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Ranking Models for Selection of Cloud Services Based On the Fuzzy Logic

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Abstract: *The third Millennium generation has been geared to operate on large recourses with verity of choices of services to satisfy the user's requirement. Hence in the recent past, there is wide increase in the demand of cloud services due to its advantages of reduction in infrastructural cost, service availability, Performance, scalability and quality of service(QoS). From the available cloud services, there is a great need of the hour to choose the service provider through the Cloud Broker architecture. The Cloud services Ranking model comes as an aid for an effeccent selection of the cloud prover for the requested user. We use the service ranking as a process of selection based on the Fuzzy Logic. The different Fuzzy ranking methods are discussed and Ranking model is proposed based on the Random variable selection in ranking with the extended parameters like quality of service, cost reduction, performance and response time by the cloud services providers. In the proposed approach, FCA shortlisted the related CSPs for the user tasks automatically and choose the optimal provider using the concept of ranking mechanism. Service Level Agreement (SLA) is an agreement that illustrates the level of performance assured by the provider to the user. The effective solutions is arrived at by accomplishment of Quality of Service (QoS) based provider selection from the pool of CSPs.*

Keywords: *Fuzzy Set, Ranking Model, Quality of Service(QoS), Service Level Agreement(SLA), Cloud Service Provider (CSP)*

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I. Introduction

A cloud is large group of interconnected computers that extends beyond a single company or enterprise. Cloud computing is a upcoming model of convenient, on-demand communication and symbol of collaborative internet, representing complex infrastructure, including configurable computing resources such as software, hardware, infrastructure, application and storage as a Service from different pool of resources. Cloud computing helps the customers to expand their services from local computing power onto relatively infinite processing power of the internet. In a global economic scenario, businesses are gradually looking for more innovative ways to cut technical costs while maximizing their business and service value. In the IT market, growing acceptance of the pioneering technologies make cloud computing as the biggest buzzword for the customers to use what they require, and pay for what they actually use.

Clouds are a concept for uncertainty mediating between the concept of a fuzzy set and that of a probability distribution. A cloud is to a random variable more or less what an interval is to a number. We discuss the basic theoretical and numerical properties of clouds, and relate them to histograms, cumulative distribution functions, and likelihood ratios. We show how to compute nonlinear transformations of clouds, using global optimization and constraint satisfaction techniques. We also show how to compute rigorous enclosures for the expectation of arbitrary functions of random variables, and for probabilities of arbitrary statements involving random variables, even for problems involving more than a few variables[1].

II. Fuzzy Set

The man who introduced the Fuzziness in Mathematics is L.A. Zadesh in 1965. A fuzzy set μin a given set X is associated with an assignment of a degree of membership μ to each element of X where degree if membership means some real number on the closed interval[0,1].The larger the membership the stronger the sense of "belongingness" to X.

A Fuzzy set in X is a map from X to [0,1], it is an element of $[0,1]^x$, it is an element of $[0,1]^x$. Let F(X) = $[0,1]^x$ be the set of all fuzzy sets in X. If $\mu \in F(X)$, then the subset in X in which μ assumes non zero values is known as the support of μ. For every $x \in X$, μ(x) is known as the degree of membership of x in μ. If μonly takes 0 and 1 then μ is called the crisp set. If any subset A of a set X can be identified with its characteristic function if Ψ_A: X →{0,1} defined by $\Psi_A(X)$ = { 1 if X ϵ A and 0 if X ∉ A} and such characteristic functions are fuzzy sets in X [2].

III. Fuzzy Ranking Methods

In many fuzzy decision problem, the first scores of alternative are represented in terms of Fuzzy numbers. In order to express a crisp preference of alternative, we need a method for constructing a crisp total ordering from fuzzy numbers. The Lattice of fuzzy numbers(R, MIN, MAX) is not linearly ordered. Then they are not directly comparable.

3.1 Methods of Ranking

There are many methods of ranking in fuzzy set. Analyzing from many available methods we take for consideration only the following three principle methods.

