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Strategic Evaluation and Optimization of Clan Sides Based on Floyd Algorithm

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Abstract: According to the Topsis method and the related data, this paper fully considers the parameters such as marching speed, equipment range, and air defense deployment of each node, thus obtaining a comprehensive evaluation of the strength value of each equipment and then effectively analyzes the results. Then, considering the preparation of the red and blue edges given, this paper combines the score of the node radius proportionally. Finally, the traffic network diagram is drawn through the specific geographic information. Based on the location and distance displayed on the map, this paper combines the coverage location and Floyd algorithm to find the best position and alternative position for both sides.

1. Introduction

In the current social context, both sides of the war must have effective war strategies to increase the threat of war and reduce the loss of war. At this time, knowledge of dynamic planning is particularly important. Through dynamic planning, a relatively stable and balanced war dynamic can be formed so that consensus can be reached and losses can be reduced [1]. In the context of war, we consider the war relationship between the red camp and the blue camp. It is a common problem to model the attack and defense based on the military material of the two camps. On this basis, site selection is a hot topic in the military.

2. The Evaluation model based on entropy weight Topsis

In this paper, according to the principles of scientificity, importance, integrity, systematicity and practicality, the final selected indicators are marching speed, equipment range and grenade content to evaluate the attack difficulty indicators.

2.1 The theory of Topsis ideal solution

TOPSIS [2] is a commonly used comprehensive evaluation method within the group, which can make full use of the information of original data, and its results can accurately reflect the differences between evaluation schemes. The basic process is based on the normalized original data matrix. The cosine method is used to find out the best scheme and the worst scheme among the limited schemes, and then the distance between each evaluation object and the best scheme and the worst scheme is calculated respectively to obtain the relative proximity between each evaluation object and the best scheme, which is used as the basis for evaluation. This method has no strict restrictions on data distribution and sample size, and data calculation is simple and feasible.

The weight can be calculated in two ways, AHP and entropy weight. In this paper, entropy weight method is used to calculate the weight. The calculation steps are as follows:

* Prepare the data, and conduct the same trend processing and dimensional problems;

* To confirm the weight of each indicator, entropy weight method and user-defined weight can be used (self processing is required, MPai quantification AHP can be used) (self processing is required, MPai feature engineering data cleaning normalization can be used);

* Find out the best and worst matrix vectors (MPAI automatic processing);

* Calculate the distance D+ between the evaluation object and the positive ideal solution or the distance D - between the negative ideal solution;

* Combined with the distance value, the comprehensive score C is calculated and sorted to draw a conclusion.

In general, the flow chart of the Topsis method is shown in Figure 1.

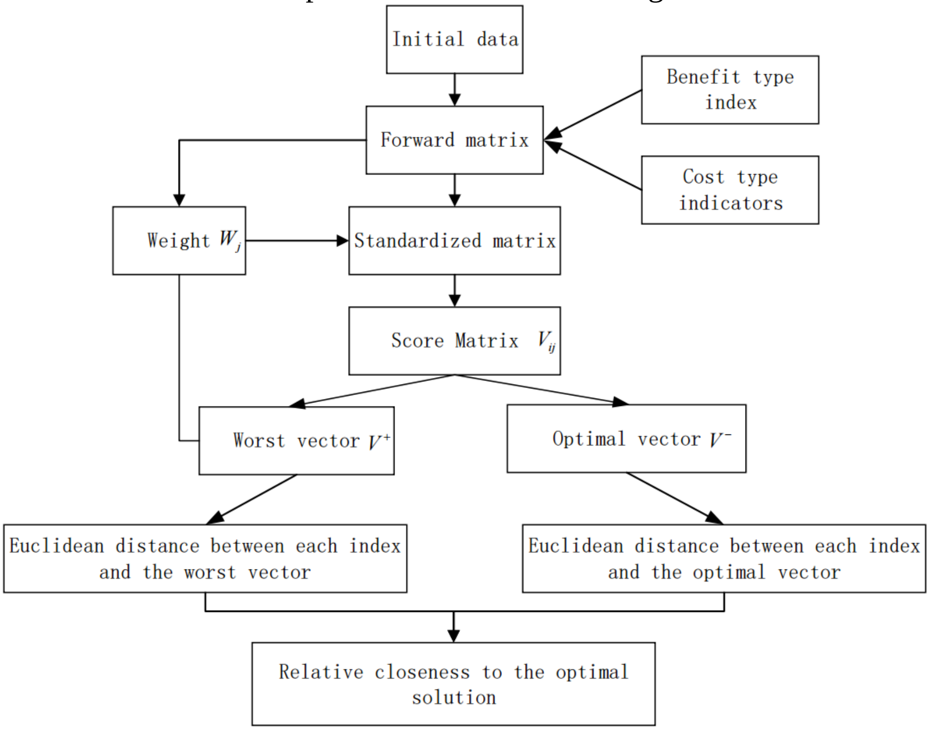

Figure 1: Flow Chart of Topsis Method in General

2.2 The establishment of Evaluation model

Step 1: Forward processing of indicators

Since the three factors considered in this question are all the bigger the better, there is no need to consider the forward process in the context of this question.

