e-ISSN: 2250-0758 | p-ISSN: 2394-6962
Volume-10, Issue-4 (August 2020)
https://doi.org/10.31033/ijemr.10.4.29

Matrix Function for Solving Optimal Game Pass Strategy Summary

Qinling Zhao[1] and Xiangdan Wen[2]
[1]Student, College of Science, Yanbian University, Yanji, P.R., CHINA
[2]Student, College of Science, Yanbian University, Yanji, P.R., CHINA

[1]Corresponding Author: 2858028924@qq.com

ABSTRACT

The breakthrough is to quantify the amount of water, food and money carried by people in the desert and to construct a discrete function with the number of days as a time variable, optimal Planning and design for the outflow of desert-walking resources and the introduction of resources and funds from the starting point, villages and mining areas, these resources and funds are fitted by the Adjacency Matrix and the coherent knowledge of probability to describe their dynamic changes with time (days). According to the restriction of the rules of the game, we try to find the optimal solution by computer software (Matlab) in order to reduce the computation of human brain.

***Keywords*—** Adjacency Matrix, Discrete Function, Step Transition Probability Matrix

I. INTRODUCTION

In the game the player carries on the game through the map, arrives the destination game then to win. During the game has the following rules: the Basic Unit of time is the day as the unit, Day 0 as the game's start time, the player's initial position as the starting point. The winning condition is that the player arrives at the finish line on or before the final deadline.

(1) water and food are the two resources needed to cross the desert, and the box is their smallest unit of measure. The combined weight of food and water should not exceed the maximum load per day. The conditions for failure are failure to reach the finish line within the specified time or exhaustion of food and water.

(2) "Sunny", "hot" and "sandstorm" are one of the three kinds of weather conditions every day. All weather conditions are the same as desert.

(3) players can stay where they are every day, or they can move from one area to the next. Sandstorm Day has to stay put.

(4) the amount of resources consumed by the player for a day of standing still is twice the amount of resources consumed by the player for a day of walking.

(5) on Day 0 the player can buy food and water at the starting point at a base price with the initial funds. Players can stay at the starting point or return to the starting point, but resources cannot be purchased multiple times at the starting point. The remaining food and water will be returned by the player upon reaching the finish line, at half of the base price per box.

(6) if the player stays in the mine, the amount of money that can be made in a day from mining will be the base income. If the player digs, the base consumption is three times the original amount; if the player does not dig, the base consumption is the amount consumed. And you can't dig on the day you arrive, but you can dig on sandstorm day.

(7) players can buy water and food at any time after passing through or staying in the village with the remaining seed money or money from mining, at twice the base price per box.

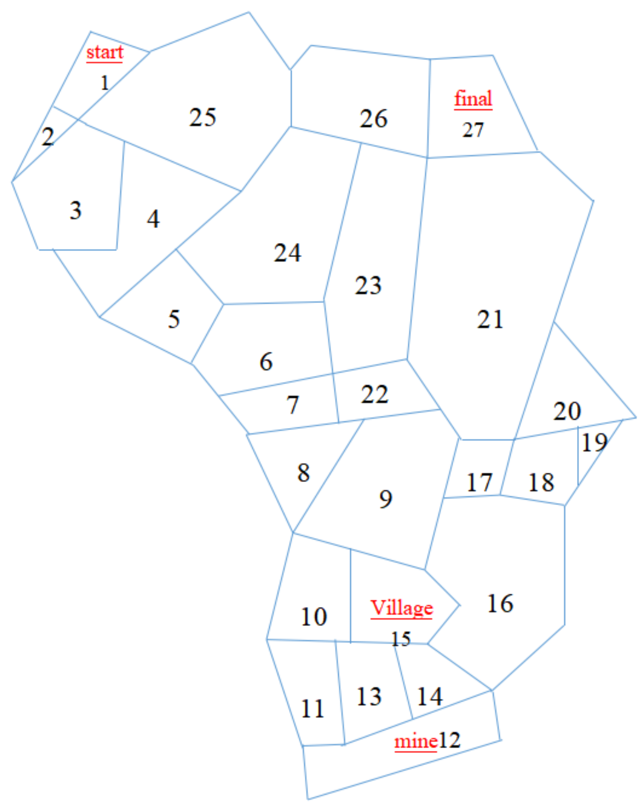

Figure 1: Desert map

e-ISSN: 2250-0758 | p-ISSN: 2394-6962
Volume-10, Issue-4 (August 2020)
https://doi.org/10.31033/ijemr.10.4.29

