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Original Article

Optimization Model of Hospital Bed Arrangement

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Abstract *- Aiming at the problem of bed arrangement, this paper evaluates the original First come, First Serve rules by using comprehensive evaluation method. The four quantified indicators eliminate dimension by using linear proportion change method, and get weight coefficient by using range method to evaluate the model and get comprehensive evaluation indicators. The Monte Carlo method was used to establish a new priority bed arrangement model. Compared with the original model, except for a slight decrease in the satisfaction of the sick and injured, the utilization rate and waiting time of hospital beds were greatly improved.*

Keywords *- Comprehensive evaluation, Computer simulation, Priority allocation, Queuing model, Waiting time.*

1. Introduction

With the background of the 2009 National Mathematical Contest in Modeling B [1], we solve the following two problems. Firstly, a reasonable evaluation index system is determined to evaluate the merits and demerits of the bed arrangement model. Secondly, according to the current situation of the inpatient department, a reasonable bed arrangement model is established to determine which patients should be hospitalized the next day according to the known number of patients to be discharged the next day. And evaluate your model using the index system in problem one.

In the first question, the indexes of fairness, bed utilization, hospital work efficiency and satisfaction were quantified as: average waiting time for admission T_a, operation preparation time T_b, average postoperative observation time T_c and length of stay T_d. For these four indicators, the linear proportion change method[15-19] is used to eliminate the dimension, and the range method[20-22] is used to obtain the weight coefficient to evaluate the specific model, and the comprehensive evaluation index is $A=0.0186T_a+0.2021T_b+0.4109T_c+0.3684T_d$.The lower the A value, the more reasonable the bed arrangement. For the original hospital bed arrangement plan, the comprehensive evaluation index is $A=6.96961$.

In the second one, in order to satisfy the interests of both patients and hospitals, we use Monte Carlo [8-14] method to build the priority model [2-7]. According to the problem a of the evaluation index system, we put the First come, First Serve model [25,26] comparing with priority level model, compared with the First come, First Serve model except for the injury of satisfaction are down a bit, sickbed utilization rate and waiting time has the very big change, but under the priority level model, the patient admission arrangements have primary and secondary points will cause disease of fairness in the treatment process, Meanwhile, due to the limitation of the number of hospital beds, the number of hospitalized patients will reach saturation over time, and then the number of hospitalized patients will be equal to the number of discharged patients, so the waiting time will become longer.

2. Problem analysis

2.1. Analysis of one

In order to determine a reasonable evaluation index system, general hospitals and patients should be selected to evaluate the advantages and disadvantages of the eye hospital bed arrangement model. From the point of view of hospital, the ultimate goal of this model is to make more effective use of ward resources and make doctors achieve higher work efficiency. From the patient's point of view, the patient should have a shorter wait time and a shorter recovery time. Therefore, this paper selected the following indicators: average waiting time for admission, operation preparation time, average postoperative observation time, and average length of stay to comprehensively evaluate the bed arrangement model.

2.2. Analysis of two

In this paper, we construct a deterministic bed scheduling problem considering multiple types of patients and their different resource needs, and propose a mixed integer programming model to solve the problem. Specifically, we will consider three categories in the model, namely acute, no acute and complex. Acute patients must be admitted as soon as a bed becomes available, or they will have to be transferred. No acute or complex patients can plan their admission dates. In addition, the scheduling of surgical patients should not only consider the constraints of bed resources, but also the workload of surgeons, so as to avoid the phenomenon of excessive one-day operation burden.

3. Assumption of the model

Hypothesis 1: Trauma patients have the highest priority;
Hypothesis 2: Compare the patient's waiting time from outpatient to inpatient, and when it is greater than 20 days (the patient's psychological limit of waiting time), then the customer has priority in admission;
Hypothesis 3: On Saturday and Sunday: Patients with cataracts in both eyes should be admitted first; If there are no patients with cataracts in both eyes, but there are patients with cataracts in one eye, then the patients with cataracts in one eye should be admitted first; If the patient has neither type of cataract, the patient is admitted according to the waiting time.
Hypothesis 4: On Monday and Tuesday: Patients with cataract monocular, then priority admission; If there are no cataract monocular patients, non-cataract patients will be assigned priority according to the waiting time; If and only if there are only cataract patients left in both eyes, we schedule them for the length of wait.
Hypothesis 5: On Wednesday, Thursday and Friday: We arrange admission of non-cataract patients according to the length of waiting time; When there were only cataract patients left, we put them in by waiting time.

