

MCDM in the Selection of Doctor for an Illness: An Application of Electre

Arman Rasool Faridi*

Department of Computer Science, Aligarh Muslim University, Aligarh

Abstract – ELECTRE stands for “*ELimination Et Choix Traduisant la REalité (Elimination and Choice Expressing reality)*” and is one of the most famous Multiple-criteria decision analysis technique. In contrast to previous optimization strategies, which comprise in figuring the problem as a cost function and in finding the optimum solution, here a comparison of every pair is done, the criterion by criterion advancing an inclination of a response to another and gives ranking matrix. In this paper ELECTRE method has been used and implemented in MATLAB to help give the rank of doctors and to identify which one is the best suited for someone’s need based on criteria like cost, location, experience, etc. Experimental results have been discussed.

Keywords: Electre, Multi-Criteria Decision Analysis, Multiple-Criteria Decision-Making

INTRODUCTION

One of the sub-disciplines of operations research is Multiple-criteria decision-making (MCDM), which helps in making decisions about a problem in which there are multiple selection criterions. It is also known as Multiple-Criteria Decision Analysis (MCDA) as it helps to analyse a situation based on various parameters which are conflicting in nature and helps to decide which is better. Some of the popular MCDM methods include SAW [1, 2], TOPSIS [3], AHP [4], SMART [5], ELECTRE [6,7] etc.

ELECTRE method is not just based on the cost function, but it compares each pair and finally presents the results. Decision-making problem provides various solutions which are called actions or alternatives. These actions, whether recorded comprehensively or not, must be formulated by the user. The outcomes of every one of them are assessed utilizing criteria. A criterion can be qualitative or quantitative and must be characterized by the user. When it is qualitative, the assessment of the actions on this criterion must be converted to a numerical scale. For example, let's consider the criterion "Diagnosis Efficiency" for the selection of a doctor for a particular illness. Then this criterion should be first converted to numerical values scaling from 1 to 5. Also, weight is assigned to each criterion, which will increase based on its importance. For example, in selecting doctor diagnose efficiency of doctor is more important than experience so diagnose efficiency will be assigned more weight than experience. To use ELECTRE, we need the list of actions, the list of criteria,

the evaluation of each action by criterion, and the weight of each criterion.

The output of the ELECTRE method is a rank matrix which helps to identify which action is better than others.

CASE STUDY

MCDM is not only helpful for industries or government, but it is also beneficial for taking daily life decisions. In this paper ELECTRE method has been used to select a doctor based on various criterions like Geographic location, Cost/Fees for the diagnosis, Consultation time given to the patient, Diagnosis efficiency of the doctor, Availability of the doctor and Doctor's experience. Geographic location means the distance of patient to that doctor clinic or hospital, and it is a numerical criterion. Fees or cost includes prescriptions fees only, which is also a quantitative criterion. Consultation time means how much average time a doctor gives to his/her patient; this is also a quantitative criterion. Diagnosis efficiency means how much the prescribed medicines are useful, and this is a qualitative criterion, so it has been converted to a numerical value ranging from 1 to 5. Availability means how many days and every day how many hours the doctor is available. Whether the doctor provides emergency services or not. So this is a qualitative criterion and converted it to a numerical value ranging from 1 to 5. The last criterion is experience in years, and it is a quantitative value.

Now out of these criterions most important one is Diagnosis efficiency, so it has been given 35% weight, next one is experience and availability, so 15% weightage given to each of them. Similarly,

Table 1: Criterion and weightage for our case study

Criterion	Weightage (in %)
Geographic Location	10
Cost	10
Consultation Time	15
Diagnosis Efficiency	35
Availability	15
Experience	15

15% weight to consultation time, 10% to cost, and 10% to geographic location have been given.

EXPERIMENTATION PROCESS

Now the given details are to be converted to matrix form for different doctors. As shown below, columns represent criterion, i.e., Geographic Location, Cost, Consultation Time, Diagnosis Efficiency, Availability, and Experience, respectively. Similarly, rows represent different doctors. Here below is our decision matrix:

1	2	3	4	5	6
1	2	90	2	1	1
2	4	150	5	2	2
3	7	100	12	3	3
4	1	100	5	1	4
5					7

And weights for each criterion are shown below:

1	2	3	4	5	6
1	0.1000	0.1000	0.1500	0.3500	0.1500
2					0.1500

EXECUTION

>> ELECTRE(DecisionMatrix,Weights)

