COMPARATIVE ANALYSIS OF CLOUD SERVICE SELECTION METHODS

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Abstract
Cloud computing has been encorporated in almost every fold of customer's world today. As more challenging becomes the world of a resource consumer, so does the plethora of numerous cloud vendors. Every vendor tries to sell off their services with different attractions. Some of them are free, some as pay-as-you-go services and some at rented structures. With so many choices available to a random user, making the right choice about the type of vendor is a cru-cial decision. We present in this paper novel meth-ods for cloud service selection. The methods de-rives from the traditional selection methods with emphasis on user criteria weights. Inherent com-parisons have been conducted amongst the various methods to help in analyzing and finalizing a bro-ker architecture for selection of the best service provider among the contending cloud vendors.
Keywords: cloud computing, cloud service selec-tion, cloud user weights, TOPSIS, VIKOR.

1. Introduction

Some of the best works done so far cover various Multi Criteria Decision Making methods like TOPSIS[[1]] , ELECTRE[[28]], VIKOR[[6]], PROMETHEE[[11]], AHP[[12]] etc. with new age additions to user preferences for fuzzy or trusted requirements[[24]]. Having come across various work done us-ing these methods, it is highly imperative to understand that all these are time tested and efficient in one scenario or other. However most of these methods are applied to inherent ready set of data on the whole. The dataset though complete with past values, seldom explores the individual performances of the cloud providers on an instance basis. In this paper we propose a method where we concentrate on the instance based outcomes of the service provider. To do this, we select the most accepted 2 methods TOPSIS and VIKOR for our service selection of Iaas Clouds. We shall then categorize the inputs in two directions. First by altering the way the functional requirements are taken and secondly the way how the user weights are assigned. All these shall be realized using a simulation tool Cloudsim[[13]] before concluding on the final result.

1.1. Multi Criteria Decision Making Model

When it comes to the cloud service selection problem, we deal with multiple vendors with multiple services and varied user preferences[[2]]. Hence they automatically fall into the MCDM category. As with any MCDM problem, we can have numer-ous approaches like MAUT methods, AHP, French Outranking methods and Russian ordinal methods[[14]]. Every method has its strong and weak areas. While some methods work well with small dataset, some are very effective with large datasets like that of a cloud service provider.[[25]] If we were to take a generic ex-ample of cloud services along with the user wanted criteria, then with the inclusion of user preference the problem of cloud ser-vice selection becomes very difficult[[21]]. Also another impor-tant factor is the consideration of these aspects both in real time and also past performance[[8]]. When a comparison is made be-tween clouds, it is highly preferred to have a trust factor built into the decision. This factor can be obtained by observing the performance of the said criteria over a period of time and not in an instant.[[16]]. For doing this, we have to micro calculate the best cloud services in parts i.e one instance of a time. This method keeps the selection more accurate in comparison to the selection from the average dataset values.

To summarize, despite many MCDM methods applied to cloud service selection, the ever changing nature of clouds and their quality of service criteria with time has not been encor-porated effectively.Hence the existing approaches are not com-pletely accurate in determining the best service provider.This pa-per considers the different aspects of time in past and present. While MCDM methods are the most suitable to sort out multi criteria problems, they themselves are inefficient in giving real time answers to user requirement. Experiments done to validate our method and outcome are an intelligent, resourceful and prac-tical way of getting the cloud selection from user point of view.

2. Proposed Model

2.1. Architecture

The architecture of this selection model is simple in terms of the components involved. To start with we have the comput-ing environment with different cloud Datacenters[[15]]. These can be considered as either cloud service providers or instances of CSPs. These are simulated as an IaaS with core computing qualities.They are responsible for publishing their services and respective paradigms. This service related information is stored in a database for further use.Next we have the user group who call in the cards by specifying which criteria of the service is of importance to them.This can be realized with either assigning weights with variance method or by fuzzy weights by asking the user his/her level of importance of each criterion in relation to other.In between these 2 categories we have the main decision maker the broker who is responsible for employing the decision making algorithm to get us the best service as the result.

Traditional methods involve simple concept of taking an ab-solute average of all criteria values and applying MCDM to it, however very accepted, this method is not free of flaws when dealing with a huge dataset of criteria values over a considerably long period. Any Cloud provider can vary with its services over a period of time. We may have a trusted cloud server to be per-forming poorly in the recent past or vice versa. In order to get the most unbiased measure of all the criteria, it is imperative to give more weightage to the recent past. Hence the algorithm is applied on every instance(daily) of the values received and then the overall result is computed. We can dig further and calculate the best provider on quarter hourly or hourly bass, however with the huge amount of data produced, and citing no major upheavals like the stock market, daily basis is sufficient enough.

