Research on scheduling problem

YU Yipeng
North China Electric Power University（Baoding）， Baoding 071000，China

Abstract: This paper studies the emergency related issues. In the subject, under different circumstances, the distribution of the ambulance six regions is the main discussion.

Considering the accident area may include a plurality of regions in the given problem, this paper introduces the people concept of satisfaction. People satisfaction is a time as the independent variable of a function, which meets the "S" shaped curve in time. We used a logistic curve to express our satisfaction with the people. With the time increases, people satisfaction presentation decreasing trend of different rates. Among them, the growth coefficient r is in direct proportion to the number of population of each region. With the satisfaction of the people, we put three ambulances different programs should be evaluated and get people in different accident situations were higher satisfaction with the optimal solution. On the basis of this scheme, we employed on the use of the model determined in scheduling scheme three ambulances at different accident situations.

Keywords: optimal， satisfaction of the people

1. INTRODUCTION

With the progress of urbanization, urban emergency treatment to deal with regional issues becomes increasingly prominent problem. Due to geographic reasons different areas of the city, coupled with the limited emergency conditions, the city staff to meet as many people as possible to enjoy the emergency ambulance service. Therefore, for different areas, how to allocate a limited number of ambulances, so that the ambulance can park in the right position and the number of people of the city's six regions that can get emergency care within 8 minutes after the emergency telephone call service can maximize, is an urgent problem. In this paper, the basis of the average time a certain area of the city in general to another area and population required for each region, the need to address the following issues:

If a major accident involving numerous personnel from all regions occurred in an area the city, the city emergency center should be handled? Reasonable treatment plan designed according to the model established.

2. The problem analysis

The title is an optimal decision problem for different scheduling scheme, it is to the city as the background emergency care issues, mainly on the ability of regional planning for emergency ambulance carried.

Two important factors affecting the planning of emergency ambulance transportation conditions and the number of population in each region between the cities of different areas. So the algorithm we use must be taken into account while for these two important factors. For the evaluation of a program, we are here as a reference to a satisfaction to judge good and bad scheduling scheme. The time required for the site of the accident emergency vehicle arrives to give satisfaction to reflect a time-variable, while, for different regions, the population of the region will inevitably affect satisfaction for emergency ambulance services.

3. The model assumptions

(1) The title given in the data are true and reliable, but is not affected by other external conditions.

(2) Under normal circumstances, the emergency vehicle to the average time required for the occurrence of the accident area conditions consistent with the known data given.

(3) Under normal circumstances, the population of each region is a long-term active population in the region, rather than the domicile of the population of the region, and does not consider migration, namely the population of the region

is essentially fixed.

(4) In the title given in Table I, there has been the starting point and end point of the region can not be separately ambiguity. We believe that the starting point and end point in the model do not affect the terms of building a model, so only consider the case. We here in the form of a vertical column of numbers in the region as a starting point, the area number of courses as the end point.

(5) Two accidents adjacent interval occurred a long time, and did not affect the association between each other.

(6) After receiving an emergency call an emergency ambulance emergency medical judgments made time ignored.

(7) In the event of an emergency after the need to reconfigure the scheduling scheme, we believe that the time required to complete the scheduling is very short, is the scheduling process does not affect the emergency ambulance.

4. Parameter Description

A_n : One can arrange ambulance locations, namely the title given in the region

B : Location of emergency

X : Number of ambulances needed

x_i : Within the time limit can be freely scheduled number of emergency vehicles

x'_i : The actual number of vehicles involved in dispatching emergency

t_i : The average time from the ambulance to be used

$T(>0)$: Emergency response time in emergency restrictions

R_j : Indicates the number of the first areas of population

S : Indicates vehicle display programs

$N(\mathrm{t})$: That people Satisfaction

r : That "S" shaped curve growth factor

K: represents the upper limit of the logistic curve

G: represents accident rating

5. Model

5.1 Description of the problem

Set A_1 , A_2 , $\cdots$, An n-emergency vehicles for supply points, B for emergencies locations, X is required for emergency vehicle demand B, within the limits of the number of emergency vehicles in the period A_i freely scheduled for x_i , x_i is the actual participation dispatching emergency vehicle number, $1 \le i \le n$, and satisfies $\sum_{i=1}^{n} x_i = X$. From A_i to the emergency response time B uses $t_i(>0), i = 1, 2, \cdots, \mathrm{n}$. T (> 0) for emergency treatment in the emergency restriction period. R_j is the number of population in the area owned by j, where $1 \le j \le m$, m is the total number of regions, the number of people here for population activities for a fixed value. Now undergone major emergencies from multiple regions, the need to deploy multi-vehicle emergency ambulances rushed to the place of accident emergency rescue. And often due to the severity of the accident and regional belonging unknown factors, and therefore within the limits of the period may not be part of an emergency ambulance to reach the scene in time. According to people for emergency ambulance service quality feedback, people are now introducing a concept SAT to measure satisfaction with the quality of how good or bad the emergency ambulance service. This problem calls for an emergency vehicle dispatch program, which requires considering emergency vehicle dispatch time and regional population of two factors, the established model to meet the "emergency vehicle dispatch the shortest and most satisfied people."