4. Symbol description

T_a： Average waiting time in hospital

T_b : Operation preparation time, in days

T_c： Mean postoperative observation time

T_d : Average length of stay

x : One day

m : Number of discharges

n : Maximum waiting time for patients

5. Problem 1 model establishment and solution

Step 1：To establish indicators

The evaluation indexes considered in this model are divided into fairness index, bed occupancy index, hospital efficiency index and satisfaction index. In order to closely link these four indicators with the model data and realize quantification, an index analysis chart is established as shown in figure 1 below:

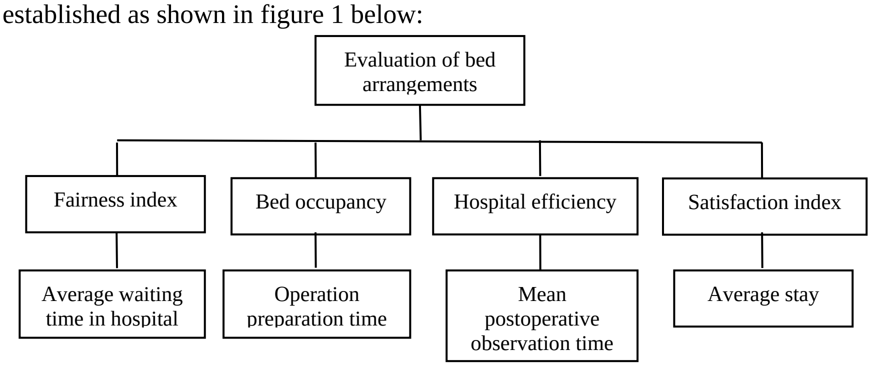

Fig. 1 Index analysis chart

For each type of patient, the time of outpatient visit, time of admission, time of operation, and time of discharge should be concerned. And some of these times are mutually limiting. For example, outpatient time and hospital stay are the waiting time of patients; Admission time and operation time are preparation time; The operation time and discharge time are the observation period. We need to know which is the point and which is the time period.

Step 2: Preprocessing of data

In the Excel table given in the problem, the data of various eye diseases from outpatient to discharge have been given. The following four indicators are solved to obtain the data in Table 1.

Table 1. Indicators to solve

disease type	average waiting time	Average preparation time	Mean postoperative observation time	average stay
traumatism	1.00	1,00	6.04	7.04
glaucoma	12.26	2.41	8.08	10.49
retinal disease	12.54	2.38	10.17	12.54
cataract	12.67	2.33	2.90	5.24
cataract(binoculus)	12.51	3.60	4.96	8.56

As traumatic illnesses are usually acute, hospital admission is arranged as soon as beds become available and surgery is arranged the following day. Itself with very obvious particularity, so external injury these special data were deleted.

Step 3: Consistent processing of indicators

The shorter the average waiting time for admission, the higher the fairness, which is a very small index. When the utilization rate of hospital beds is high, the preoperative preparation time can be reduced, which is a very small index. The shorter the patient's postoperative observation time, the higher the hospital's work efficiency, this index is an extremely small index, and the shorter the hospital stay, the higher the patient's satisfaction, Therefore, this index is also an extremely small index. The data are all extremely small indicators, so it is unnecessary to process it.

Step 4：Dimensionless treatment of index

Using the linear scaling method

$$x^{*}_{ij}=\frac{\sum_{1\le i\le 4} x_{ij}}{x_{ij}}\,(1\le i\le 4, 1\le j\le 4) \qquad (1)$$

Eliminating dimensions, the evaluation matrix R_1 in Table 2 can be obtained from Equation (1) and the procedure is shown in Appendix 1.

