Research on optimal path Modeling based on DP Model

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Abstract. Nowadays, the emergence of all kinds of games greatly enriches our life and enlightens our wisdom; As a vehicle of enlightenment, the game itself involves the choice of a variety of strategies and the choice of routes and solutions. In the case of multiple constraints, the core idea of strategy choice games is to make the optimal solution to a certain problem, and such a choice plan needs the support of a variety of theories, such as game theory dynamic programming, the application of operations research, and so on. In this case, it is essentially a given condition of the game, using the above known mathematical model to find the optimal solution, that is, under the condition of meeting the safety of the end, the most money is left.

When the weather is known and the map is known, we can make the most optimal solution; by using the DP model and the correlation of the TSP problem, we have found a certain rule: give priority to choosing the mine that can bring us income, and then replenish the resources when there is a problem with the resources, so as to plan the best route. For the calculation of money, we take the reverse program to calculate and deduce, and find that level 1 and level 2 can finally make money, and give the specific value in the detailed explanation of their respective problems. Under normal circumstances, it is impossible to know the changes of the weather in the future, so it is necessary to make different analyses for different weather conditions every day; here, we assume a certain strategy, that is, to accept the relatively non-optimal solution with a certain probability, and then through the increase of the number of iterations, we finally retrieve the optimal solution in this hypothesis.

1. Introduction
The emergence of all kinds of games has greatly enriched our life and enlightened our wisdom; and as a carrier of enlightening wisdom, the game itself also involves the choice of a variety of strategies as well as the choice of routes and solutions. The "crossing the desert" problem assumes a series of rules for players. In the game, players have three action states to choose from every day-stop, move and mine. The three operational states consume different amounts of supplies, depending on the weather of the day [1]. In addition, it is impossible to choose a moving state in a sandstorm day. Supplies in the game can be traded at the starting point, village and end point, but prices vary from place to place. At the beginning of the game, the player has a certain amount of initial capital, and the player can get extra money if he
chooses to dig in the mine. The goal of the game is that players need to cross the desert within a specified period of time and have as much money as possible when they reach the finish line. In fact, the optimal strategy of this problem is to solve the surplus after the player reaches the finish line and sells all the remaining materials [2].

The more money, the better the plan. To simplify the problem, we translate this optimal decision into three decisive parts-how to trade goods, how to choose a route, and what to do on that route every day [3].

2. Analysis of optimal route model
To simplify the problem, we translate this optimal decision into three decisive parts-how to trade goods, how to choose a route, and what to do on that route every day. First discuss how to trade goods and materials. In this environment, the funds change only under the following three conditions-the purchase of materials from the starting point, the purchase of materials from the village and the sale of materials at the end point. Due to the difference in transaction prices at these three points, the unit price of materials purchased from the starting point and the village is higher than that sold at the end point, and because the unit of materials purchased is the smallest unit when consuming materials, there is no problem such as the remaining half of the box. So, the best decision must be the decision that all materials have just been consumed when the destination is reached. And because the unit price of the starting point is lower than that of the village, players need to buy food at the starting point as much as possible in the case of ensuring that they do not appear to the end point [4].

But obviously, because of the upper limit of 1200Kg carrying materials, in most cases, players cannot buy all the supplies they need along the way at the starting point, and buy 1200Kg at most. As a result, if the total amount of goods needed along the way is greater than 1200Kg, we will inevitably need to buy the excess in the village. On this basis, we make a simple analysis: the unit price of kg of water purchased from the starting point is 3x5 yuan / Kg, village, the unit price of kg of water is 3x10 yuan / Kg, the difference between the price and the price is 3x5 yuan / Kg. And the starting point to buy food kg unit price is 5 yuan / Kg, village to buy water kg unit price is 10 yuan / Kg, price difference of 10 yuan / Kg. This means that if the total amount of goods exceeds 1200kg [5].

The cost of replenishing food in the village is much higher than the cost of replenishing water. It can be concluded that if the material required for the whole process exceeds 1200 kg, in the case of ensuring that there is no water shortage in the process, it is necessary to buy as much food as possible at the starting point to achieve the optimal decision.

![Fig 1. Adjacency matrix.](image-url)
3. Construction of optimal route model

For checkpoint one, there is a path through the village in the shortest path from the starting point to the mine, and the shortest path from the mine to the end point is also the path through the village. We compare villages with ordinary meaningless places, where villages can buy materials or not, while ordinary meaningless places cannot buy materials. In this way, we might as well choose the path through the village to and from the mine. So, the path of checkpoint one can be divided into two according to whether it passes through the mine: one is not passing through the mine, the shortest path is to the end, and the other is the starting point-village-mine-village-destination (allowing repeated back and forth between the mine and the village).

For level 2, there are similar determined paths, but there are a large number of them, which will appear in the later analysis of the state of action in each day, so I will not repeat them here.

With the optimal resource purchase method and mobile path, we can discuss the daily action status on the basis of both.

