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Applying "Analytical Hierarchy Process" to evaluate the Performance of different operating systems

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Abstract

When we are thinking about choosing best Operating System for any specific requirement, then this selection is dependent on multiple parameters and criteria. Some of these parameters are Durability, Scalability, Integrated Functionalities, Security and many more. Whenever an application is developed, priority charts are prepared for selection of most suitable operating system. In our work, we are going to apply "Analytical Hierarchy Process" (AHP) to evaluate the performance of different operating System. AHP is the Multi-Criteria Decision Making (MCDM) tool which is used in decision making This paper discusses about a useful mechanism that has been built to guide the decision makers in how to make decision for certain problem using AHP .This paper focused on comparative performance analysis of Windows, Linux OS/400 Operating Systems.

Keywords: AHP, criteria, Operating System, MCDM, Security, Durability, OS/400, Linux, Windows.

1. Introduction:

Decision making on the basis of several criteria and alternatives is very difficult task. To solve such problems we are using Analytical hierarchy process (AHP). AHP is the Multi-Criteria Decision Making (MCDM) tool that has been used in decision making. In this paper I apply a MCDM method for the performance analysis of different operating system.

In this paper the attention is focused on comparative performance analysis of three different operating systems

Windows

Linux

OS/400

Present study uses the Analytic Hierarchy Process (AHP) for the selection of the most suitable operating system according to the user's requirements.

2. General Methodology of AHP:

Suppose we have m alternatives and n criteria corresponding to the problem, then in the first step we have to construct a pair wise comparison matrix for the criteria.

	Criteria 1	Criteria 2	----	Criteria n
Criteria 1	a_{11}	a_{12}	----	a_{1n}
Criteria 2	a_{21}	a_{22}	----	a_{2n}
-	-	-		-
-	-	-		-
-	-	-		-
-	-	-		-
Criteria n	a_{n1}	a_{n2}	----	a_{nn}

This matrix indicates the priorities of the user as far as criteria have been concerned. For example a12 = 2 indicates that 1 is twice prior for the user than criteria 2. In comparison matrix

aij= 1 , for every i = j
And aij = 1/aji

After pair wise comparison, we need to determine weights of all the criteria. For determining weights, first normalize the pair wise matrix by dividing entries in the column by the sum of the elements in the corresponding column.

	Criteria 1	Criteria 2	----	Criteria n
Criteria 1	b_{11}	b_{12}	----	b_{1n}
Criteria 2	b_{21}	b_{22}	----	b_{2n}
-	-	-		-
-	-	-		-
-	-	-		-
-	-	-		-
Criteria n	b_{n1}	b_{n2}	----	b_{nn}

Where

$$b_{ij} = a_{ij} / \sum_{i=1}^{n} (a_{ij}) \quad , \quad \text{for } j=1,2....n$$

Using this normalized matrix calculate the weights of all the criteria using the relation

$$w_i = \frac{\sum_{j=1}^{n} (b_{ij})}{n} \quad , \quad \text{for } i=1,2....n$$

Then we find n different comparison matrices for alternatives (on the basis of each criterion), which gives information about the alternatives.

Criteria i	Alternative 1	Alternative 2	---	Alternative m
Alternative 1	c_{11}	c_{12}	----	c_{1n}
Alternative 2	c_{21}	c_{22}	----	c_{2n}
.	.	.		.
.	.	.		.
.	.	.		.
.	.	.		.
Alternative m	c_{n1}	c_{n2}	----	c_{nn}

Here, c_{ij}= 1 when i= j
and cij= $1/c_{ji}$

For example: c_{12} = 2 and I =1 indicates that alternative 1 is twice beneficial than alternative 2, as far as criteria 1 is concerned.