Step 2: Standardize the data

$$z_i = \frac{x_i}{\sqrt{\sum_{i=1}^{n} x_i}} \tag{1}$$

Step 3: Determine the ideal solution

$$Z^{+}=\max_{1\le i\le n}\left\{Z_{ij}\right\}=\left(Z_1^{+},Z_2^{+},\cdots,Z_n^{+}\right)$$
$$Z^{-}=\min_{1\le i\le n}\left\{Z_{ij}\right\}=\left(Z_1^{-},Z_2^{-},\cdots,Z_n^{-}\right) \tag{2}$$

Step 4: Calculation of index weight by entropy weight method [3]
Step 5: Calculate European distance

$$D_i^{+}=\sqrt{\sum_{j=1}^{m}\left[\omega_i\left(Z_J^{+}-Z_{ij}\right)^2\right]}$$
$$D_i^{-}=\sqrt{\sum_{j=1}^{m}\left[\omega_i\left(Z_J^{-}-Z_{ij}\right)^2\right]} \tag{3}$$

Step 6: Calculate the relative proximity to the optimal value [4]

$$W_i=\frac{D_i^{-}}{D_i^{+}+D_i^{-}} \tag{4}$$

2.3 The application of Floyd algorithm

The mathematical model of the Location Set Covering problem (LSCP) was first proposed by Toregas et al. Its goal is to determine the number of emergency service facilities or the minimum construction cost under the condition that all emergency points are covered, and configure these service facilities so that all emergency points can be covered. It is mainly used to solve the site selection problem of emergency service facilities such as fire stations and ambulances.

According to the node data given by the topic, we use Floyd algorithm to calculate the shortest distance between any node. Then, in order to facilitate us to select better command positions and alternative positions, we establish a location set coverage model and solve it.

It is known that the speed of the fastest UAV is 320km/h. We assume that the arrival speed of the incident is min. According to the calculation, the distance traveled by the UAV in 3min is 5.3 * 3=15.9km, so the coverage radius of the site should be 15.9km. We impose time constraints on its jurisdiction radius, which has the following expression:

$$y_{ij}*d_{ij}\le 15.9 \tag{5}$$

We get 18 optimal jurisdictional nodes, and then use the following model to optimize the jurisdictional area [5].

$$\min\sum_{i=1}^{18}\sum_{j=1}^{286}y_{ij}d_{ij} \tag{6}$$

$$s.t.\begin{cases}\sum_{i=1}^{18}y_{ij}=1(j=1,2,...,286)\\ y_{ij}=0\ or\ 1\end{cases} \tag{7}$$

This equation constraint indicates that 286 nodes of the red side must be under the jurisdiction of a certain service platform. For y_{ij}, if $y_{ij}=1$, it means that the jth node is under the jurisdiction of the ith service platform; otherwise, if $y_{ij}=0$, it means that the jth node is not under the jurisdiction of the ith service platform. d_{ij} represents the shortest distance between nodes.

3. Results

3.1 The Solution ideas

First, we combine the related data according to the Topsis method and fully consider the marching speed, equipment range and air defence deployment of each node to obtain a comprehensive evaluation, that is, the force value evaluation of each equipment. Then consider the equipment preparation materials of the red and blue sides given in the question stem, and adjust them in proportion to the score obtained in combination with the radius of the node. That is, the larger the radius shown on the map, the more difficult it is to attack that node. The more sophisticated the equipments used, the higher the force value at the node. Finally, the network map is drawn according to the geographical information given. According to the location and distance shown on the map, we combine the coverage location and the Floyd algorithm to find the best location and alternative location for both sides.

3.2 Process and Result analysis

On this basis, this paper constructs the red and blue camps and the corresponding transportation network diagram, as shown in Figure 2:

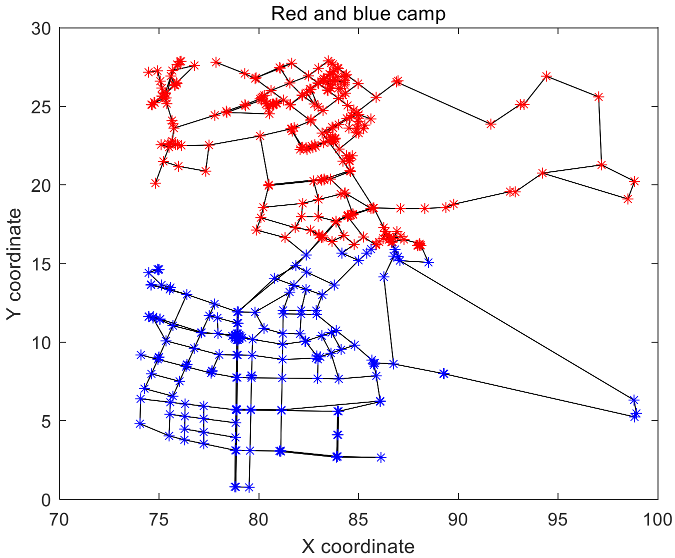

Figure 2: Red and blue camp

By consulting the information given in the data and topics, we will summarize the data as shown in Table 1 and Table 2:

Table 1: Red Party's war readiness

Type	Travel speed	Maximum stroke	Arms
Link-tank	85km/h	230km	7.62mm
Medium-tank	76km/h	400km	76mm
Heavy-tank	37km/h	185km	122mm,12.7mm, 7.62*3mm
Self-propelled gun	2358km/h=655m/s	17.23km	155mm

Table 2: Blue Party's war readiness

Type	Travel speed	Maximum stroke	Arms
Link-tank	37km/h	520km	7.92*2mm
Medium-tank	46km/h	760km	75mm+8mm*2
Heavy-tank	45km/h	110-160km	88mm
Self-propelled gun	1782km/h=495m/s	13.25km	160mm

Among them, we found that the walking speed of an ordinary infantry was 5.43km/h, and the flying speed of the UAV was 120km/h. For the convenience of calculation, we also inquired about the approximate travel range and ammunition of infantry and UAV. The calculation results are shown below. In addition, we believe that the faster the travel speed is, the wider the maximum range is, and the more equipments are equipped, the higher the comprehensive force value will be.

Red square:

The normalized decision matrix is calculated as follows:

$$d=\begin{bmatrix} 0.0023 & 0.2077 & 0.0310 \\ 0.0360 & 0.2388 & 0.0310 \\ 0.0321 & 0.4154 & 0.3089 \\ 0.0157 & 0.1921 & 0.6405 \\ 0.9 & 0.018 & 0.6301 \\ 0.051 & 0.84 & 0.3089 \end{bmatrix} \tag{8}$$

The weight coefficient is:

$$w=\begin{bmatrix} 0.2 & 0.2 & 0.6 \end{bmatrix} \tag{9}$$

The weighting matrix is:

$$c=\begin{bmatrix} 0.0005 & 0.042 & 0.0186 \\ 0.007 & 0.048 & 0.0186 \\ 0.006 & 0.083 & 0.185 \\ 0.003 & 0.038 & 0.384 \\ 0.20 & 0.0036 & 0.378 \\ 0.01 & 0.167 & 0.1854 \end{bmatrix} \tag{10}$$

The evaluation score is:

$$T=\begin{bmatrix} 0.06 & 0.095 & 0.39 & 0.61 & 0.7144 & 0.4603 \end{bmatrix} \tag{11}$$

Based on the attack radius data given in the question, we analyze the force distribution and get the formula as follows:

$$y_i=[a_i,b_i,c_i,d_i,e_i]'*\frac{T_i}{T} \tag{12}$$

Formulas for Calculating the Distribution of Different Types of Equipments:

$$num_i = \frac{k_i}{\sum_{i=1}^{268} k_i} * \sum num \tag{13}$$

Where, num represents the upper limit of armaments of the Red Party, K represents the armament coefficient corresponding to num obtained from the previous question. The red and blue sides attack 436 camps, including 268 for the red side and 168 for the blue side. This is shown in Table 3:

Table 3: Red Force Deployment

ID	Infantry	Link-tank	Medium-tank	Heavy-tank	Self-propelled gun	Drones
1	1744	1	1	1	1	1
2	2019	1	0	0	11	1
3	1652	1	0	0	9	1
4	9085	3	2	1	51	4
…	…	…	…	…	…	…

Blue square:

The normalized decision matrix is calculated as follows:

$$d = \begin{bmatrix} 0.003 & 0.1210 & 0.0349 \\ 0.0207 & 0.4195 & 0.0725 \\ 0.0257 & 0.6132 & 0.4166 \\ 0.0252 & 0.1291 & 0.4029 \\ 0.9969 & 0.0107 & 0.7325 \\ 0.0671 & 0.6454 & 0.3479 \end{bmatrix} \tag{14}$$

The weight coefficient is:

$$w = \begin{bmatrix} 0.2 & 0.2 & 0.6 \end{bmatrix} \tag{15}$$

The weighting matrix is:

$$c = \begin{bmatrix} 0.0006 & 0.0242 & 0.0209 \\ 0.0041 & 0.0839 & 0.0435 \\ 0.0051 & 0.1226 & 0.25 \\ 0.005 & 0.0258 & 0.2417 \\ 0.1994 & 0.0021 & 0.4395 \\ 0.0134 & 0.1291 & 0.2088 \end{bmatrix} \tag{16}$$