5.2 Modeling

5.2.1 Model parameters

Set S_j for j-kind emergency vehicle scheduling

scheme, T for emergency treatment in the emergency restriction period, $t_{Si}(A_1, A_2, \cdots, A_n)$ for the j-kind emergency vehicle scheduling scheme each vehicle supply point to the time required for the scene, according to the severity of the occurrence of an accident discrimination incidents grade G, SAT_j kinds of people for the first j satisfaction programs. The entire emergency vehicle dispatch solution for $S = \{S_1, S_2, \cdots, S_m\}$.

5.2.2 Satisfaction SAT people

People satisfaction SAT is based on people for emergency ambulance service quality reflects a feedback parameter. It should have the "S" shaped curve characteristic, namely the value of the emergency response limitations of T within the SAT substantially reduced marginally, namely the public satisfaction essentially unchanged. And in the time range is greater than T, SAT's value decreases significantly faster, that people satisfaction showing a decreased trend. For a description of SAT, choose classic logistic growth function curves.

There are a lot of "S" type changes in the natural and social phenomena, logistic model is almost describe "S" type growth only mathematical models. This is a continuous, monotonically increasing order parameter K is the asymptote of "S" shaped curve. Its rate of change in a relatively slow start, the middle segment growth has accelerated, and the subsequent decline in the growth rate stable. You can use it to characterize the change of people's satisfaction with SAT. Public satisfaction curve is a continuous monotone decreasing to 1 "S" shaped curve on the asymptotic lines. Its rate of change is relatively slow in the start, the middle section reduces the speed, after the reducing the rate of decline and regional stability. In the form of differential equations:

$$\begin{cases} \frac{dN}{dt} = -r(1-\frac{N}{K})N \\ N(t_0) = N_0 \end{cases}$$

The use of first-order differential equations separation of variables, find the solution for:

$$N(t) = \frac{-K}{\frac{N_0 - K}{N_0} e^{-rt_o + rt} + 1}$$

Where, N (t) for the public satisfaction, r represents the growth factor, K represents the upper limit curve (K = 1).

r characterize different regions of growth factor is determined by the number of population in the region. Here r values specified number R_j proportional to population areas, namely $r \propto R_j$. We artificially prescribed $r = R_j / 10,000$.

t_0 represents emergency in the emergency restriction period T, the provisions of N_0 = 0.8 for the public satisfaction SAT satisfaction at time T.

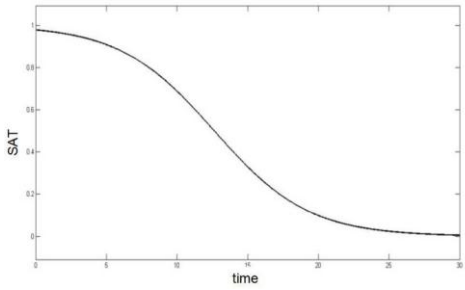

Figure1 Satisfaction of every region

5.3 Model solution

5.3.1 Solving ideas:

First, we think the most reasonable solution must be three ambulances can arrange for us that there is no ambulance in emergencies. At the same time, we do not consider two or three ambulances cars in the same areas of the program. In this context, we have 20 kinds of solutions exist for analysis. Our problem in the number of vehicles for a "place in the city an area of major accidents involving numerous officers from various regions" in the number of incidents of regional seminars, direct impact on the number of accidents for the area you need an ambulance rushed to

the scene of the accident.

1) When the accident occurred is located in an area of the city, we need an ambulance.

2) In order to make the greatest satisfaction of the people, this question of scheduling scheme for ambulances rushed to the accident site locations for the shortest time to reach the bike ambulance. When the accident occurred in the city of three areas, we need all three ambulances rushed to the accident site. For a program to determine the placement of the ambulance, we were six regional analysis of any of the three regions in the accident occurs, comparison of different scheduling methods to obtain maximum satisfaction. Synthesizing the satisfaction of the 20 kinds of accident regions, you can get the public satisfaction with the program.

Comprehensive same program in satisfaction of three conditions the accident area, select the best decision, so that in case of an accident can not be sentenced to know the area, three ambulances placement. In determining the placing of the program after three ambulances, ambulance dispatching scheme analyze different regions of the accident occurred.

5.3.2 Algorithm steps:

The algorithm steps are as follows:

(1) According to the problem given in the Table II, the six regions were drawn satisfaction function of the variation over time in a graph.