Table 2. The evaluation matrix

R1			
1.0000	0.9681	0.3594	0.3594
0.9770	0.9819	0.2855	0.4174
0.9676	1.0000	1.0000	1.0000
0.9796	0.6486	0.5848	0.6116

Step 5：Determination of weight coefficient of evaluation index

The range method is the simplest index to measure the change of the mark in the fluctuation range of the mark value. Therefore, the weight coefficient can be obtained by the range method, and the range of the observed value of the j index is denoted:

$$r_j=\max_{\substack{1\le i,k\le 4\\ i\ne k}}\left|x_{ij}-x_{kj}\right|\,(j=1,2,3,4)$$

take the weight coefficient of the j index as

$$w_j=\frac{r_j}{\sum_{j=1}^{m} r_j}\,(j=1,2,3,4) \qquad (2)$$

Matlab was used to calculate the weight value of formula (2), and the results in Table 3 were obtained

Table 3. Weight value

weight			
0.0186	0.2021	0.4109	0.3684

Step 6: Comprehensive evaluation

The linear weighted comprehensive model makes each index compensate each other (this rises and the other falls, the total evaluation value remains unchanged), and the comprehensive evaluation index is obtained as follows:

$$A=0.0186T_a+0.2021T_b+0.4109T_c+0.3684T_d$$

The smaller A is, the more reasonable the bed arrangement is. After analyzing and calculating the original data, the value obtained $T_{a,}T_{b,}T_{c,}T_d$ is shown in Table 4

Table 4. Calculated result value

disease type	average waiting time	Average preparation time	Mean postoperative observation time	average stay
Eye disease	12.53	2.71	6.66	9.37

The comprehensive evaluation indicators of the original hospital bed arrangement plan are as follows:

$$A=0.0186*12.53+0.2021*2.71+0.4109*6.66+0.3684*9.37=6.96961$$

6. Problem 2 model establishment and solution

From the distribution of each type of patients from operation to discharge time, we can know the law of operation to discharge time, and then deduce the discharge time of patients during this period and arrange the admission.

According to the model assumption we made above, that is, admission rules, Monte Carlo method was used to conduct computer simulation, and the number of patients admitted and discharged every day was obtained until the requirements were met. The specific algorithm is shown in the simulation block diagram below:

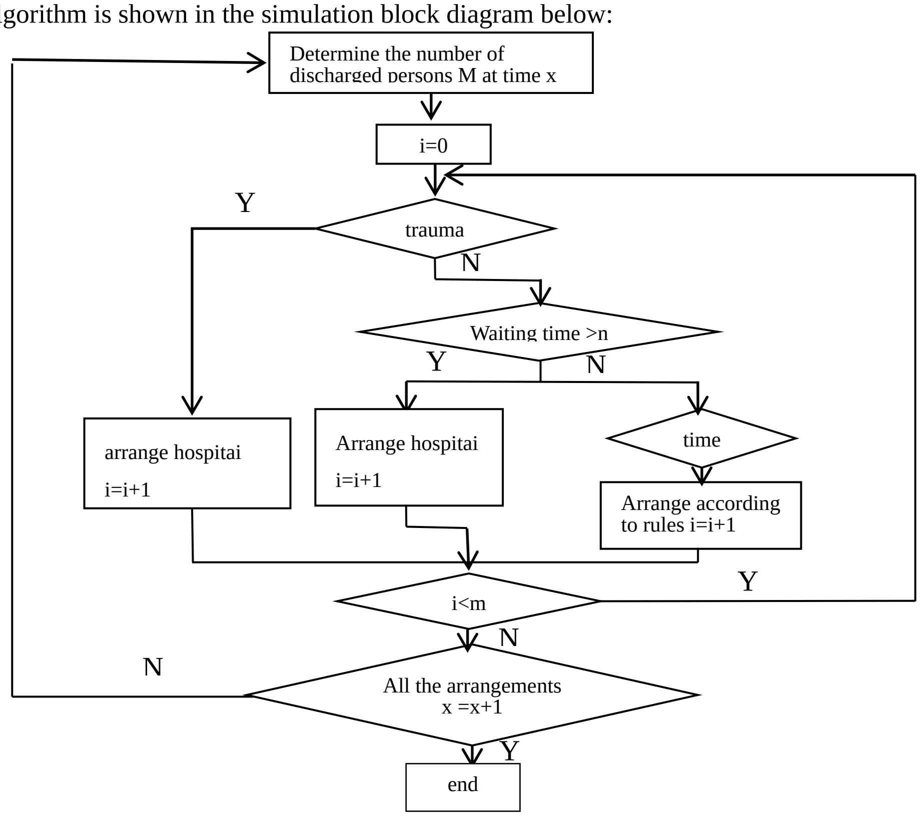

Fig. 2 Computer simulation diagram

Using MATLAB programming, random simulation of every day discharged from all kinds of patients and statistics of the number of discharged. (See Appendix 1 for the procedure) According to the above rules, we will arrange the outpatient patients to be admitted from August 30, 2008 to September 11, 2008 and the results in Table 5 are obtained. Here, we have done the work of determining which patients should be admitted based on the number of people discharged the next day.