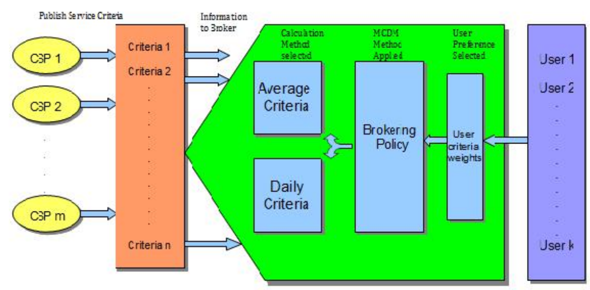

Fig. 1: Broker Policy Implementation

2.2. Methodology

Once the details of the CSPs are obtained, the users are asked to weigh in the criteria as per their need. Thereafter any of the MCDM algorithms mentioned below are applied to get the best service for daily set of values. For this experiment we have cho-sen 2 MCDM algorithms - TOPSIS and VIKOR. Both of them have proven their efficiency and worth in the area of multi crite-ria decision making.

TOPSIS takes in the alternatives and using their ideal dis-tance from the solution, both positive and negative, sorts them in increasing order of the final index. VIKOR is basically an outranking method, whereby it takes in the alternatives and cal-culates the utility and regret measures in order to rank the out-comes. Both work on the basic concept of normalized data as with cloud or any other multiple criteria problems, the alterna-tives may have varied metrics of measurement.Next the result is consolidated by days and best alternative is chosen. The pro-posed method is different from traditional methods in the sense that varying time is considered before making a final decision about the best cloud. A cloud provider is considered best for the user not by accounting the current values for its criteria. We have to consider the long standing performance of the particular cloud provider in order to come to an unbiased and informed decision. The user criteria weight is considered using the variance of the alternatives. For ease of simulation, currently number of users is restricted to 1.

Hence we propose calculating the cloud service ranking on a daily basis for a large number of days. After having considered the best service ranked daily, the results are brought together to yield the final result. The days are themselves assigned a weight factor in order to maintain fairness to old and recent values.We have used the exponential decay option to give weights to the days.

$$A(t) = A_0 e^{kt} \quad k > 0 \qquad (1)$$

Here A(t) is the weight of the day in relation to the current day on which selection is done.
A0 is the weight of day on which the selection is done k is the decay rate.
t is the time elapsed.

For better range of values we keep weight at a range from 0.1 to 1.anything outside this range is rounded off their closest bound-ary.Using this function and the best service selected per day , we can bring together a collective decision in order to select the best cloud service.Therefore overall ranking is archived by mul-tiplying the time decay weights to the daily top service provider matrix depicted as 1s and 0s, where 1 gives the output where a particular service is the winner for a particular day.

3. Results

For validation purpose, cloud providers were simulated using Cloudsim simulation tool. For ease of calculation the clouds were assigned only 3 parameters CPU, Bandwidth and Stor-age from which to base the decision. Using this tool a broker also was created which would be implementing the MCDM al-gorithm as a broker policy.Cloudsim randomly assigns values for the sad parameters without any interference.
The randomness keeps the data unbiased for testing. For evaluation purpose small period of data was collected(say 30 Days) for about 10 clouds simulated. As mentioned before the data was simulated with the clouds and the days as per require-ment.To start with we used the traditional method of taking av-erage of the criteria and taking this as the input. Next of user weights were given using the variance method. e next imple-mented the proposed method on the same set of data, however now instead of calculating accumulated average, daily best cloud was selected. To keep the relevance of the time period, the decay of time is calculated as per equation 1.
The daily results are then brought together to get the final result. The experiments done using the random values of the simulation environment is able to draw us many conclusions. Most important one being that while the user requirements keep changing so does the nature of service parameters in cloud. As depicted in the tables Table 1 with the corresponding Evaluation matrix in Table 2. After calculating best option through TOPSIS and VIKOR separately, we shown the outcome of our method in Table 5. The final comparison is shown in Table 6.

MCDM Algorithms

procedure TOPSIS

Identify the alternatives N

For x_{ij} D(m; n) of m n,obtain x_{ij} where

i = 1; 2; :; m,j = 1; 2; :n

x_{ij} D(m; n) compute N = N_{ij} = n N_{ij} ,

For every i = 1; 2'; :::; m,j = 1^{ij};2; :: P i=1

Calculate Variance of weights

V_j = (1=n) n i=1 (N ij (N)mean$)^2$ ij i = 1; 2; :::; m j = 1; 2; ::n

Obtain weights W_i P = V_i = m i=1 , V_i and m j=1 , w_i = 1,

i = 1; 2; :::; m j = 1; 2; ::n P, P

Compute Weighted normalized matrix W V_{ij} == W_j N_i

,i = 1; 2; :::; m,j = 1; 2; ::n

Determine best and worst ideal solutions as

A^+ = fa^+_1; :; a^+_mgi:e(maxW V_{ij})j(minW V_{ij})

A = fa_1 ; :; $a_m$gi:e(minW V_{ij})j(maxW V_{ij})