The state of action is limited by two factors, one is the weather, and the other is the amount of remaining resources. Due to the meaning of the topic, sandstorm weather, cannot choose the state of movement, the remaining resources are not enough to return to the village or the destination, it is necessary to reduce consumption or return in time. According to the weather and consumption, we list the following Excel table.

| Date | 1   | 2   | 3   | 4   | 5   | 6   | 7   | 8   | 9   | 10  |
|------|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|
| Climate | hot | hot | Sunny | Sandstorm | Sunny | hot | Sandstorm | Sunny | hot | hot |
| stop  | 24  | 12  | 24  | 12  | 15  | 14  | 30  | 20  | 15  | 14  |
| go    | 48  | 24  | 48  | 24  | 30  | 28  | 30  | 28  | 48  | 24  |
| work  | 72  | 36  | 72  | 36  | 45  | 42  | 90  | 60  | 45  | 42  |
| Date  | 11  | 12  | 13  | 14  | 15  | 16  | 17  | 18  | 19  | 20  |
| Climate | Sandstorm | hot | Sunny | hot | hot | hot | Sandstorm | Sandstorm | hot | hot |
| stop  | 30  | 20  | 24  | 12  | 15  | 14  | 24  | 12  | 24  | 12  |
| go    | 48  | 24  | 48  | 24  | 30  | 28  | 48  | 24  | 48  | 24  |
| work  | 90  | 60  | 72  | 36  | 45  | 42  | 72  | 36  | 72  | 36  |
| Date  | 21  | 22  | 23  | 24  | 25  | 26  | 27  | 28  | 29  | 30  |
| Climate | Sunny | Sunny | Very hot | Sunny | Sandstorm | hot | Sunny | Sunny | hot | hot |
| stop  | 15  | 14  | 15  | 14  | 24  | 12  | 15  | 14  | 14  | 15  |
| go    | 30  | 28  | 30  | 28  | 48  | 24  | 30  | 28  | 48  | 24  |
| work  | 45  | 42  | 45  | 42  | 72  | 36  | 45  | 42  | 72  | 36  |

Table 1. The climate and path statistics.

![Fig 2. Route simulation.](image)
As a result, it is divided into two parts, and the best funding for the k-th time is $X_k$. Second, the decision variables of the best path each time are $U_k$. Third, the state transition equation is, where the state is:

$$X_{k+1} = \alpha U_k + \beta (X_k - U_k)$$

Establish the combination of equations as DP objective function

$$F_k(X_k) = \text{opt} \{ r_k(X_k, V_k(X_k)) * f_{k+1}(X_k + 1) \}$$

$$V_k, U_k \in D_k(U_k)$$

$$f_{n+1}(X_{n+1}) = C \quad k = n, n-1, n-2, \ldots, 1$$

To establish a system of equations with limited conditions:
1. Set the amount of supply in each village at a time.
2. The maximum amount of food carried is $T$.
3. 1 indicates sunny day, 2 indicates high temperature, and 3 indicates sandstorm.
4. The total fund is $W$.
5. The consumption of food is, and the consumption of water is.
6. $X2q_w$, $x2q_f$, $x2m_w$ and $x2m_f$ represents the quality (kg) corresponding to a box of water, the quality (kg) corresponding to a box of food, the price corresponding to a box of water (yuan), and the price corresponding to a box of food (yuan).
7. The basic income of one day of mining $S$.
8. Mining days $x$, rest days $y$, walking days $z$

The dynamic programming algorithm is essentially a way to solve the optimization problem. In the process of this problem, the whole problem is divided into several small solving stages, and there is a certain relationship between the stages. Therefore, the algorithm will make corresponding decisions for each stage, so that the whole process can achieve the best results. There is a multi-decision problem in this topic, and in view of the relationship between each stage, the selection of stage decision is not arbitrary, but actually make a judgment on the current state, affecting the follow-up development. When the decision of each stage is determined, a decision sequence is formed, and the final consumption is solved by coding the decision sequence (see straight support material for the code), and the result of each possible solution is calculated.

4. Model solving
Following the above strategy, the final satisfied solution is: Among them, the number 2 represents the rush, the number 3 represents mining, and the number 1 represents the rest. The final result can be obtained by bringing the result into the C++ function of calculating funds:
The first possible loss is at least 375, and in the fourth case, the maximum loss is 645, and the data expectation is 515. Therefore, the corresponding strategy should be: regardless of the weather, go straight to the mine under permissible conditions, and then bury yourself in the mine. After five days of mining, directly return to the end point. In this case, it is the best choice strategy, that is, the mathematical expectation of the loss amount is the lowest.

Replace the map with an undirected graph. The solution stage is divided into eight stages, and the conditions are the same as the previous level, in which what needs to be changed is to accept the strategy, calculate the value of the strategy, and calculate that when the other conditions are the same, when the probability of continuing walking in high temperature weather is 32.2%, the total amount can reach the maximum, and the state sequence can be brought into the cpp program to solve the problem. Because each path search is accidental, it is iterated 1000 times here to take the optimal five sets of solutions:
From the results, we can see that when the game is in a static game with incomplete information, each adventurer will set his own plan in advance as the optimal solution in the case of a single person, which is also in line with the game theory: when individual rationality conflicts with collective rationality, if there are no compulsory legal measures, the agreement subject to collective rationality is difficult to implement. In the context of this topic, the realization of the maximization of collective interests is a very small probability event, which is almost impossible.

5. Conclusions
This model better makes the path planning and scheme planning of the best strategy under unknown weather conditions, can reach the optimal solution under certain limited conditions (see model hypothesis), and sums up a certain fixed route. that is, each ground path planning needs to give priority to planning the road directly to the mine, and then optimize the follow-up road and solution. Often the solution planned according to this method is the optimal solution; for the decision-making strategy, the simulation percentage method is used to calculate all the cases through special cases, and then the route planning is carried out by trying different probabilities to choose the path. This method can obtain the optimal solution in general by controlling the accuracy, and can make full use of the efficient computing properties of the computer to get the optimal solution.

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