Table 5. Admission schedule results

number	type	Outpatient service time	Admission time	Time of the first operation	Time of the second operation	Discharge time	Admission waiting time	Waiting time for surgery
1	cataract(binoculus)	2008-8-30	2008-9-13	2008-9-15	2008-9-17	/	14	2
2	retinal disease	2008-8-30	2008-9-12	2008-9-14			13	2
3	glaucoma	2008-8-30	2008-9-12	2008-9-14			13	2
4	retinal disease	2008-8-30	2008-9-12	2008-9-14			13	2
5	retinal disease	2008-8-30	2008-9-12	2008-9-14			13	2
6	cataract(binoculus)	2008-8-30	2008-9-13	2008-9-15	2008-9-17	/	14	2
7	cataract	2008-8-31	2008-9-14	2008-9-17	/	/	14	3
8	glaucoma	2008-8-31	2008-9-12	2008-9-14			12	2
9	cataract(binoculus)	2008-8-31	2008-9-13	2008-9-15	2008-9-17	/	13	2
10	retinal disease	2008-8-31	2008-9-12	2008-9-14			12	2
11	retinal disease	2008-8-31	2008-9-12	2008-9-14			12	2
12	retinal disease	2008-8-31	2008-9-15	2008-9-17			15	2
13	glaucoma	2008-8-31	2008-9-16	2008-9-18			16	2
14	cataract	2008-8-31	2008-9-14	2008-9-17	/	/	14	3
15	retinal disease	2008-9-1	2008-9-16	2008-9-18			15	2
16	retinal disease	2008-9-1	2008-9-16	2008-9-18			15	2
17	glaucoma	2008-9-1	2008-9-16	2008-9-18			15	2
18	cataract(binoculus)	2008-9-1	2008-9-13	2008-9-15	2008-9-17	/	12	2
19	cataract(binoculus)	2008-9-1	2008-9-13	2008-9-15	2008-9-17	/	12	2
20	cataract(binoculus)	2008-9-1	2008-9-13	2008-9-15	2008-9-17	/	12	2
21	retinal disease	2008-9-1	2008-9-16	2008-9-18			15	2
22	cataract	2008-9-1	2008-9-14	2008-9-15	/	/	13	1
23	retinal disease	2008-9-1	2008-9-16	2008-9-18			15	2
24	retinal disease	2008-9-1	2008-9-16	2008-9-18			15	2
25	cataract	2008-9-2	2008-9-14	2008-9-15	/	/	12	1
26	cataract	2008-9-2	2008-9-15	2008-9-17	/	/	13	2
27	cataract(binoculus)	2008-9-2	2008-9-13	2008-9-15	2008-9-17	/	11	2
28	cataract	2008-9-2	2008-9-15	2008-9-17	/	/	13	2
29	retinal disease	2008-9-2	2008-9-16	2008-9-18			14	2
30	retinal disease	2008-9-3	2008-9-16	2008-9-18			13	2
31	retinal disease	2008-9-3	2008-9-16	2008-9-18			13	2
32	cataract(binoculus)	2008-9-3	2008-9-13	2008-9-15	2008-9-17	/	10	2
33	cataract	2008-9-3	2008-9-15	2008-9-17	/	/	12	2
34	retinal disease	2008-9-3	2008-9-16	2008-9-18			13	2
35	cataract	2008-9-3	2008-9-15	2008-9-17	/	/	12	2
36	retinal disease	2008-9-3	2008-9-16	2008-9-18			13	2
37	retinal disease	2008-9-3	2008-9-16	2008-9-18			13	2
38	cataract(binoculus)	2008-9-4	2008-9-13	2008-9-15	2008-9-17	/	9	2
39	cataract	2008-9-4	2008-9-15	2008-9-17	/	/	11	2
40	glaucoma	2008-9-4	2008-9-16	2008-9-18			12	2
41	retinal disease	2008-9-4	2008-9-16	2008-9-18			12	2