1. Hamming distance

Defining the a hamming distance on the set R of all fuzzy numbers for a given fuzzy number A and B, the Hamming distance, d(A,B) is defined and the formula d(A,B)= ∫|A(X) – B(X)|dx ---(1)
For a given fuzzy number A & B when we want to compare and determine the upper bond on $MAX(A,B)^R$ in the Lattice. Then calculate the Hamming distance d(MAX(A,B)A) and d(MAX(A,B)B) and define A≤ B if d(MAX(A,B)B) --- (2)
If A≤B, then the MAX(A,B)=B i.e ordering by the Hamming distance is compatible with the ordering of comparable fuzzy number in R[3].

2. Method based on α-cuts

A α-cuts method proceeds as follows. Given fuzzy numbers A and B to be compared we select a particular value of αϵ[0,1]and determine the α-cuts $^{\alpha}A=[a_1,a_2]$ and $^{\alpha}B[b_1, b_2]$ then we define A≤B if $a_2 \leq b_2$ then if defines the degrees expressing the dominace of one fuzzy number over the other one for all α-cuts [4].

3. Method based on Extension Principle

This method is based on the extension principle which employs for ordering several fuzzy numbers, say A_1 , A_2 , $A_3 \ldots A_n$, constructing a fuzzy set P on { A_1 , A_2 , $A_3 \ldots A_n$} called a priority set, such as P(C is the degree to which A_i is raned on the greatest fuzzy number. Thus P is defined for each $i \epsilon N_n$ by $\rightarrow P(A_i)$=Sup Min/$i\epsilon N_n$ $AK(r_k)$ where supernum for all vetors {r_1, r_2, $r_3 \ldots r_n$}ϵ N_n.
Thus we can construct a priority fuzzy set P on {A,B} as
P(A) =SupMin{$A(r_1)$, $B(r_2)$] =0.75 where $r_1 \geq r_2$ ---(1)

P(B) =SupMin{$A(r_1)$, $B(r_2)$] = 1 where $r_2 \geq r_1$ ---(1) [5].

IV. Broker Learning Algorithm

Federated cloud provider selection algorithm uses the quality metrics according to the Service Measurement Index (SMI) , short list the matched providers depends on the SLA and functional requirements. Let CP= {CP1, $CP_2 \ldots CP_n$} are the list of cloud providers in the Federated Cloud (FC). Let CB= {CB_1, $CB_2 \ldots CB_n$} are the cloud brokers that connected CP to the Cloud Manager (CM) in the proposed federated cloud architecture. Cloud broker considered the list of QoS indicators Q_i = {Q1, Q2, Q3….Q_N} for the service requests submitted by the user, broker initiated the processing and short listed the providers based on the value for the quality indicators assured. Then apply ranking on the short listed providers using Fuzzy based logic sets approach. In order to normalize the value of QoS indicators, the following are considered such as QoS metrics are measured uniform, qualities of the providers are analyzed using uniform index and assign threshold for the quality indicators based on the priority of it. The matching of provider is identified by the representation of the given set

MP = {QI, FA, RCP, CCP}

MP denotes the Matching provider for the service. QI is the list of Quality Indicator recognized by the SMI. FA discuss the functional requirements.RCP refers the resource demand by the service and released by the provider. Cloud providers are clustered based on the service referred as CCP.[6] The functionality of provider discovery is shown in Figure 1.

