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Research on Path Selection Decision Based on Probability Analysis

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Abstract: *This paper studies the route selection across the desert. Considering different weather conditions, it is necessary to buy a certain amount of water and food. The goal is to reach the destination within the specified time and retain as much money as possible. Based on the relevant knowledge of probability theory and mathematical statistics, this paper analyzes the days of sunny, high temperature and sandstorm. By excluding the case of small probability, this paper focuses on the remaining cases and gives the optimal path decision.*

Keywords: *Probability Analysis, Selection Decision, Ecosystem Evaluation*

1. Introduction

Consider the following small games: players use a map to purchase a certain amount of water and food (including food and other daily necessities) with initial funds, start from the starting point and walk in the desert [1]. They will encounter different weather on the way, and can also supplement funds or resources in mines and villages. The goal is to reach the end point within the specified time and retain as much funds as possible [2].

The basic rules of the game are as follows:

(1) Take the day as the basic time unit, the start time of the game is day 0, and the player is at the starting point. The player must reach the end point on or before the deadline. After reaching the end point, the player's game ends.

(2) Water and food resources are needed to cross the desert, and their minimum unit of measurement is box. The sum of water and food quality owned by players every day cannot exceed the upper limit of weight bearing. If you don't reach the end point and the water or food is exhausted, the game will be regarded as a failure.

(3) The daily weather is one of the three conditions of "sunny", "high temperature" and "sandstorm", and the weather in all areas of the desert is the same.

(4) Every day, players can go from one area in the map to another area adjacent to it, or stay in place. You must stay where you are on Sandstorm day.

(5) The amount of resources consumed by players staying in place for one day is called the basic consumption, and the amount of resources consumed by walking for one day is times the basic consumption.

(6) On day 0, players can buy water and food at the base price with initial funds at the starting point. Players can stay at the starting point or return to the starting point, but they cannot buy resources at the starting point multiple times. Players can return the remaining water and food after reaching the destination. The return price of each box is half of the benchmark price.

(7) When players stay in the mine, they can obtain funds through mining. The amount of funds obtained in a mining day is called basic income. If mining, the amount of resources consumed is times of the basic consumption; If there is no mining, the amount of resources consumed is the base consumption. No mining is allowed on the day of arrival at the mine. Mining can also be carried out on sandstorm days.

(8) When players pass or stay in the village, they can use the remaining initial funds or the funds

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obtained from mining to buy water and food at any time. The price of each box is twice the benchmark price.

According to the different settings of the game, establish a mathematical model to solve the following problems. Assuming that there is only one player and the player only knows the weather conditions of the day, the player can decide the action plan of the day, try to give the player's best strategy in general[3].

2. Model assumptions

1) Suppose that players do not know the route chosen by the other party and do not know the other party's tendency.

2) Suppose that player a chooses scheme and another person is B

3) Suppose that the player will not choose to return because of the long time consumed

4) Suppose players are thinking about their remaining money. They are all conservative people.

5) It is assumed that players will not be affected to reach the destination during the journey because there is no sandstorm

6) It is assumed that both parties will not stay on the road for more than one day in order to ensure their best interests.

3. Path planning model considering weather factors

Because players don't know the weather of the next day, they only know the weather of the day. What we know is that there are few sandstorms in 30 days of this level. Therefore, we assume that the sandstorm weather follows a normal distribution [4]. Because there are few sandstorms, not very few or few, we think the probability of sandstorm weather is 2σ. The probability of sand storm is 1-0.9544 = 0.0456 (as shown in the figure).

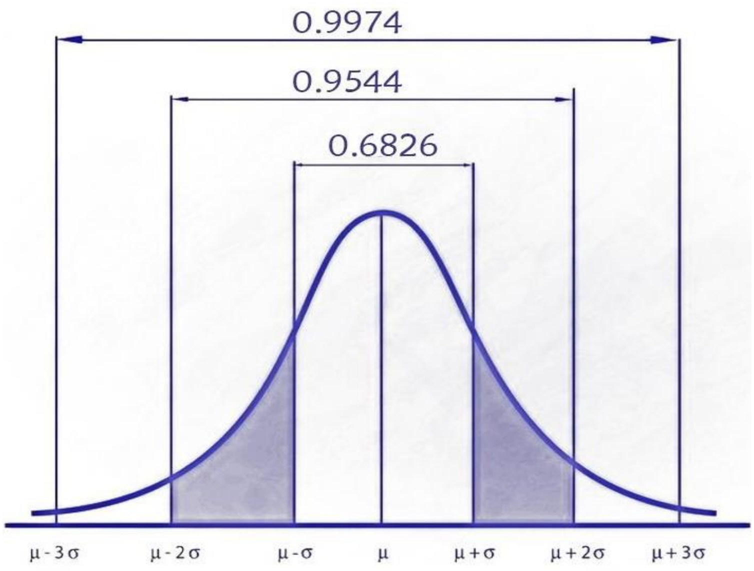

Figure 1: Probability of sandstorm.