42	**retinal disease**	2008-9-4	2008-9-16	2008-9-18			12	2
43	**retinal disease**	2008-9-4	2008-9-16	2008-9-18			12	2
44	**glaucoma**	2008-9-4	2008-9-16	2008-9-18			12	2
45	**cataract(binoculus)**	2008-9-4	2008-9-13	2008-9-15	2008-9-17	/	9	2
46	**cataract(binoculus)**	2008-9-4	2008-9-13	2008-9-15	2008-9-17	/	9	2
47	**glaucoma**	2008-9-4	2008-9-16	2008-9-18			12	2
48	**glaucoma**	2008-9-4	2008-9-16	2008-9-18			12	2
49	**retinal disease**	2008-9-4	2008-9-16	2008-9-18			12	2
50	**retinal disease**	2008-9-4	2008-9-16	2008-9-18			12	2
51	**cataract(binoculus)**	2008-9-5	2008-9-13	2008-9-15	2008-9-17	/	8	2
52	**cataract(binoculus)**	2008-9-5	2008-9-13	2008-9-15	2008-9-17	/	8	2
53	**cataract(binoculus)**	2008-9-5	2008-9-14	2008-9-15	2008-9-17	/	9	1
54	**retinal disease**	2008-9-5	2008-9-16	2008-9-18			11	2
55	**cataract(binoculus)**	2008-9-5	2008-9-14	2008-9-15	2008-9-17	/	9	1
56	**glaucoma**	2008-9-5	2008-9-16	2008-9-18			11	2
57	**cataract(binoculus)**	2008-9-5	2008-9-14	2008-9-15	2008-9-17	/	9	1
58	**cataract**	2008-9-5	2008-9-15	2008-9-17	/	/	10	2
59	**cataract(binoculus)**	2008-9-5	2008-9-14	2008-9-15	2008-9-17	/	9	1
60	**cataract(binoculus)**	2008-9-5	2008-9-14	2008-9-15	2008-9-17	/	9	1
61	**cataract(binoculus)**	2008-9-6	2008-9-14	2008-9-15	2008-9-17	/	8	1
62	**retinal disease**	2008-9-6	2008-9-16	2008-9-18			10	2
63	**glaucoma**	2008-9-6	2008-9-17	2008-9-19			11	2
64	**cataract(binoculus)**	2008-9-6	2008-9-14	2008-9-15	2008-9-17	/	8	1
65	**retinal disease**	2008-9-7	2008-9-17	2008-9-19			10	2
66	**cataract(binoculus)**	2008-9-7	2008-9-14	2008-9-15	2008-9-17	/	7	1
67	**retinal disease**	2008-9-7	2008-9-17	2008-9-19			10	2
68	**cataract**	2008-9-8	2008-9-15	2008-9-17	/	/	7	2
69	**retinal disease**	2008-9-8	2008-9-17	2008-9-19			9	2
70	**retinal disease**	2008-9-8	2008-9-17	2008-9-19			9	2
71	**cataract**	2008-9-8	2008-9-15	2008-9-17	/	/	7	2
72	**cataract(binoculus)**	2008-9-8	2008-9-14	2008-9-15	2008-9-17	/	6	1
73	**cataract**	2008-9-8	2008-9-15	2008-9-17	/	/	7	2
74	**retinal disease**	2008-9-8	2008-9-17	2008-9-19			9	2
75	**cataract**	2008-9-8	2008-9-15	2008-9-17	/	/	7	2
76	**glaucoma**	2008-9-9	2008-9-17	2008-9-19			8	2
77	**glaucoma**	2008-9-9	2008-9-17	2008-9-19			8	2
78	**retinal disease**	2008-9-9	2008-9-17	2008-9-19			8	2
79	**cataract**	2008-9-9	2008-9-15	2008-9-17	/	/	6	2
80	**cataract**	2008-9-9	2008-9-15	2008-9-17	/	/	6	2
81	**retinal disease**	2008-9-10	2008-9-17	2008-9-19			7	2
82	**cataract**	2008-9-10	2008-9-15	2008-9-17	/	/	5	2
83	**cataract(binoculus)**	2008-9-10	2008-9-14	2008-9-15	2008-9-17	/	4	1
84	**cataract**	2008-9-10	2008-9-15	2008-9-17	/	/	5	2
85	**cataract**	2008-9-10	2008-9-15	2008-9-17	/	/	5	2
86	**cataract(binoculus)**	2008-9-10	2008-9-14	2008-9-15	2008-9-17	/	4	1
87	**cataract**	2008-9-10	2008-9-15	2008-9-17	/	/	5	2
88	**glaucoma**	2008-9-10	2008-9-17	2008-9-19			7	2
89	**cataract(binoculus)**	2008-9-10	2008-9-14	2008-9-15	2008-9-17	/	4	1
90	**retinal disease**	2008-9-11	2008-9-17	2008-9-19			6	2
91	**retinal disease**	2008-9-11	2008-9-17	2008-9-19			6	2
92	**glaucoma**	2008-9-11	2008-9-17	2008-9-19			6	2