TABLE 1: Parameter setting

Maximum weight		1200kg	Initial capital	100000yuan	
Deadline		30day	Base income	1000yuan	
Resources	Mass per carton (kg)	Base price (Yuan/box)	Basic consumption (box)		
			sunny	high-temperature	storm
water	3	5	5	8	10
food	2	10	7	6	10

TABLE 2: Weather in 30 days

	the weather	day	the weather	day	the weather
1	high-temperature	11	storm	21	sunny
2	high-temperature	12	high-temperature	22	sunny
3	sunny	13	sunny	23	high-temperature
4	storm	14	high-temperature	24	sunny
5	sunny	15	high-temperature	25	storm
6	high-temperature	16	high-temperature	26	high-temperature
7	storm	17	storm	27	sunny
8	sunny	18	storm	28	sunny
9	high-temperature	19	high-temperature	29	high-temperature
10	high-temperature	20	high-temperature	30	high-temperature

According to the different settings of the game, please build a mathematical model to solve the following problems.

1. If there is only one player, and the weather is known in advance for the entire duration of the game, give it a try and give the player the best strategy in general.

2. Suppose there is only one player, and that player only knows the weather of the day, and can decide the day's itinerary according to the game plan, trying to give the player in general the best strategy, and "the third pass" and "the fourth pass" in the annex are discussed in detail.

II. MODEL ESTABLISHMENT AND SOLUTION

e-ISSN: 2250-0758 | p-ISSN: 2394-6962
Volume-10, Issue-4 (August 2020)
https://doi.org/10.31033/ijemr.10.4.29

2.1 An Analysis of Question 1

The key to problem 1 is to quantify the amount of water, food, and money carried by people in the desert and use the number of days as a time variable, in order to describe the dynamic change of resources and funds, the resources and funds flowing out of the desert and the introduction of resources and funds in the starting point, villages and mining areas are planned and designed. According to the constraints of the rules of the game, to find the game conditions to meet the lines and programs, in order to ease the calculation of the human brain we can use computer simulation to find the optimal solution.

2.2 An analysis of Question 2 of Question 1

The solution of problem 2 is certainly based on the solution of problem 1, but the only difference is that the weather condition of problem 2 is unknown. We need to make a mathematical model of the weather, and then predict the weather from one day to the next day. To do that, we need a step transition probability matrix.

III. MODEL ASSUMPTIONS AND CONVENTIONS

1. Assume that the rules of the game are set in realistic terms

2. It is assumed that the player will be able to use the map correctly during the game

3. It is assumed that the player will not encounter any sudden natural disasters in the game

4. It is assumed that the player will not lose supplies and funds during the game

5. Assume that the starting point and village provide all the material that the player can buy

6. Through big data analysis or game play, the probability that one state of the weather will be forwarded to another state of the weather or the weather itself is given[1].

IV. SYMBOL DESCRIPTION AND DEFINITION OF NOUNS

4.1 The Symbolic Description and the Definition of Nouns in Question 1

TABLE 3： Symbolic descriptions and Noun definitions for question 1

Symbols	***Symbol description and Noun definition***
$A = (a_{ij})_{n\times n}$	$n \times n$ adjacent matrix
$\not{f}_{water}\ (n)$	The number of water tanks consumed in n days
i_k	Index that represents a positive integer from 1to 27
w_k	Number of tanks of water consumed on the nth day
$\delta_{i_k i_{+1}}$	Kronecker Delta
$\not{f}_{food}\ (n)$	The nth day consumed a total of boxes of food
$\vartriangle w^1$	Number of water tanks purchased at the starting point
$\vartriangle f^1$	Number of boxes of food purchased at the starting point
$\Delta \not{f}^{water}{}_{k}$	Number of water containers purchased in the village on the nth day
$\Delta \not{f}^{food}{}_{k}$	Number of boxes of food purchased in the village on the nth Day
$\mathcal{F}_{water}\ (n)$	How many boxes of water were purchased in the game by the nth day
$\mathcal{F}_{water}\ (n)$	How many boxes of food

e-ISSN: 2250-0758 | p-ISSN: 2394-6962
Volume-10, Issue-4 (August 2020)
https://doi.org/10.31033/ijemr.10.4.29

	were purchased in the game by the nth day
$\mathcal{R}_{water}\ (n)$	On the nth day, the water surplus
$\mathcal{R}_{water}\ (n)$	On the nth day, the surplus of Food Resources
$C(n)$	Total number of mining operations by nth day
$\mathcal{M}(n)$	The sum of the remaining funds normally accounted for in the game