Sunny weather and hot weather are $\frac{1}{2} * 0.9544 = 0.4772$.

According to the paper on small probability events and applications, those with a probability less than 0.05 can be called small probability events, while those with a probability of 0.0456 * 0.0456 for two consecutive days are 0.00207936 in outside the area 3σ (as shown in the figure), so it can be ignored in this problem.

Similarly, the probability of sandstorm weather on any two days in three consecutive days can be obtained:

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$$C_3^2 * 0.0456^2 * 0.9544 = 0.0059 \ll 0.05 \tag{1}$$

The probability of sand storm weather on any two days in four consecutive days is:

$$C_4^2 * 0.0456^2 * 0.9544^2 = 0.0113 < 0.05 \tag{2}$$

The probability of sand storm weather on any two days in five consecutive days is:

$$C_5^2 * 0.0456^2 * 0.9544^3 = 0.0181 < 0.05 \tag{3}$$

Therefore, according to the pessimistic criterion, there are at most 2 days of sandstorm weather in 5 consecutive days. The total number of sandstorm days in 30 days will be discussed below.

The probability of one day's sandstorm is:

$$C_{30}^1 * 0.0456^1 * 0.9544^{29} = 0.3534 \tag{4}$$

By analogy, the number of days with i-day sandstorm in 30 days is shown in the table below:

Table 1: Days of sandstorm.

Days of sandstorm	1	2	3	4	5	6
Probability	$3.534X10^{-1}$	$2.448X10^{-1}$	$1.092X10^{-1}$	$3.521X10^{-2}$	$8.748\ X10^{-3}$	$1.741\ X10^{-3}$

Because P (3)= $1.092X10^{-1}<0.05$, P(4)=$3.521X10^{-2}<0.05$, P(5)=$8.748\ X10^{-3}<<0.05$.

According to the pessimistic criterion, the upper limit of sandstorm weather is 4, that is, the upper limit of sandstorm weather in 30 days is 4 days.

Because there are three choices in the fourth level, whether to work in the mine or not, and whether to go to the village, we will discuss the fourth level in four cases.

Assuming that you don't go to mines and villages, you can directly choose ten routes from the beginning to the end. Since the length of the passing path is the same, the route will not be repeated. The shortest time is eight days from the starting point to the end point (without encountering a sandstorm), and the longest time is twelve days (encountering a sandstorm).

(1) When using the eight day time from the starting point to the end point, the possibility that all eight days are sunny is C80*(1/2)8(1/2)0 = 1/256 < < 0.05. According to the conclusion above, the possibility that all eight days are sunny is excluded.

(2) When using eight days from the beginning to the end, seven days are sunny and one day is hot C8 1*(1/2)8(1/2)0 =1/32.

The materials consumed at this time are water: 3*7*2+9*2=60; food: 4*7*2+9*2=74.

The money consumed in this case is: 60*5+74*10=1040; the remaining money is 10000-1040=8960.

In this case, the load of materials to be carried is 60*3+74*2=328.

(3) When using eight days from the beginning to the end, six days are sunny and two days are hot $C8\ 2 * \left(\frac{1}{8}\right)^8 * \left(\frac{1}{2}\right)^0 = 7/64.$

The materials consumed at this time are water: 3*6*2+9*2*2=72; food: 4*6*2+9*2*2=84.

The money consumed in this case is: 72*5+84*10=1200; the remaining money is 10000-1200=8800.

In this case, the load of materials to be carried is 72*3+84*2=384.

(4) When using the eight day time from the starting point to the end point, the possibility that five days are sunny and three days are high temperature is C8 3*(1/2)8(1/2)0=7/32.

The materials consumed at this time are water: 3*5*2+9*3*2=84; food: 4*5*2+9*3*2=94.

The money consumed in this case is: 84*5+94*10=1360; the remaining money is 10000-1360=8640.

In this case, the load of materials to be carried is 84*3+94*2=440.

(5) When using eight days from the beginning to the end, four days are sunny and four days are hot C8 4*(1/2)8(1/2)0 =35/128.

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The materials consumed at this time are water: 3*4*2+9*4*2=96; food: 4*4*2+9*4*2=104.

The money consumed in this case is: 96*5+104*10=1520; the remaining money is 10000-1520=8480.

In this case, the load of materials to be carried is 96*3+104*2=496.

(6) When using eight days from the beginning to the end, it is possible that three days are sunny and five days are hot C8 3*(1/2)8(1/2)0 =7/32.

The materials consumed at this time are water: 3*3*2+9*5*2=108; food: 4*3*2+9*5*2=114.

