption, there are various routes to cross the desert. This paper will establish a model to analyze the following problems:

For checkpoint 1: firstly, it is necessary to consider how to carry water and food between different places, such as: how much water and food to carry from the starting point to reach the village smoothly, how much water and food to rest from the mine to reach the village safely for supply, and how to supply in the village to reach the destination smoothly. Secondly, it is necessary to consider whether to mine or not. The analysis shows that the mining income is positive and the mining days are positively correlated with the income, Therefore, mining will inevitably bring benefits, but there is also the risk of game failure, so it is necessary to rationally plan the specific mining time after successfully reaching the mine.

## 3. Model preparation

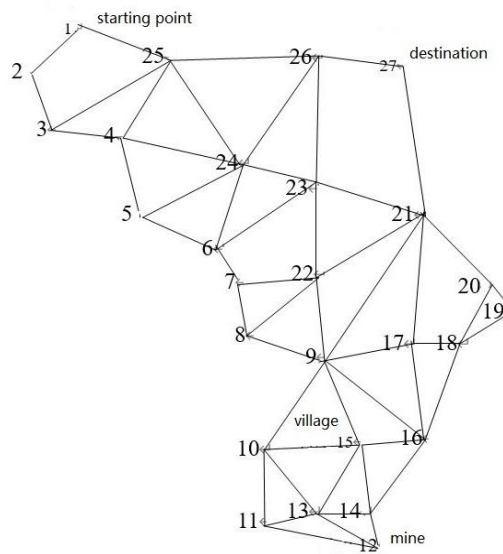
Through the integration and analysis of the relevant conditions provided by the title, it is found that players can draw up different travel routes for different maps. But fundamentally, players need to consider the following problems: firstly, the optimal route; secondly, whether or not to mine and the number of days of mining will directly affect the amount of remaining funds after the player reaches the finish line; finally, whether or not to go to the village for replenishment after mining is

also one of the key factors that determine the amount of remaining funds. The specific thinking about the scheme is shown in the following figure.

**3.1. For level 1**

Through the known conditions, it can be seen intuitively that there are only two kinds of "level one" optimal methods, one is to walk directly from the starting point to the end point, and this method is the shortest path; The other is to start from the starting point, get the income and supplement materials through mines and villages, and finally return to the end point, By calculating the final income of the two methods and comparing them, the optimal strategy of "level one" can be obtained. The logical thinking is shown in the figure 1.

Replace each small area in the map with points, and connect adjacent areas with straight lines, and draw all feasible routes for players as follows

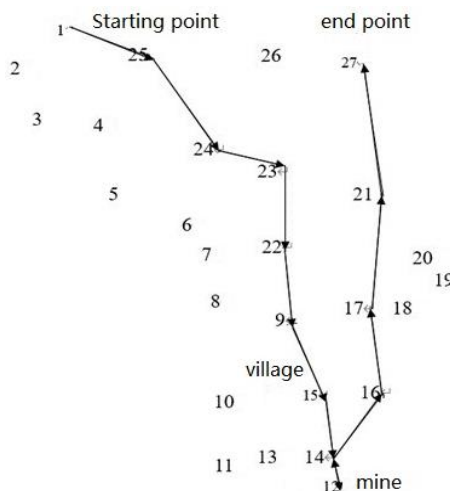


**Figure 1.** The maximum load, total cost and remaining funds of all road maps.

The maximum load, total cost and remaining funds of all road maps of "Level 1" are as follows:

The first scheme: the player walks directly from the starting point to the end point (i.e, 1→25→26→27). This scheme can reach the destination in 3 days, with a total negative weight of 202 kg, a total cost of 590 yuan and a surplus of 9410 yuan.

The second scheme: the player starts from the starting point, supplies a certain amount of funds or materials through villages and mines, and then directly returns to the end point. The traveling route is shown in the Figure 2.