4. 2 Symbolic Descriptions and Definitions of Nouns in Question 2

TABLE 4： Symbolic descriptions and Noun definitions for question 2

Symbols	Symbol description and Noun definition
$P_{i\to j}$	Status i to status j
p_{ij}	State i to state j to probability
$P^{(n)}$	Step-n-shift Matrix

V. MODEL ESTABLISHMENT

5. 1 Problem 1 Modeling

The key to solving problem 1 is to quantify the amount of water, food and money carried in the desert and use the number of days as a time variable. According to the restriction of the rules of the game, we find the lines and schemes which meet the conditions at the beginning and simulate them by computer to find the optimal solution. The resource consumption function for walking or staying put is created as follows:

5.1.1 Resource-Water Consumption Model

First, we use variables n to represent the nth day after departure. Secondly, the concept of Adjacency Matrix is introduced. Set Adjacency Matrix

$$A = (a_{ij})_{n\times n} \qquad (1)$$

When

$$\forall i\&j, a_{ij} = 0 \ or\ 1 \qquad (2)$$

If

$$a_{ij} = 1 \qquad (3)$$

that means the player is free to walk from the region i to the region j [2].

If

$$a_{ij} = 0 \qquad (4)$$

it means the player can not walk freely from the region i to the region j.

According to the definition of Adjacency Matrix, the adjacency matrix of the first level in problem 1 is represented by the Adjacency.

According to the rules of the game, a water consumption model was introduced to show how many boxes of water were consumed on the nth day of departure, as follows:

$$f_{water}\ (n) = \sum_{k=1}^{n} a_{i_k i_{k+1}} w_k$$

Among them:

$$i_1 = 1$$

And there’s

$$i_k = \{1,2,3,\cdots,27\}$$

If yes:

$$a_{i_k i_{k+1}} = 0$$

The assumption is:

$$\mathcal{f}_{water}\,(n) = \infty$$

And the number of w_k that represent the water consumed on the kth day is as follows:

$$w_k = (2 - \delta_{i_k i_{k+1}}) y_k$$

Definition $\delta_{i_k i_{+1}}$: The definition is an extension of the Kronecker Delta definition, which is as follows:

$$\delta_{i_k i_{k+1}} \begin{cases} -1, i_k = i_{k+1} = 12, mine \\ 1, \quad others \\ 0, \quad i_k \neq i_{k+1} \end{cases}$$

(Note: Mine indicates that the player stayed in zone 12 and did a mining operation)
Some definitions are as follows:

$$y_k = \begin{cases} 5, \quad sunny \\ 8, high - temperature \\ 10, \quad storm \end{cases}$$

According to "sandstorm day must stay in place" , the following relational expression can be obtained:
If:

$$y_k = 10$$

Then:

$$i_k = i_{k+1}$$

Because if there is $i_k = i_{k+1}$,

$$a_{i_k i_{k+1}} = a_{i_k i_k} = 1$$

Indicates that the player stays in the same area.

5. 1.2 Resources -- Food Consumption Model

Similarly, the water consumption model, according to the rules of the game design, introduced the consumption model of food resources, with $\mathcal{f}_{food}\,(n)$ consumed on the nth day after the departure guidance, as follows:

$$\mathcal{f}_{food}\,(n) = \sum_{k=1}^{n} a_{i_k i_{k+1}} f_k$$

Among them:

$$f_k = (2 - \delta_{i_k i_{k+1}}) z_k$$

And there are:

$$z_k = \begin{cases} 7\, sunny \\ 6, high - temperature \\ 10, storm \end{cases}$$

According to 'sandstorm day must stay in place',
the following relational expression can be obtained:

$$y_k = 10$$

Then:

$$i_k = i_{k+1}$$

5.1.3 Material Supply Models for Starting Points and Villages

According to the title condition, material can not be purchased more than once at the starting point, so we assume that the material can only be purchased once at the starting point. $\triangle w^1$ indicates the number of water tanks purchased at the starting point and $\triangle f^1$ indicates the number of food tanks purchased at the starting point.

The village can be purchased multiple times, so Kronecker Delta is introduced to depict whether the game is to purchase supplies in the village. And$\Delta \mathcal{f}^{water}{}_k$ indicates the number of water containers purchased in the village on the th day, $\Delta \mathcal{f}^{food}{}_k$ expresses in boxes of food purchased in the village on the nth day.