The money consumed in this case is: 108*5+114*10=1680; the remaining money is 10000-1680=8320.

In this case, the load of materials to be carried is 108*3+114*2=552.

(7) When using eight days from the beginning to the end, it is possible that the second day is sunny and the sixth day is hot C8 3*(1/2)8(1/2)0=7/64.

The materials consumed at this time are water: 3*2*2+9*6*2=120; food: 4*2*2+9*6*2=124.

The money consumed in this case is: 120*5+124*10=1840; the remaining money is 10000-1840=8160.

In this case, the load of materials to be carried is 120*3+124*2=608.

(8) When using eight days from the beginning to the end, it is possible that one day is sunny and seven days are hot C8 3*(1/2)8(1/2)0=1/32.

The materials consumed at this time are water: 3*1*2+9*7*2=132; food: 4*1*2+9*7*2=134.

The money consumed in this case is: 132*5+134*10=2000; the remaining money is 10000-2000=8000.

In this case, the load of materials to be carried is 132*3+134*2=664.

When the 12 day time is used from the starting point to the end point, except for the four-day sandstorm weather, the additional materials added on the basis of the eight day time are water: 10*4=40; food 10*4=40.

The additional money consumed at this time is 40*5+40*10=600, the extra weight is 40*3+40*2=200. See the table below for details.

Table 2: Specific information table.

Sunny	7	6	5	4	3	2	1
High temperature	1	2	3	4	5	6	7
Sandstorm	4	4	4	4	4	4	4
Water	100	112	124	136	148	160	172
Food	114	124	134	144	154	164	174
Weight bearing	528	584	640	696	752	808	864
Consume money	1640	1800	1960	2120	2280	2440	2600
Surplus money	8360	8200	8040	7880	7720	7560	7400

1) Suppose you go to the mine instead of the village, there are ten routes to the mine. Because the length of the route is the same, I won't repeat the route. There are three routes from the mine to the terminal: 18-19-20-25, 18-19-24-25 and 18-23-24-25. It can be seen that it takes at least 8 days to pass through the mine from the starting point to the end point. That is, you can stay in the mine for up to 22 days. We know that the consumption of working in the mine will be more than that of walking. In the same weather, the consumption of walking is 2/3 of that of working in the mine then, when the load is only 1200kg, you must go to the village after working in the mine for a certain time. Therefore, the best strategy is to maximize the profit. You can't choose not to go to the mine.

2) Suppose you don't go to the mine but only to the village, which can be obtained from the meaning of the question. Because you don't go through the mine and choose the best, it is the shortest path. Therefore, it is the same as the first case, that is, if you don't go to the mine and village, you can directly choose the decision from the starting point to the end point.

3) Assuming that both the mine and the village go, there are ten routes to the mine or village. Because the length of the routes is the same, we will not repeat the routes. There are three routes from the mine

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to the village or from the village to the mine: 18-19-20-25, 18-19-24-25 and 18-23-24-25.

According to the pessimistic criterion, we believe that there are four sandstorm days, and they are all on the way. For us, we can think that if we want to go to the mine, we have to consider the materials consumed in the mine. Moreover, there are materials consumed on the road from the mine to the village.

(1) When the mine arrived at the village, it was sunny for two days:

Materials needed: water: 3*2*2=12; food: 4*2*2=16; money consumed: 12*5+16*10=220; load condition: 12*3+16*2=68.

(2) When the mine to the village two days are hot:

Materials needed: water: 9*2*2=36; food: 9*2*2=36; money consumed: 36*5+36*10=540; load condition: 36*3+36*2=180.

(3) When the mine goes to the village, one day is hot and one day is sunny:

Materials needed: water: 9*2+3*2=24; food: 9*2+4*2=26; money consumed: 24*5+26*10= 380; load condition: 24*3+26*2=124.

(4) When it's a sandstorm one day:

The other two days from the mine to the village were sunny:

Materials needed: water: 10+3*2*2=22; food: 10+4*2*2=26; money consumed: 22*5+26*10= 370; load condition: 22*3+26*2=118.

The other two days from the mine to the village were hot:

Materials needed: water: 10+9*2*2=46; food: 10+9*2*2=46; money consumed: 46*5+46*10= 690; load condition: 46*3+46*2=230.

The rest of the mine to the village one day is hot, one day is sunny:

Materials needed: water: 10+9*2+3*2=34; food: 10+9*2+4*2=36; money consumed: 34*5+ 36*10=530; load condition: 34*3+36*2=174.

By analogy, the optimal strategy for both mines and villages. (Because the path and weather to mines and villages are the same)

To sum up, the optimal strategy is to meet four days of sand storms, six days of sunny days and six days of high temperature on the road, and the remaining money is 7640 yuan.

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