Obtain separation of each alternative from A^+ and A as below

D^+_i = m j=1 (a_{ij} $a^+_j)^2$

D_i = q P m j=1 (a_{ij} $a_j)^2$

Obtain similarity Index C_i^q = D =(D + D) i P i i i Choose best alternatives in increasing order of C_i

procedure VIKOR

Identify the alternatives N

for every x_{ij} D(m; n) with degree m n

,i = 1; 2; :::; m,j = 1; 2; ::n, obtain x_{ij} i = 1; 2; :::; m,j = 1; 2; :: P i=1

for every x_{ij} D(m; n) compute N_{ij} = N_{ij} = n N_{ij} ,

Calculate Variance for weights

V_j = (1=n) n i=1 (N ij (N)mean$)^2$ ij i = 1; 2; :::; m j = 1; 2; ::n

Obtain P weights W_i i = 1; 2; :::; = V_i = m i=1 , V_i and P m j=1 , w_j = 1,

m j = 1; 2; ::n

Compute Weighted normalized matrix W V_{ij} == W_j N_i

,i = 1; 2; :::; m,j = 1; 2; ::n

Obtain Maximum Criterion Weight and Minimum Criteria Weight as below:

F_{ij}^+ = max(N_{ij})

F_{ij} = min(N_{ij})

Compute Utility Measure

U_i = Pm i=1 W_j (F_j^+ F_{ij})=(F_j^+ F_j)

Regret Measure

R_i = max[W_j (F_j^+ F_{ij})=(F_j^+ F_j)]

Calculate the Vikor Index as

V I_i = v((U_i U)=(U^+ U))+(1 v)((R_i R)=(R^+ R)) Choose best ranking alternative in increasing order of V I_i

Table 1: Table with the Average Criteria Values

Cloud	RAM	Bandwidth	Storage
Cloud1	1433	18000	360000
Cloud2	1638	22000	160000
Cloud3	1843	22000	240000
Cloud4	1433	18000	360000
Cloud5	1843	21000	480000
Cloud6	1433	20000	320000
Cloud7	1024	12000	300000
Cloud8	1433	23000	360000
Cloud9	1740	18000	340000
Cloud10	1331	28000	360000

Table 2: Evaluation Matrix

Cloud	RAM	Bandwidth	Storage
Cloud1	0.059	0.083	0.168
Cloud2	0.068	0.101	0.075
Cloud3	0.076	0.101	0.112
Cloud4	0.059	0.083	0.168
Cloud5	0.076	0.097	0.224
Cloud6	0.059	0.092	0.15
Cloud7	0.042	0.055	0.14
Cloud8	0.059	0.106	0.168
Cloud9	0.072	0.083	0.159
Cloud10	0.055	0.129	0.168

Table 3: Table with the Similarity Index using TOPSIS

Cloud	Similarity Index
Cloud1	0.446
Cloud2	0.449
Cloud3	0.530
Cloud4	0.446
Cloud5	0.433
Cloud6	0.473
Cloud7	0.432
Cloud8	0.485
Cloud9	0.431
Cloud10	0.535

Table 4: Table with the Vikor Index using VIKOR

Cloud	Vikor Index
Cloud1	0.341
Cloud2	0.909
Cloud3	0.605
Cloud4	0.341
Cloud5	0.0
Cloud6	0.445
Cloud7	0.729
Cloud8	0.269
Cloud9	0.35
Cloud10	0.216

Table 5: Table with the proposed Daily Method

Days	TOPSIS	VIKOR
1	cloud6	cloud9
2	cloud5	cloud6
3	cloud2	cloud2
4	cloud9	cloud6
5	cloud8	cloud2
6	cloud2	cloud2
7	cloud1	cloud7
8	cloud2	cloud8
9	cloud6	cloud2
10	cloud2	cloud6
11	cloud1	cloud8
12	cloud9	cloud2
13	cloud2	cloud8
14	cloud5	cloud6
15	cloud2	cloud2
16	cloud5	cloud10
17	cloud2	cloud2
18	cloud9	cloud2
19	cloud7	cloud5
20	cloud3	cloud6
21	cloud2	cloud2
22	cloud8	cloud2
23	cloud2	cloud1
24	cloud7	cloud8
25	cloud1	cloud2
26	cloud10	cloud7
27	cloud2	cloud2
28	cloud9	cloud9
29	cloud2	cloud2
30	cloud2	cloud2

Table 6: Result Comparison

Average Method		Daily Method	
TOSIS	VIKOR	TOPSIS	VIKOR
cloud10	cloud2	cloud2	cloud2

4. Conclusion

In conclusion, we assert that the method proposed by us is effi-cient and practical in terms of real time and changing cloud envi-ronments.This method keeps into account the instance based cal-culation of metrics and hence gives a more focussed result than the assumptions based on entire average of metrics in whole. As we have shown the results for a small group of data, this method can be tested against a fairly large dataset without issues. En-hancement of this method could be to include fuzzy weights and future predictions of criteria change. Also some important pa-rameters like the cost, vendor lock in, data disruption etc. have not been considered, which can be included in this model.

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