Next we normalize all these n matrices and calculate the weight corresponding to each matrix. Let S_1, S_2 ….. , S_n are the vectors (column vectors) carrying weights corresponding to criteria1, 2, 3…., n respectively.

$$S_j = \begin{bmatrix} V_{1j} \\ V_{2j} \\ V_{3j} \\ - \\ - \\ V_{mj} \end{bmatrix}$$

j=1,2…..n

Construct a matrix using these vectors S_1, S_2 ….. , S_n

	Criteria 1	Criteria 2	---	Criteria n
Alternative 1				
Alternative 2	S_1	S_2	.....	S_n
.				
.				
.				
.				
Alternative m				

Now obtain the final results using this matrix and the weights w_i (i = 1,2,3…. n)
Score of alternative i:

$$A[i] = \sum_{j=1}^{n} V_{ij} \times w_j$$

Whichever alternative has highest score, will be the most suitable choice to the user (according to his requirement).

3. Analysis of different Operating systems using AHP:

Now we are going to particularly discuss the technique.
Suppose the comparison matrix for the criteria is,

	Cost	Security
Cost	$a_{11} = 1$	$a_{12} = 0.5$
Security	$a_{21} = 2$	$a_{22} = 1$

Here a21 = 2 indicates that effectiveness is twice prior while prioritizing the condition monitoring technique, as compared to cost.
Now, as discussed earlier, normalized form of this comparison matrix will be,

	Cost	Security
Cost	0.333	0.333
Security	0.667	0.667

	average weights
w_1 =	0.333
w_2 =	0.667

Weights w_1 and w_2 are also calculated here, which are calculated as per the formula described earlier.
Now, let comparison matrices for three alternatives on the basis of each criterion are,

Cost	Windows	Linux	OS400
Windows	1	1	0.333
Linux	1	1	0.5
OS400	3	2	1

Comparison matrix for alternatives on the basis of cost

In this matrix, OS/400→ Windows has an entry 3, which indicates that OS/400 is three times costly than Windows.

Security	Windows	Linux	OS400
Windows	1	1	0.5
Linux	1	1	0.5
OS400	2	2	1

Comparison matrix for alternatives on the basis of security

In this matrix Windows→ OS/400 has an entry 0.5, which indicates that Windows is half secure as compared to OS/400.
Now, after normalizing these two matrices, we will get,

Cost	Windows	Linux	OS400
Windows	0.2	0.25	0.182
Linux	0.2	0.25	0.273
OS400	0.6	0.5	0.545

Normalized matrix for alternatives on the basis of cost

Security	Windows	Linux	OS400
Windows	0.25	0.25	0.25
Linux	0.25	0.25	0.25
OS400	0.5	0.5	0.5

Normalized matrix for alternatives on the basis of security

From these normalized matrices vectors S_1 and S_2 will be calculated

$$S_1 = \begin{bmatrix} 0.211 \\ 0.241 \\ 0.548 \end{bmatrix}, \quad S_2 = \begin{bmatrix} 0.25 \\ 0.25 \\ 0.5 \end{bmatrix}$$

Using S_1, S_2 and weights w_1, w_2, we will finally calculate final scores for the alternatives,

A [1] = (0.211 x 0.333) + (0.25 x 0.667)

A [1] = **0.237**
A [2] = (0.241 x 0.333) + (0.25 x 0.667)
A [2] = **0.247**
A [3] = (0.548 x 0.333) + (0.5 x 0.667)
A [3] = **0.515**

4. Conclusion:

So on the given information in pair wise comparison matrix for the criteria and the pair wise comparison matrix for the alternatives on the basis of these criteria; we'll apply the procedure of AHP. And finally we have got the final scores for all three alternatives,

Score of Windows Operating System: 0.237
Score of Linux Operating system: 0.247
Score of OS/400 Operating System: 0.515

Here, OS/400 has the highest score, which indicates that OS/400 is the most suitable Operating System for the user. Since the requirement of the user is security, not cost, therefore Os/400 is the most suitable Operating System for user.
Hence we can safely conclude that AHP can be used for the selection of Operating systems.

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