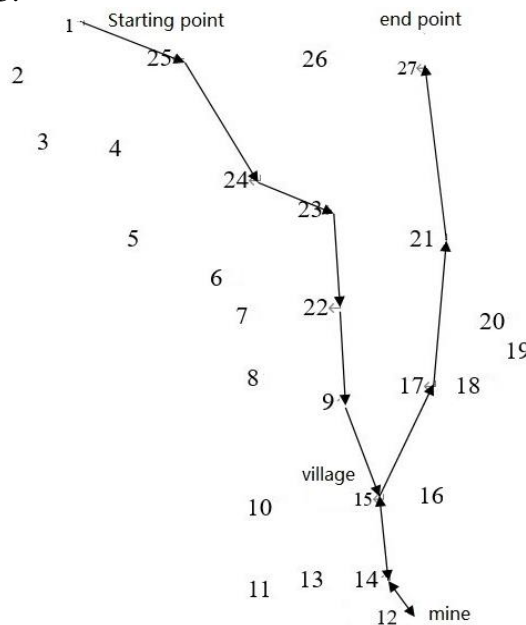


**Figure 2.** Roadmap for the second scheme of "Level 1".

In this scheme, it takes at most 22 days from the starting point to the end point, after specific analysis, the optimal scheme is that it takes at least 8 days for water to travel from the first day to the village for replenishment, in which the total weight of water and food consumed is 540 kg (including 294 kg of water and 246 kg of food), and the cost is 1470 yuan. Considering that the price of each box of water and food purchased in the village is twice the benchmark price, which is the same box, the water only needs 10 yuan, but the food needs 20 yuan. Therefore, in addition to ensuring 540 kg of materials needed to reach the village, we can buy as much food as possible, from this analysis, we can get 477 kg of water and 722 kg of food (i.e., 159 boxes of water and 361 boxes of food, note: the food is enough for players to reach the terminal), totaling 100. In order to make the mining time longest, it is necessary to replenish in the village. It is known that there is enough food, that is, it is only necessary to replenish the water needed for the remaining distance in the village. Using the backward method, we can know that 711 kg of water is needed for the subsequent journey, from which we can get:

It is found that 176 boxes of water need to be replenished in the village, which costs 1760 yuan, and the load after replenishment is 1004 kg, which does not exceed the upper limit of 1200 kg. From this formula: =+It is calculated that the total cost is 1545 yuan and the remaining funds are 8455 yuan.

The third scheme: the player starts from the starting point and goes to the mine after being replenished by the village for the first time. On the premise that the mine can be replenished by the village again, he will spend as much time as possible to increase the amount of funds, then return to the village to replenish the materials to the end point, and finally return to the end point, the travel route is shown in the Figure 3:



**Figure 3.** Roadmap of the third scheme of "Level 1".

In this scheme, it takes at most 23 days from the starting point to the end point, the specific scheme is as follows: the upper limit of load bearing from the starting point is 1200 kg, in order to ensure smooth arrival in the village, the total amount of materials should exceed the total amount of water and food consumed from the starting point to the village (including 294 kg of water and 246 kg of food). Considering that the price of each box of water and food purchased by players in the village is twice the benchmark price, which is the same box, water only needs 10 yuan, but food needs 20 yuan, so as much food as possible in addition to 540 kg of materials needed to reach the village when starting, from this analysis, it can be found that 1198 kg (including 450 kg of water, 150 boxes of food, 748 kg of food, 374 boxes of food) are carried when starting, Note: food is enough to meet the needs of players to reach the terminal. In order to make the mining time longest, it is necessary to replenish in the village, it is known that there is enough food, that is, it is only necessary to replenish

the water needed for the remaining distance in the village. Using the backward method, it can be known that 725 kg of water is needed for the subsequent journey, which can be obtained as follows:

= [()] ÷ 229 boxes of water need to be replenished in the village, which costs 2290 yuan, and the daily load does not exceed the upper limit of load

1200 kg. From this formula: =+It is calculated that the total cost is 675 yuan and the remaining funds are 9325 yuan.

A comparative analysis of the above three schemes shows that the first scheme is the best strategy of "the first level", and its route is 1→25→26→27, and the remaining amount is 9410 yuan. [2]

### 3.2. For level 2

For "Level 2", three types of schemes can be analyzed from known conditions, Scheme 1: Players only increase the amount of funds through mining in Mine A (that is, the mine numbered 30); Option 2: Players only increase the amount of funds through mining in Mine B (the mine numbered 55), and then go directly to the end point; Option 3: Players only dig through the B mine (that is, the mine numbered 55) to increase the amount of funds and return to the end after being replenished by the village B; Scheme 4: The player not only increases the amount of funds by mining in Mine A (mine No.30), but also mines in Mine B (mine No.55), Comprehensive calculation and analysis show that Scheme 4 can maximize the player's income. (Note: The village close to Mine A numbered 30 is designated as Village A, and the village close to Mine B numbered 55 is designated as Village B. The logical thinking diagram of "Level 2" is as follows:

The maximum load, total cost and remaining funds of each scheme analyzed are as follows:

Scheme 1: players only increase funds by mining in a mine (i.e., mine No.30), and then go directly to the destination after being replenished by nearby village a. Travel route: 1 → 2 → 10 → 11 → 20 → 21 → 29 → 30 → 39 → 47 → 56 → 64 (the shortest route is not unique, only one is taken as an example here). As shown in the figure, 1C indicates that the total weight of materials carried from the starting point to the village A is 1,199 kg, of which 741 kg is water and 458 kg is food (4 kg is reserve food, but it is not necessary.; In the same way, 1D indicates that the total amount of materials carried from village a to the destination is 316kg, of which water accounts for 204kg and food accounts for 112kg. In this process, under the condition that the daily load does not exceed the upper limit of 1200 kg, the remaining total fund after all expenses are removed is 10595 yuan.

Scheme 2: players not only increase the amount of funds through mining in mine a (mine No.30), but also expand the funds through mine b (mine No.55), but they should make supplies in village a and make plans on the premise of ensuring sufficient materials to return to the destination within the specified time. The travel route of this scheme is: 1 → 9 → 18 → 26 → 27 → 28 → 29 → 30 → 39 → 47 → 55 → 56 → 64 (the shortest path is not unique, only one is taken as an example here). As shown in Figure 6.1.1-2(1) above, 2C indicates that the total weight of materials to be prepared from the starting point to the way to Village A is 1199 kg, of which 741 kg is water and 458 kg is food (of which 4 kg is reserve food, but it is not necessary. ; In the same way, 2D indicates that the total amount of materials to be prepared from village A to the destination is kg, of which 720kg is water and 476kg is food. In this process, under the condition that the daily load does not exceed the upper limit of 1200 kg, the remaining total funds are 12355 yuan.

Scheme 3: players only increase the amount of funds by mining in mine b (i.e., mine No.55), and then return to the destination after village b supplies. The traveling mode is as follows: 1 → 9 → 18 → 26 → 35 → 43 → 52 → 53 → 54 → 55 → 62 → 63 → 64 (the shortest path is not unique, only one is taken as an example here). The details are shown in Figure 6.1.12(1) above: 3C indicates that the total weight of materials to be carried from the starting point to the way to Village A is 1199 kg, including 717 kg of water and 482 kg of food (of which 40 kg of food is reserve food, but it is not necessary. ; In the same way, 3D indicates that the total amount of materials to be carried from village A to the destination is 244 kg, including 156 kg of water and 88 kg of food. The total remaining funds of the scheme after all expenses are 9395 yuan.

Scheme 4: players only increase the amount of funds by mining in mine b (i.e., mine No.55), and then directly return to the finish line. The traveling mode is as follows: 1 → 9 → 18 → 26 → 35 → 43 → 52 → 53 → 54 → 55 → 63 → 64 (the shortest path is not unique, only one is taken as an example here). The details are shown in Figure 6.1.1-2(1) above: 4C indicates that the total weight of materials needed to reach the end point straight from the starting point is 1095 kg, including 681 kg of water and 414 kg of food. The total cost of this scheme is 1205 yuan, and the remaining amount is 8795 yuan.

### 3.3. For level 3

In the third level, there are two choices for players to wait in place and move forward, and the resource loss of players under high temperature and sunny weather conditions is known, as shown in Table 1:

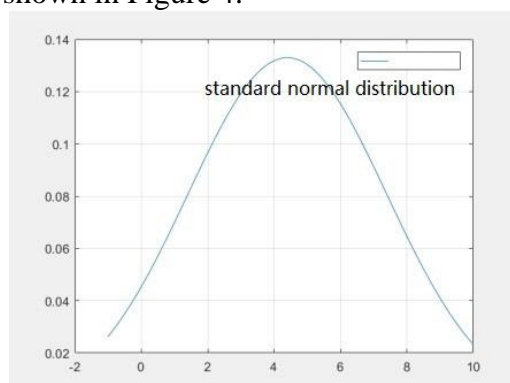
**Table 1.** "Level 3" Resource Consumption under High Temperature and Clear Weather Conditions

	Sunny foundation box	High temperature foundation box	Walk sunny box	High temperature walking box	Qinglang mining box	High temperature mining box
water	three	nine	six	18	nine	27
food	four	nine	eight	18	12	27
Total costlyuan	55	135	110	270	165	405

