A matlab simulation of the Kruskal algorithm for erecting communication network

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***Abstract*—In this paper, a kruskal algorithm of graph theory in calculating the cost of the erecting communication network by matlab is presented. With the algorithm, optimization choice of total cost of the communication construction cost between the cities and provide some code and GUI which uses the fuzzy weight process, is obtained.**

Keywords- kruskal; modeling; fuzzy processing; optimization

I. INTRODUCTION

With cost calculation of the erecting communication network, the simulation of kruskal algorithm by matlab is achieved in the paper. With the development of mathematics science and computer technology, the mathematical modeling is playing an important role in various fields and abstracting practical problem. Using mathematical modeling, practical problems can be abstracted and simplified, and the variables and parameters can be determined and certain mathematical model between variables and parameters based on some of the "disciplines" can also be established. An ideal mathematical model should satisfy two conditions: the one, the reliability of the model. it can correctly reflect the internal relations of the related properties of the system considered and the objective reality within the allowable error range. The other, the solvability of the model. it is easy for mathematical processing and calculation. This paper mainly researches on the problem of minimum cost in erecting a communication network system. With mathematical modeling knowledge, corresponding mathematical model is established. Then the problem comes down to the shortest path problem in graph theory.

II. 2 SYSTEM MODELING

In the system, inter-communication network system is set among seven inter-cities. Due to the different distances between every two cities and the influence of the geographical environment, comprehensive cost in erecting communication lines between different cities is different. So the comprehensive cost can be estimated by vague language.

Table1 the distance between different cities (Unit: km)

	R2	R3	R4	R5	R6	R7
R1	4	10	5	8	6	10
R2		11	8	4	9	10
R3			10	3	6	7
R4				2	5	9
R5					5	5
R6						5

Table2 the comparison between the cost of erecting networks per kilometer among cities and 10,000 Yuan

	R2	R3	R4	R5	R6	R7
R1	NB	NS	ZO	NS	NB	NS
R2		NM	NM	NS	NS	ZO
R3			NS	NS	NS	NM
R4				ZO	NS	NS
R5					ZO	NS
R6						NM

Note: Here we refer to the fuzzy control rule and obfuscate the results.

As is shown in the two tables above, with the distances between different cities and the cost of erecting, the weighted value of erecting the network can be deduced. Each city can be looked as a point and two different cities can be connected to form a line. Then the network connection between the cities can be viewed as an undirected connected graph and each line has a weighted value which forms a weighted matrix as follow Table3.

Table3 the weight matrix of distance between two different cities (km)

	R1	R2	R3	R4	R5	R6	R7
R1	0	4	10	5	8	6	10
R2	4	0	11	8	4	9	10
R3	10	11	0	10	3	6	7
R4	5	8	10	0	2	5	9
R5	8	4	3	2	0	5	5
R6	6	9	6	5	5	0	5
R7	10	10	7	9	5	5	0

Then the weighted connected graph can be shown as figure 1.

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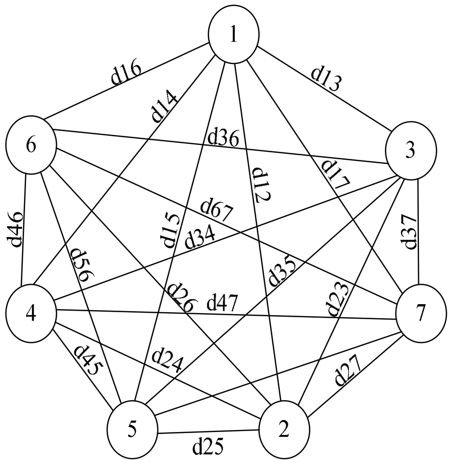

Figure 1 the distance weighted connected graph G of the urban communication network system

Since the cost of erecting the network per kilometer is an estimate with respect to one million, data sum should be achieved in quantity in the calculation. In the paper, there are three membership functions of Z distribution, sigmoid, normal distribution to be selected to obtain the estimated value. The table4 is one of the matrixes obtained by fuzzy control.

Table4 the comparison matrix between the cost of erecting networks per kilometer between different cities and 10,000 Yuan (Sigmoid function)

	R1	**R2**	**R3**	**R4**	**R5**	**R6**	**R7**
R1	0	0.9619	0.9999	1.0000	0.9994	0.9669	0.9999
R2	0.9619	0	0.9928	0.9834	0.9987	0.9998	1.0000
R3	0.9999	0.9928	0	0.9998	0.9999	0.9994	0.9834
R4	1.0000	0.9834	0.9998	0	1.0000	0.9987	0.9969
R5	0.9994	0.9987	0.9999	1.0000	0	1.0000	0.9994
R6	0.9969	0.9998	0.9994	0.9987	1.0000	0	0.9834
R7	0.9999	1.0000	0.9834	0.9969	0.9994	0.9834	0

III. 3 Kruskal Algorithm solves the optimal route of erection network

Kruskal Algorithm is a graph algorithm which can generate the minimum tree. Its basic idea is: select a edge of the smallest weight from the picture, then continually add the edges of the smallest weight which can not form a circle with the selected edge, do not stop until select N-1 edges (N is the number of nodes). It can be done with the following steps:

i. Select the crest (link) e_1, let $w(e_1)$.

ii. If $e_1, e_2, \cdots, e_i$ have been selected，then select the crest e_{i+1} form $E(G)\setminus\{e_1, e_2, \cdots, e_i\}$,let

① $G[\{e_1, e_2, \cdots, e_i, e_{i+1}\} U \{e_{i+1}\}]$ have no circle.