93	**cataract(binoculus)**	2008-9-11	2008-9-14	2008-9-15	2008-9-17	/	3	1
94	**cataract(binoculus)**	2008-9-11	2008-9-14	2008-9-15	2008-9-17	/	3	1
95	**glaucoma**	2008-9-11	2008-9-17	2008-9-19			6	2
96	**cataract(binoculus)**	2008-9-11	2008-9-14	2008-9-15	2008-9-17	/	3	1
97	**traumatism**	2008-9-11	2008-9-12	2008-9-13			1	1
98	**cataract(binoculus)**	2008-9-11	2008-9-14	2008-9-15	2008-9-17	/	3	1
99	**retinal disease**	2008-9-11	2008-9-17	2008-9-19			6	2
100	**cataract**	2008-9-11	2008-9-15	2008-9-17	/	/	4	2
101	**retinal disease**	2008-9-11	2008-9-17	2008-9-19			6	2
102	**retinal disease**	2008-9-11	2008-9-17	2008-9-19			6	2

The results of the above models were statistically obtained $T_a = 9.83$, $T_b = 1.84$, The change of bed arrangement model will not affect the postoperative recovery time of patients, so $T_c = 6.66$ remains unchanged. These three data are still without considering trauma. Since the discharge time is not provided in the data, so let $T_d = 9.37$ remain unchanged, and the comprehensive evaluation index of the improved hospital bed arrangement plan is as follows:

$$A = 0.0186 * 9.83 + 0.2021 * 1.84 + 0.4109 * 6.66 + 0.3684 * 9.37 = 6.743204$$

Average admission waiting time $T_a = 9.83 < 12.53$, fairness has been improved, $T_b = 1.84 < 2.71$, Hospital bed utilization has also increased.

It can be seen that the total evaluation index $6.743204 < 6.96961$, so this rule is superior to the original First come, First Serve rule.

Appendix 1

Question 1:

Range method to find the weight coefficient:

```
R1=[1.0000  0.9681  0.3594  0.3594;
0.9770  0.9819  0.2855  0.4174;
0.9676  1.0000  1.0000  1.0000;
0.9796  0.6486  0.5848  0.6116];
R1max=max(R1);% the maximum value of each column
R1min=min(R1);%the minimum value of each column
r=R1max-R1min;%the maximum value of each column minus the minimum value
qz=r./sum(r) %strives for the weights
```