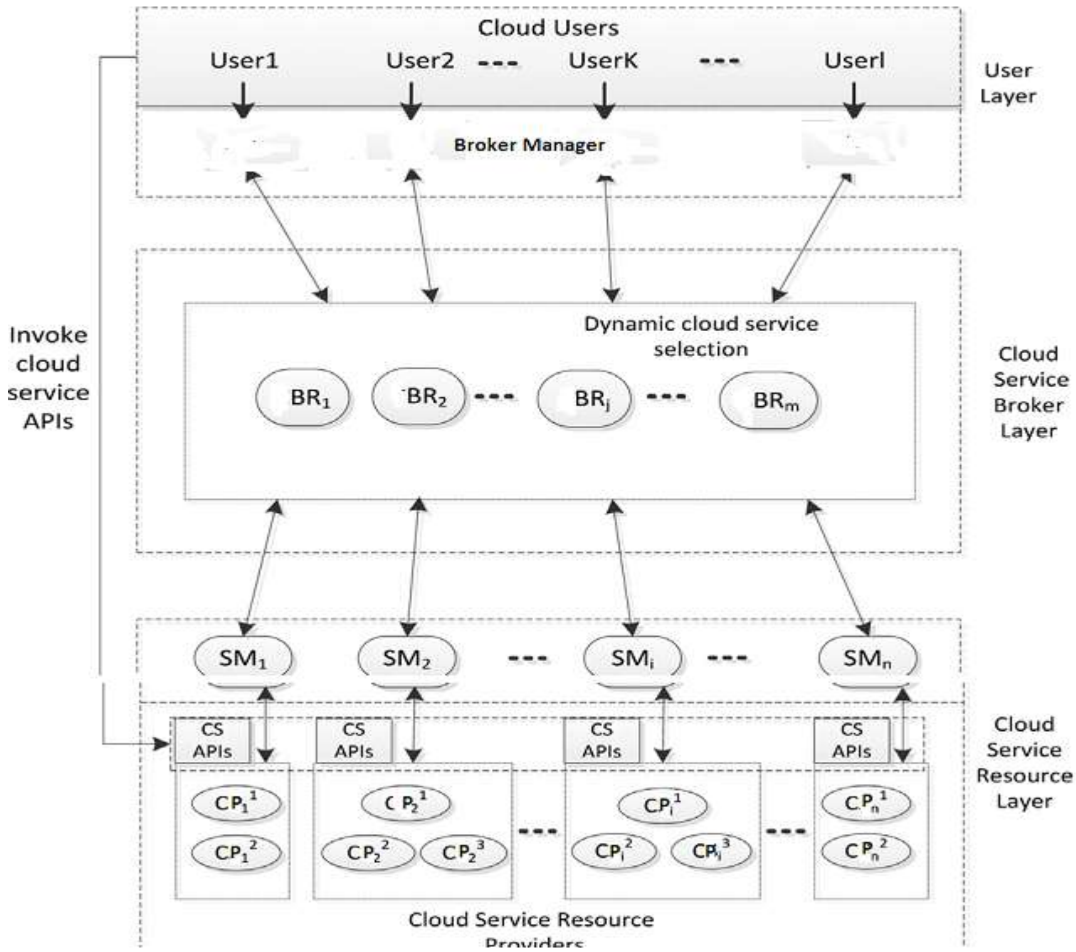


Figure: 1 Discovery of Service Provider in Federated Architecture

Broker registry in broker manages information about the provider and helps to select the matching provider based on the equation MP = { Q1, FA, RCP, CCP}. The Algorithm steps are as follows.

1. Broker manager shortlisted the cloud providers and rank it using Fuzzy Logic set
2. Resource layer comprises of cloud providers, mapping with broker using service mapping (SM). SM can help the respective broker register the status of its connected provider in its registry including the failures of some services.
3. Each provider defines API(Application Programming Interface) as Means invoked by broker and used after finishing the process of cloud service selection.
4. Cloud providers are clustered based on the level of service group, the number of available and matched providers are shortlisted for ranking using fuzzy logic set [7].

V. Ranking Based On Fuzzy Logic Set

To propose ranking mechanism based on fuzzy set approach having three general phases such as problem decomposition, judgment of priorities and aggregation of these priorities. Fuzzy set may be combined by some simple rules. To rank the service providers, the service functionality attributes are classified into three. Categories such as class A, Class B, and class C. Class A refers high level attributes. Accountability, assurance, security, and privacy. Class B Refers next level attributes such as usability, reliability and interoperability. Class C denotes low level attributes such as user interest, stability, cost, throughput and efficiency. Broker is responsible for interaction with users and understanding their Request needs Ranking system considered two aspects such as (i) the service quality ranking based on fuzzy set and (ii) the final ranking based on the cost quality ranking. Cloud provider selection model is based on three steps evaluation [8].