According to Table 1, we can conclude that walking in sunny weather is more cost-effective for players than waiting in place in hot weather, so we can draw a simple conclusion that players should try their best to walk forward in sunny weather and wait in place in hot weather. There are no villages in the map of Level 3, which does not involve the problem of supply during the game. However, there is a mine, and we may need to consider whether mining can increase our income. If mining can increase our income, how much income can we increase? This problem can be calculated. The net income from mining in sunny weather is 35 yuan, while the net income from mining under high temperature is -205 yuan. And the net income we calculated is negligible compared with the money we spent on the road. Moreover, according to the map of Level 3, it can be seen from the knowledge of graph theory that it takes a total of three days to reach the destination from the starting point (the representative route is 1→5→6→13), while it takes a total of five days to reach the destination after passing through the mine (the representative route is 1→4→3→9→10→13). Therefore, we can ignore the conditions of mining at the third level, so we should try not to mine at the third level. Just consider walking forward and waiting in different weather conditions. In this way, we can use the following flow chart to express our judgment method.

### 3.4. For level 4

For level 4, we assume that in a desert area, the number of sandstorm days (within one month) obeys normal distribution, as shown in Figure 4.



**Figure 4.** Fitting of Standard Normal Distribution Curve

Then we take the sandstorm days (6 days) given by the first and second levels as the reference condition that the sandstorm days are normal, and assume that the sandstorm days ( $t_{sand}$ ) within one month (30 days) meet the normal distribution. By looking up the data, we can draw the conclusion from "Sandstorm Weather in Alashan Region in Recent 40 Years", and the chart "Sandstorm Days Change in Alashan League in Several Months" shows the change of sandstorm days in each month in the whole year. We can assume that the sandstorm days  $x$  in each month meet the normal distribution, that is,  $x \sim n(\delta, 2)$ , from which we can conclude that the sandstorm days  $x$  in each month in the whole year meet the normal distribution  $X \sim N(4.4, 3.0)$ , so we can conclude that the value range of  $x$  is  $[1.4, 7.4]$ . Because it is known that sandstorm weather seldom occurs within 30 days, we assume that the days of sandstorm weather are 0 days, 1 day and 2 days within one month (30 days) of checkpoint 4. If the number of days in sandstorm weather is 0 days, the treatment method can refer to the idea of the third level, that is, advance in sunny weather, but stay still in hot weather. And the mining income of the fourth level is 1000 yuan, then his various benefits can be as Table 2:

**Table 2.** Income Statement of "Level 4" A

	Clear foundationbox	High temperature foundationbox	Clear walkingbox	High temperature walkingbox	Clear miningbox	High temperature miningbox
water	three	nine	six	18	nine	27
food	four	nine	eight	18	12	27
Total Costyuan	55	135	110	270	165	405
Clean Incomeyuan	-55	-135	-110	-270	835	595

Therefore, the net income from mining is greater than the consumption funds in each weather. Therefore, mining brings great benefits, so players should mine as much as possible at this level. At the same time, because there are villages in this level, we should consider the problem that the outstanding ones can be replenished in the middle.

If starting point  $\rightarrow$  mine  $\rightarrow$  village  $\rightarrow$  end point, and comparing starting point  $\rightarrow$  mine  $\rightarrow$  end point, we can find that the former takes two days longer than the latter, which can be obtained by using the methods of the first level and the second level for specific thinking about the model scheme.

#### 4. Conclusion

In this evaluation, the rationality of the optimal scheme is evaluated only with reference to the evaluation index system composed of two indexes: travel path and capital. This is only from the practical point of view, and we can try to adopt more effective indicators for comprehensive evaluation, so that the model can achieve the purpose of more optimization. In the process of modeling and forecasting, we keep the influence of the original variables on the model. From the results, we can see that our model is accurate under certain conditions, but due to the above reasons, it may not be able to accurately predict the long-term development of the model, so I can regard this conflict as a tool that can achieve or complete this task under certain constraints. In order to get a more accurate mathematical model, we must further improve the above model. VII Model Promotion.

In this paper, an evaluation model of the best scheme based on different maps and different weather conditions is constructed. It is reasonable to express the related variables in the form of fuzzy numbers, which can be used to evaluate problems with various uncertainties. In this paper, it is proposed that optimizing the scheme of multiplayer games based on game theory has a good application prospect and can be combined with other basic mathematical theories to get a more reasonable optimization model. The multi-person path optimization model based on game theory proposed in this paper solves the related problems in daily life and can be used in other uncertain multi-attribute decision-making problems. The path optimization model established by graph theory analysis in this paper can be used in other problems such as path optimization and resource allocation, and this method is simple and effective. In addition, the model of multiplayer game in "Level 6" can be deeply studied and applied

in board games, tourism route planning and other issues. This model provides a certain reference for this kind of problems.

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