Question 2:

```
n=20;
offef=100000
x1=[ 9    9    11    11    16    16    16];
x2=[9  9  9  9  9  9  9  9  9  9  9  9  9  9  9  16  16  16  16  16  16  16];
x3=[5 8 8 10 10 10 12 13 13 ];
x4=[1  1  5  5  5  6  6  7  7  7  7  7  8  8  10  10  10  10  10  10  10  10  12  12  12  12  13  13  13  13  13  14  14];
x5=[7 8 8 8 9 11 12 12 ] ;
n1=length(x1);
n2=length(x2);%for the length
n3=length(x3);
n4=length(x4);
n5=length(x5);
for i=1:n1
   y(i)=x1(i)+ceil(unidrnd(3)+1);%ceil(X)circle the elements of X to the nearest integer to infinity
end
for i=n1+1:n1+n2
```

```
     y(i)=x2(i-n1)+ceil(unidrnd(3)+3);%unidrnd(x)generate date with a discrete uniformly distributed random number generator
 end
for i=n1+n2+1:n1+n2+n3
    y(i)=x3(i-n1-n2)+ceil(unidrnd(9)+3);
end
for i=n1+n2+n3+1:n1+n2+n3+n4
    y(i)=x4(i-n1-n2-n3)+ceil(unidrnd(11)+4);
end
for i=n1+n2+n3+n4+1:n1+n2+n3+n4+n5
    y(i)=x5(i-n1-n2-n3-n4)+ceil(unidrnd(3)+1);
end
a=[1   1  2  3  3  3  4  4  5  6  9  9  9  9  10  10  11  11  11  11  12 offef];
b=[0   0  1  2  2  2  3  4  5  5  5  6  6  6  6  6  6  6  7  7  8  9  11  11  11  12  12  12  12 offef];
c=[0   0  0  0  1  1  1  1  1  2  2  2  2  2  2  3  4  4  4  4  4  5  5  5  5  5  5  5  5  5  6  6  7  7  8  8  9  9  9
10  10  10  11  11  12  12  12  12  12  12  12 offef]
d=[12 offef]
q1=length(a)-1;
q2=length(b)-1;
q3=length(c)-1;
q4=length(d)-1;
p1=0;
p2=0;
p3=0;
p4=0;
x=12;
while 1
    if p1==q1&p2==q2&p3==q3&p4==q4
        break;
    end
     m=0;

     sort(y);
    for i=1:79
        if y(i)<x+1
           m=m+1;
        end
    end
    for i=1:m
       if p1==q1&p2==q2&p3==q3&p4==q4
        break;
    end
        if p4~=q4
            r(x-11,i)=4
            p4=p4+1;
            y(i)=x+1+ceil(unidrnd(8)+2);
            continue;
        end
     e=[x-a(p1+1) ,x-b(p2+1), x-c(p3+1)]
      max=max_1(e);
       if max>n
         r(x-11,i)=maxn
          if maxn==1
              p1=p1+1;

    y(i)=x+2+(ceil(unidrnd(3)+1)+ceil(unidrnd(3)+3))/2;
```

```
      end
      if maxn==2
         p2=p2+1;

y(i)=x+2+(ceil(unidrnd(3)+3)+ceil(unidrnd(9)+3))/2;
     end
     if maxn==3
        p3=p3+1;
       y(i)=x+ 2+(ceil(unidrnd(9)+3)+ceil(unidrnd(11)+4))/2
    end
       continue;
   end
     if mod(x,7)==6|mod(x,7)==0
       if p2~=q2
         r(x-11,i)=2;
           p2=p2+1;

y(i)=x+2+(ceil(unidrnd(3)+1)+ceil(unidrnd(3)+3))/2;
          continue;
      elseif p1~=q1
           r(x-11,i)=1;
           p1=p1+1;

y(i)=x+2+(ceil(unidrnd(3)+3)+ceil(unidrnd(9)+3))/2;
           continue;
       elseif p3~=q3
           r(x-11,i)=3;
          p3=p3+1;
          y(i)=x+2+(ceil(unidrnd(9)+3)+ceil(unidrnd(11)+4))/2
          continue;
      end
   end
    if mod(x,7)==1|mod(x,7)==2
        if p1~=q1
        r(x-11,i)=1;
        p1=p1+1;

y(i)=x+2+(ceil(unidrnd(3)+1)+ceil(unidrnd(3)+3))/2;
        continue;
    elseif p3~=q3
        r(x-11,i)=3;
        p3=p3+1;
        y(i)=x+2+(ceil(unidrnd(9)+3)+ceil(unidrnd(11)+4))/2
        continue;
    elseif p2~=q2
        r(x-11,i)=2;
        p2=p2+1;

y(i)=x+2+(ceil(unidrnd(3)+3)+ceil(unidrnd(9)+3))/2;
        continue;
    end
 end
    if p3~=q3
        r(x-11,i)=3;
        p3=p3+1;
```

```
        y(i)=x+2+(ceil(unidrnd(9)+3)+ceil(unidrnd(11)+4))/2
       continue;
    elseif p2~=q2
       r(x-11,i)=2;
        p2=p2+1;

  y(i)=x+2+(ceil(unidrnd(3)+3)+ceil(unidrnd(9)+3))/2;
        continue;
     elseif  p1~=q1
       r(x-11,i)=1;
       p1=p1+1;

  y(i)=x+2+(ceil(unidrnd(3)+1)+ceil(unidrnd(3)+3))/2;
        continue;
     end

   end
  x=x+1;
 end
```

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