In order to make it easier for all materials to express the dynamic changes of various materials in terms of the time and the number of days as the only variable, we introduce a function $\mathcal{F}_{water}$ (n)to express the total number of boxes of water purchased during the game up to the nth day, a function $\mathcal{F}_{food}$ (n)was introduced to indicate how many boxes of food had been purchased in the game by the nth day, as follows:

e-ISSN: 2250-0758 | p-ISSN: 2394-6962
Volume-10, Issue-4 (August 2020)
https://doi.org/10.31033/ijemr.10.4.29

$$\mathcal{F}_{water}\,(\mathrm{n}) = \Delta\, w^1 + \sum_{k=1}^{n} \delta_{i_k 15} \Delta \not{f}^{water}{}_k$$

$$\mathcal{F}_{food}\,(\mathrm{n}) = \Delta\, f^1 + \sum_{k=1}^{n} \delta_{i_k 15} \Delta \not{f}^{food}{}_k$$

5.1.4 Functional Model of Residual Resources

Based on the previously established resource consumption and resource purchase function, we can quantify to the n[th] days, the remainder of the various resources, as follows:

$$\mathcal{R}_{water}\,(n) = \mathcal{F}_{water}\,(\mathrm{n}) - \not{f}_{water}\,(n)$$

$$\mathcal{R}_{food}\,(n) = \mathcal{F}_{food}\,(\mathrm{n}) - \not{f}_{food}\,(n)$$

Where a function has to satisfy the following conditions:

$$\mathcal{R}_{water}\,(n) \nless 0$$

$$\mathcal{R}_{food}\,(n) \nless 0$$

$$0 \le 3\mathcal{R}_{water}\,(n) + 2\mathcal{R}_{food}\,(n) \le 1200$$

5.1.5 Functional Model of Surplus Funds

The model focuses on the proceeds of mining and what is left over from the sale to reach the destination.

The sum of the total number of mining days is as follows:

$$\mathrm{C}(n) = \sum_{k=1}^{n} \aleph_k\, \delta_{i_k 15}$$

Among them:

$$\aleph_n = \begin{cases} 1, & mine \\ 0, & not\ mine \end{cases}$$

The proceeds from the sale of the finished goods are as follows:

$$\pi = \frac{5}{2}\mathcal{R}_{water}\,(n) + 5\mathcal{R}_{food}\,(n)$$

The total function of the remaining funds is:

$$\mathcal{M}(n) = 10000 - (5w^1 + 10f^1) - 2\left(5\sum_{k=1}^{n} \delta_{i_k 15}\Delta\not{f}^{water}{}_k + 10\sum_{k=1}^{n} \delta_{i_k 15}\Delta\not{f}^{food}{}_k\right) + 1000\mathrm{C}(n) + \pi$$

5.1.6 Model Solution

The difficulty of this problem lies in taking the objective function M(N) as a large value under all the regular conditions.

The Adjacency Matrix of level 1 is in Annex 1(the Adjacency Matrix of level 1)

Each area in Level 2 is a regular hexagon and has 64 areas. It would be difficult to derive the adjacency matrix from level 1 observations. Since no region is a regular hexagon, assume that for the region:

Situation 1

If $i \ne 1 \pmod 8$ and $i \ne 0 (mod\ 8)$

When $i \backslash 8 \in \{2k+1, k \in Z\}$:

For adjacency matrices:

$$a_{i,i+1} = a_{i,i-1} = a_{i,i-7} = a_{i,i-8} = a_{i,i+8} = a_{i,i+9} = 1$$

Other circumstances:

$$a_{i,j} = 0$$

When $i \backslash 8 \in \{2k, k \in Z\}$:

For adjacency matrices:

$$a_{i,i+1} = a_{i,i-1} = a_{i,i-9} = a_{i,i-8} = a_{i,i+8} = a_{i,i+7} = 1$$

Other circumstances:

$$a_{i,j} = 0$$

situation 2

If $i \ne 0 (mod\ 8)$ and $i \backslash 8 \in \{2k+1, k \in Z\}$:

e-ISSN: 2250-0758 | p-ISSN: 2394-6962
Volume-10, Issue-4 (August 2020)
https://doi.org/10.31033/ijemr.10.4.29

$$a_{i,i-1} = a_{i,i-7} = a_{i,i-8} = a_{i,i+8} = a_{i,i+9} = 1$$

Other circumstances:

$$a_{i,j} = 0$$

If $i \neq 0(mod\ 8)$ and $i\backslash 8 \in \{2k+1, k \in Z\}$, then:

$$a_{i,i+1} = a_{i,i-9} = a_{i,i-8} = a_{i,i+8} = a_{i,i+7} = 1$$

Other circumstances:

$$a_{i,j} = 0$$

If $i \neq 0(mod\ 8)$ and $i\backslash 8 \in \{2k, k \in Z\}$:

$$a_{i,i-1} = a_{i,i-9} = a_{i,i-8} = a_{i,i+8} = a_{i,i+7} = 1$$

Other circumstances:

$$a_{i,j} = 0$$

situation 3

If $i \neq 0(mod\ 8)$ and $i\backslash 8 \in \{2k+1, k \in Z\}$ when:

$$a_{i,i-1} = a_{i,i-7} = a_{i,i-8} = a_{i,i+8} = a_{i,i+9} = 1$$

Other circumstances:

$$a_{i,j} = 0$$

If $i \neq 0(mod\ 8)$ and $i\backslash 8 \in \{2k, k \in Z\}$,then:

$$a_{i,i-1} = a_{i,i-9} = a_{i,i-8} = a_{i,i+8} = a_{i,i+7} = 1$$

Other circumstances:

$$a_{i,j} = 0$$

Then the adjacency matrix of level 2 can be found.

When we get the adjacency matrix for level 1 and Level 2, we can use the models and equations we established earlier to find the optimal solution.

5. 2 Problem 2 Modeling

First, a mathematical representation of the weather is given, as follows:

Table 5： Mathematical representation of weather conditions

Weather conditions	Mathematical Representation of states
Sunny	1
High temperature	2
Storm	3

Using the laws of large data or game set weather conditions, calculate the probability of transition between states as follows:

Table 6: Weather state transitions and their probability

***Status*i → j**	**Symbolic Representation**	**Probability**
1 → 1	$P_{1\to1}$	p_{11}
1 → 2	$P_{1\to2}$	p_{12}
1 → 3	$P_{1\to3}$	p_{13}
2 → 1	$P_{2\to1}$	p_{21}
2 → 2	$P_{2\to2}$	p_{22}
2 → 3	$P_{2\to3}$	p_{23}
3 → 1	$P_{3\to1}$	p_{31}
3 → 2	$P_{3\to2}$	p_{32}
3 → 3	$P_{3\to3}$	p_{33}

Among them the probability satisfies the following relations;

For ∀ □ ∈ {1,2,3},

$$\sum_{j=1}^{3} p_{ij} = 1$$

e-ISSN: 2250-0758 | p-ISSN: 2394-6962
Volume-10, Issue-4 (August 2020)
https://doi.org/10.31033/ijemr.10.4.29

The one-step Transition Probability Matrix is:

$$P^{(1)} = \begin{pmatrix} p_{11} & p_{12} & p_{13} \\ p_{21} & p_{22} & p_{23} \\ p_{31} & p_{32} & p_{33} \end{pmatrix}$$

Using the one-step transition probability moment[3], we can deduce the n-step transition probability Matrix $P^{(n)}$:

$$P^{(n)} = \left(P^{(1)}\right)^n$$

The initial probability of the weather conditions on the first day of the game is assumed to be as follows:

Table 7: Initial weather conditions and their probability of occurrence

Initial weather conditions	The probability of occurrence
1	p_1
2	p_2
3	p_3

Then the weather condition on the nth day can be obtained, and then the optimal solution of the problem can be obtained by using the model of problem 1.

VI. CONCLUSION WITH ADVANTAGES AND DISADVANTAGES OF MODELS

Model Analysis of Problem 1

Advantages: real-life Adjacency Matrix will be the use of connectivity between regions and non-well-connected with the mathematical expression. And according to the rules of the game and the introduction of the Kronecker Delta variables and the relationship between the time (days) is very good together. In this way, we can use the mathematical software of Matlab to solve this complex optimization problem.

The downside: The downside of this problem is that it makes too many model assumptions and may be somewhat different from reality[1].

Model Analysis of Problem 2

Advantages: Problem 2's model is built on top of problem 1, making good use of all the advantages of problem 1's model. Introduces n transition probability matrix, the first n good features. This model can be extended to all sides of industry and tourism Surface.

The downside: The model presents the downside of problem 1. In real life, the probability of one kind of weather changing into another will change dynamically with time, so there will be some error in the result.

REFERENCES

[1] Run jie, (2016). Application of mathematical modeling ideas and methods. *China Building Materials Science & Technology*, *6*, 135-136.

[2] Zhang Yufei, Peng Xu, Shao Guang ming, & Chen Hua you,(2016). Tourism route planning problem. *Mathematics in Practice and Theory*, *15*, 81-89.

[3] Zhu Guiman, Zhao Jinling, Xu Er, & Tang Guobin,(2015). Transition process tensor and super stochastic tensor in Markov chain. *Journal of North University of China*, *1*, 12-15.