MATLAB Function

```
function ELECTRE(X,W)
Xval=length(X(:,1));
Y = zeros([Xval,length(W)]);
for j=1:length(W)
    for i=1:Xval
        Y(i,j)=X(i,j)/sqrt(sum((X(:,j).^2)));
    end
end
Normalized_Matrix = num2str(Y);
```

```
disp('Normalised Matrix :');
disp(Normalized_Matrix);
for j=1:length(W)
    for i=1:Xval
        Yw(i,j)=Y(i,j).*W(j);
    end
end
Weighted_Normalized_Matrix = num2str([Yw]);
fprintf('\nWeighted Normalised Matrix :\n');
disp(Weighted_Normalized_Matrix);
%% CONCORDANTE SET

CMat=zeros([Xval,Xval]);
for i=1:Xval
    for j=1:Xval
        if i==j
            CMat(i,j) = 0;
        else
            sumOfWeights=0;
            for k=1:length(W)
                if Yw(i,k) >= Yw(j,k)
                    sumOfWeights=sumOfWeights+W(k);
                end
            end
            CMat(i,j)=sumOfWeights;
        end
    end
end
fprintf('\nConcordance Matrix :\n')
disp(CMat)
sumOfColumn = sum(CMat);
sumOfMatrix =sum(sumOfColumn);
ratioOfConcordanteSet =sumOfMatrix/(Xval^2);

CMatBinary=zeros([Xval,Xval]);
for i=1:Xval
    for j=1:Xval
        if CMat(i,j)>=ratioOfConcordanteSet
            CMatBinary(i,j)=1;
        end
    end
end
disp('Concordance Matrix In Binary:')
disp(CMatBinary)
%% DISCORDANCE SET
CMatDiff=zeros([Xval,Xval]);
CMatTemp=zeros(1,length(W));
for i=1:Xval
    for j=1:Xval
        if i==j
            CMatDiff(i,j) = 0 ;
        else
            for k=1:length(W)
                CMatTemp(1,k) = Yw(i,k) - Yw(j,k);
            end
        end
    end
end
```

```
end
maxi = max(CMatTemp);
mini = abs(min(CMatTemp));
CMatDiff(i,j)=(mini/maxi);
end
end
end
disp('Discordance Matrix :')
disp(CMatDiff)

%disp(CMatDiff);
sumOfColumnDiff = sum(CMatDiff);
sumOfMatrixDiff =sum(sumOfColumnDiff);
ratioOfConcordanceSetDiff
=sumOfMatrixDiff/(Xval*2);
CMatBinaryDiff=zeros([Xval,Xval]);
for i=1:Xval
    for j=1:Xval
        if CMatDiff(i,j)>=ratioOfConcordanceSetDiff
            CMatBinaryDiff(i,j)=1;
        end
    end
end
disp('Discordance Matrix In Binary:')
disp(CMatBinaryDiff)
disp('Rank Matrix:')
disp(CMatBinaryDiff & CMatBinary);
```

OUTCOME

```
Normalised Matrix :
0.23905  0.4001  0.14213  0.2582  0.18257  0.052486
0.47809  0.66683  0.35533  0.5164  0.36515  0.62984
0.83666  0.44455  0.8528  0.7746  0.54772  0.68232
0.11952  0.44455  0.35533  0.2582  0.7303  0.3674

Weighted Normalised Matrix :
0.023905  0.04001  0.02132  0.09037  0.027386  0.007873
0.047809  0.066683  0.0533  0.18074  0.054772  0.094475
0.083666  0.044455  0.12792  0.27111  0.082158  0.10235
0.011952  0.044455  0.0533  0.09037  0.10954  0.055111
```

Concordance Matrix In Binary:

0	0	0	0
1	0	0	1
1	1	0	1
1	0	0	0

Discordance Matrix In Binary:

1	0	0	1
1	1	1	1
1	1	1	1
1	1	1	1

Rank Matrix:

0	0	0	0
1	0	0	1
1	1	0	1
1	0	0	0

RESULTS

Here, finally a rank matrix is obtained. Rows and columns of this matrix represent doctors. Cells where value is 1 means that doctor at that row is preferable over the doctor represented by the column. In our case we are getting 1 in cells (2,1), (2,4), (3,1), (3,2), (3,4) and (4,1). This means that the doctor represented by row 2 has a higher preference than doctor 1. Similarly doctor 2 > doctor 4; doctor 3 > doctor 1; doctor 3 > doctor 2; doctor 3 > doctor 4; doctor 4 > doctor 1. So combining all these we get *doctor 3 >doctor 2>doctor 4 >doctor 1*.

CONCLUSION

In this paper an introduction of MCDM is given with special reference to a popular method, ELECTRE. A case study related to rank doctors to treat an illness based on certain criteria has been discussed. The same has been implemented using MATLAB and the experimental results have been discussed.

REFERENCES

1. L. A. Marks, E. G. Dunn, J. M. Keller, and L. D. Godsey (1995). "Multiple criteria decision making (MCDM) using fuzzy logic: an innovative approach to sustainable agriculture," in Proceedings of 3rd International Symposium on Uncertainty Modeling and Analysis and Annual Conference of the North American Fuzzy Information Processing Society, pp. 503–508.
2. H. Y. Wu, G.-H. Tzeng, and Y. H. Chen (2009). "A fuzzy MCDM approach for evaluating banking performance based on Balanced Scorecard," Expert Syst. Appl., vol. 36, no. 6, pp. 10135–10147.
3. G. R. Jahanshahloo, F. H. Lotfi, and M. Izadikhah (2006). "An algorithmic method to extend TOPSIS for decision-making problems with interval data," Appl. Math. Comput., vol. 175, no. 2, pp. 1375–1384.
4. H. S. Hwang, C. Moon, C. L. Chuang, and J. Goan (2005). "Supplier Selection and Planning Model Using AHP," 2005.

5. C. M. Brugha (1998). "Structuring and Weighting Criteria in Multi Criteria Decision Making (MCDM)," Springer, Berlin, Heidelberg, pp. 229–242.
6. A. R. Afshari, M. Mojahed, R. M. Yusuff, T. S. Hong, and M. Y. Ismail (2010). "Personnel Selection using ELECTRE," *J. Appl. Sci.*, vol. 10, no. 23, pp. 3068–3075.
7. X. Wang and E. Triantaphyllou (2008). "Ranking irregularities when evaluating alternatives by using some ELECTRE methods," *Omega*, vol. 36, no. 1, pp. 45–63, Feb. 2008.

Corresponding Author

Arman Rasool Faridi*

Department of Computer Science, Aligarh Muslim University, Aligarh

arman.faridi@gmail.com