② $w(e_{i+1})$ be the smallest which satisfies ①

iii. if（ii）can not proceed, stop. Otherwise，return to (ii).

Put the original response to matrix variable dis and subject. Then the m-function file is formed as follow.

```
% kruskal algorithm of minimum spanning tree
clear ,close all % fuzzy set treatment of comparison between the cost of erecting networks per kilometer and 10,000 Yuan
t=0:0.5:10;
subject=sigmf(t,[1.7,3.6]); %Choose sigmoid membership function curve and function parameters are（1.7,3.6）
for i=1:9;
x(i)=subject(2*t(11+i)+1); % Calculate the values of each element in fuzzy set x, and output the degree of membership which compares each element of x with the cost
end
monpkm =[0,x(1),x(8),x(9),x(6),x(4),x(8)
x(1),0,x(3),x(2),x(5),x(7),x(9)
x(8),x(3),0,x(7),x(8),x(6),x(2)
x(9),x(2),x(7),0,x(9),x(5),x(4)
x(6),x(5),x(8),x(9),0,x(1),x(6)
x(4),x(7),x(6),x(5),x(1),0,x(2)
x(8),x(9),x(2),x(4),x(6),x(2),0]; %Comparison matrix between the cost of erecting networks per kilometer between different cities and 10,000 Yuan
dis =[0,4,10, 5,8 ,6,10
 4, 0, 11, 8, 4, 9, 10
 10 ,11 ,0 ,1,0, 3, 6, 7
 5, 8, 10, 0 ,2 ,5, 9
 8 ,4, 3, 2, 0, 5, 5
 6, 9, 6, 5, 5, 0, 5
 10, 10, 7, 9, 5, 5, 0]; % dis: the adjacency matrix of the distances between different cities which is shown in table 3.
  monpds=dis.*monpkm;
  city=7;    % city:The number of cities
 [XX,YY]=size(monpds);
  if XX~=YY
    error(' Input must be square ')
  end
 if city <length(monpds(1,:))
 error('City not match the input adjacency matrix ')
  end
  if city >length(monpds(1,:))
     error(' Vertex does not exist ')
  end
N=length(monpds(:,1));
con=0;
monpds(find(monpds==0))=inf;
mintree=zeros(N,N);
comp=zeros(N,N);
comp(:,1)=[1:N]';
  while con<N-1
    clear min0;
    min0=min(min(monpds));
    [ X,Y]=find(monpds==min0);
    XX=X(1);
    YY=Y(1);
    monpds(XX,YY)=inf;
    [i1,j1]=find(comp==XX);
    [i2,j2]=find(comp==YY);
    if i1==i2
    continue
```

```
        else
       l1=length(find(comp(i1,:)~=0));
       l2=length(find(comp(i2,:)~=0));
comp(i1,[l1+1:l1+l2])=comp(i2,[1:l2]);
comp(i2,:)=0; mintree(XX,YY)=min0; % calculation of adjacency matrix of the minimum cost spanning tree
 con=con+1;
        end
     end
mintree=mintree'
t1=ones(1,7);
mincost = t1*mintree*t1' % Obtain the minimum cost
```

In order to show our simulation results more clearly, a simulation interface is presented as Figure 2. The simulation interface can be edited with matlab GUIDE. Through calculation, the bold lines in the figure represent the path with the least cost.

IV. CONCLUSIONS

In this paper, the simulation and selection for the optimal path of erection communication networks based on the knowledge of graph theory is done. It achieves simulation and calculation of minimum spanning tree, minimum cost of the least-cost erecting communication network system. The program has certain practicality and versatility, which can complete similar problems of traveling salesman, postman, the network maximum flow and other practical problems.

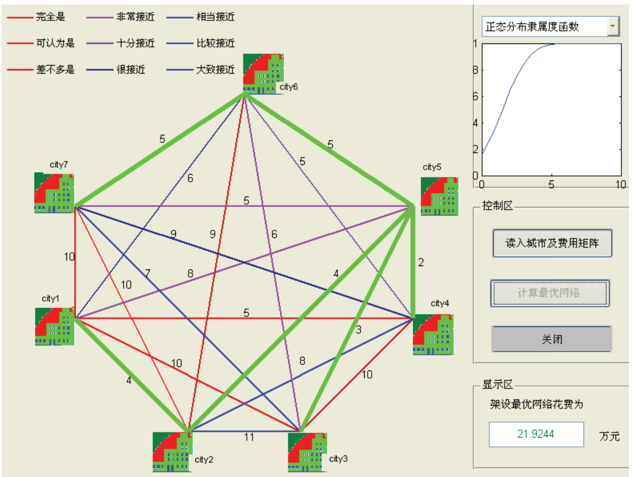

Figure 2 The distance weighted connected graph G of the urban communication network system

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