The evaluation score is:

$$T = \begin{bmatrix} 0.0444 & 0.1606 & 0.4881 & 0.4288 & 0.7849 & 0.4338 \end{bmatrix} \tag{17}$$

Based on the attack radius data given in the question, we analyze the force distribution and get the formula as follows:

$$y_i = [a_i, b_i, c_i, d_i, e_i]' * \frac{T_i}{T} \tag{18}$$

Formulas for Calculating the Distribution of Different Types of Equipments:

$$num_i = \frac{k_i}{\sum_{i=1}^{168} k_i} * \sum num \quad (19)$$

Table 4 describes the concrete blue force deployment strategy:

Table 4: Blue Force Deployment

ID	Infantry	Link-tank	Medium-tank	Heavy-tank	Self-propelled gun	Drones
25	8742	7	5	3	122	3
26	10037	8	6	3	141	3
27	3561	3	2	1	50	1
28	5828	5	3	2	82	2
…	…	…	…	…	…	…

3.3 The operation of the Floyd algorithm

Floyd algorithm, also known as interpolation method, is an algorithm that uses the idea of dynamic programming to find the shortest path between multiple source points in a given weighted graph, similar to Dijkstra algorithm [6]. The execution of the algorithm will find the length (weighted) of the shortest path between all nodes. Assume that the adjacency matrix A_0 of graph G weight is as follows:

$$\begin{bmatrix} a_{11} & a_{12} & \cdots & a_{1n} \\ a_{21} & a_{22} & \cdots & a_{2n} \\ \vdots & \vdots & \cdots & \vdots \\ a_{n1} & a_{n2} & \cdots & a_{nn} \end{bmatrix} \quad (20)$$

Where, A stores the length of each side. There are $a_{11} = 0$, $a_{ij} = \infty$, $i = 1, 2, \cdots n$, i and j without edges between them. In the program, it is replaced by a sufficiently large number that can not be reached by each side. There are $a_{ij} = w_{ij}$ and w_{ij} represent the length between i and j.

The basic idea of Floyd algorithm is to recursively generate a matrix sequence [7], such as A_0, where $A_k(i, j)$ represents the shortest path length where the number of vertices passing through the path from vertex v_i to vertex v_j is not greater than k.

The state transfer equation is as follows:

$$map[i, j] := min\{map[i, k] + map[k, j], map[i, j]\} \quad (21)$$

Where k is the number of iterations. Finally, when $k = n$, A_n is the shortest path value between vertices, and its pseudo code is shown in Table 5:

The best command position and alternative position determined by the Red Party are:3,8,30,36,39,63,118,147,151,154,162,171,183,193,214,215,232,263.

The best command position and alternative position determined by the Blue Party are:276,287,290,296,297,298,299,302,303,304,305,309,316,318,319,325,331,333,339,356,357,366,367,369,387,393,397,398,406,408,425,427,428,433,435.

The command positions of the Red Party and the corresponding jurisdictional nodes are listed in Table 6:

Table 5: Floyd pseudocode

Algorithm 1 Floyd algorithm
a) initialization: D[u,v]=A[u,v]
b)For k:=1 to n
For i:=1 to n
For j:=1 to n
If D[i,j]>D[i,k]+D[k,j] Then
D[i,j]:=D[i,k]+D[k,j];
c) The end of the algorithm: D is the shortest path matrix of all point pairs

Table 6: Red Party Command Location and Corresponding Jurisdiction Nodes

Command position	Jurisdiction node
1	1,67,68,69,71,73,74,75,76,78
2	2,39,40,43,44,70,72
3	3,54,55,65,66
4	4,57,60,62,63,64
…	…

4. Conclusions

Focusing on the strategies of the two corps in the military exercises or combat, this paper establishes the Topsis assessment model by screening and pre-processing the specific data of the armaments of the red and blue corps and combining with the search of relevant information to obtain the score of the strength value of each equipment. On this basis, this paper determines the optimal command position and a number of alternative positions for both legions using the Freudian shortest distance algorithm according to the attack difficulty and marching distance of different nodes. The results show that the red legion has 18 better options at nodes 3~263, while the blue legion has more deployable positions at 276~435. However, the actual situation may be more complex, and based on this consideration, a dynamic planning model can be further established. The model should establish state transfer equations based on the changes in the battle situation and the material situation, and give full consideration to the possible offensive strategies adopted by the other side, so as to provide a specific program for the distribution and supply of medical materials and living supplies for the red and blue armies. In addition, the model can be applied to other areas such as business and sports competitions in the future by improving it in order to develop sound competitive strategies.

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