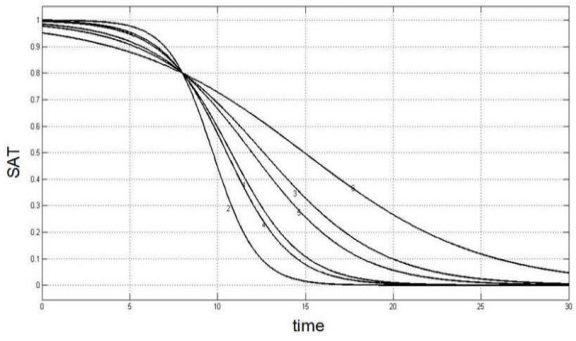

Figure 2 Satisfaction function of the variation over time

(2) Programs written in MATLAB, are seeking a different number of areas require ambulance when 20 kinds of display solutions' total Satisfaction, the total time to reach the six regions, the average standard deviation std time and time.

Get under the table:

Table 1 Ambulance rescue situations when three area needs

Regional Ambulance placement			Total Satisfaction	The total time	Average time	Time std
1	2	3	46.645596	348.500000	17.425000	7.182352
1	2	4	49.710702	356.000000	17.800000	7.038241
1	2	5	52.213533	310.000000	15.500000	7.059894
1	2	6	47.321755	316.000000	15.800000	6.685412
1	3	4	50.776051	302.500000	15.125000	5.953493
1	3	5	51.915572	280.500000	14.025000	5.872494
1	3	6	46.120814	331.500000	16.575000	6.915419
1	4	5	51.116241	270.000000	13.500000	5.226451
1	4	6	51.197628	260.000000	13.000000	5.191085
1	5	6	51.480122	276.000000	13.800000	5.277559
2	3	4	51.486513	305.000000	15.250000	6.562453
2	3	5	53.055884	265.000000	13.250000	5.550012
2	3	6	47.216409	311.000000	15.550000	6.019486
2	4	5	51.708877	273.000000	13.650000	6.063480
2	4	6	51.815882	262.000000	13.100000	5.875014
2	5	6	52.419620	264.000000	13.200000	5.454115
3	4	5	41.727096	372.500000	18.625000	7.922113
3	4	6	41.756291	369.5000	18.47500000	7.846345
3	5	6	41.767863	397.000000	19.850000	8.088491
4	5	6	39.117255	407.000000	20.350000	8.821475

(3) Comprehensive comparison of the programs in the public satisfaction with three cases, choose the optimal placement scheme ambulance.

(4) To determine under the program, ambulance dispatching scheme accident occurred in different areas.

5.4 Analysis

5.4.1 Optimal solution

According to the total satisfaction of the three regional rescue situations when needed ambulance, you can get the best emergency vehicle configuration is {2,3,5}.

5.4.2 Conclusion

Table 2 Ambulances' dispatch

Accident zone number	The required number of ambulance A_1 rushed to the area	The required number of ambulance A_2 rushed to the area	The required number of ambulance A_3 rushed to the area
1	1		
2	2		
3		3	
4			4
5			5
6			6
1，2	2	1	
1, 3	1	3	
1，4	1		4
1, 5	1		5
1，6	1		5
2，3	2	3	
2，4	2		4
2, 5	2		5
2, 6	2		6
3, 4		3	4
3，5		3	5
3，6		3	6
4, 5		5	4
4, 6		6	4
5，6		6	5
1,2,3	2	1	3
1,2,4	2	1	4
1,2,5	2	1	5
1,2,6	2	1	6
1,3,4	1	3	4
1,3,5	1	3	5
1,3,6	1	3	6
1,4,5	1	5	4
1,4,6	1	6	4
1,5,6	1	6	5
2,3,4	2	3	4
2,3,5	2	3	5
2,3,6	2	3	6
2,4,5	2	5	4
2,4,6	2	6	4
2,5,6	2	6	5
3,4,5	3	5	4
3,4,6	3	6	4
3,5,6	3	6	5
4,5,6	6	5	4

Appendix I.

Table 3 In general, the average time from one area to another area

	Average time (min)					
Area ID	1	2	3	4	5	6
1	1	8	12	14	10	16
2	8	1	6	18	16	16
3	12	18	1.5	12	6	4
4	16	14	4	1	16	12
5	18	16	10	4	2	2
6	16	18	4	12	2	2

Table 4. Number of each region's population

Region	Population
1	50,000
2	80,000
3	30,000
4	55,000
5	35,000
6	20,000
Total	270,000

6.Conclusions

Considering the accident area may include a plurality of regions in the given problem, On the basis of this scheme, we employed on the use of the model determined in scheduling scheme three ambulances at different accident situations. Comprehensive same program in satisfaction of three conditions the accident area, select the best decision, so that in case of an accident cannot be sentenced to know the area, three ambulances placement. According to the total satisfaction of the three regional rescue situations when needed ambulance, you can get the best emergency vehicle configuration

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