Step-1 is to identify the suitability of each service provider for the service render by the user. Suitability evaluation carried out by considering to reducing the effect of any particular measure in class A.
Step -2 Confirms that provider can extend service providers. Cloud providers are selected based on the overall and individual cut off threshold values of the attributes considered for evaluation.

5.1. Fuzzy Random Theory based ranking of providers

The principle of fuzzy sets and fuzzy functions found useful in applications such as pattern recognition, clustering, information retrieval, and systems analysis. The notion of fuzzy random variables was introduced as a natural generalization of random set in order to represent associations between the outcomes of random experiment and non-statistical in exact data. Kwakernakk [] introduce the concept of a fuzzy random variable as a function $F:\Omega \rightarrow F(R)$ where (Ω, A, P) is a probability space and $F(R)$ denotes all piecewise continuous functions $U:R \rightarrow [0, 1]$. A notion of a fuzzy random variable [14] slightly different than that of Kwakernakk that it as a measurable fuzzy set valued function $x:\Omega \rightarrow F0(R)$, where R is the real line, (Ω, A, P) is a probability space, $0(R) = \{A:R \rightarrow [0, 1]\}$ and $\{x \epsilon R; A(x) \geq \alpha\}$ is a bounded closed interval for each $\alpha \epsilon (0, 1)$. Let U be a nonempty usual set, P(U) denote the set of all subsets in U and F(U) denote the set of all fuzzy subsets in U. For $A \epsilon F(U)$ we define two subsets of U as follows:

$A\alpha = \{x \epsilon U; A(x) \geq \alpha\}$ for any $\alpha \epsilon [0, 1]$, -----------------------------------(3.1)

$A\alpha = \{x \epsilon U; A(x) > \alpha\}$ for any $\alpha \epsilon [0, 1]$, ________________-------_______(3.2)

Where A(x) is the membership functions of A. These are known as α-cuts of the fuzzy set A. Without loss of generality in the sequal $X\alpha$, $F\alpha$, $G\alpha$, $F\alpha$, $G\alpha$, denote the respective α-cut functions [9].

$A\alpha = [A-\alpha, A+\alpha]$ Where $A\alpha$, = inf $A\alpha$, $A+\alpha$ = sup $A\alpha$ The suggested ranking model consists of three phases namely (i) Discover service providers (ii) Rank the selected service provider (iii) Choosing the best service provider. This ranking model has been working on the concept of fuzzy random variable.

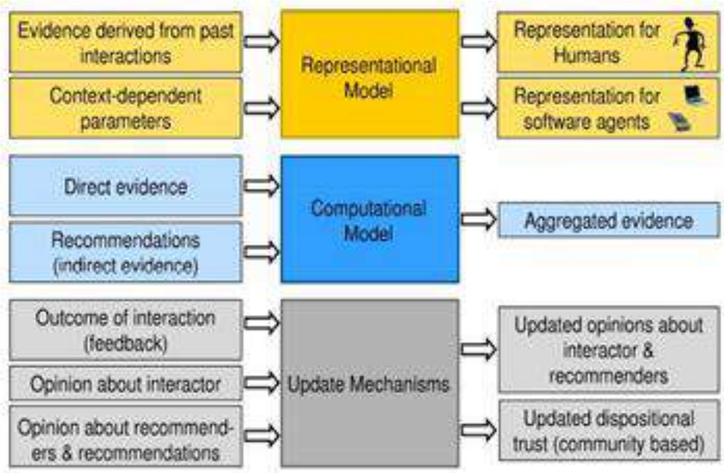


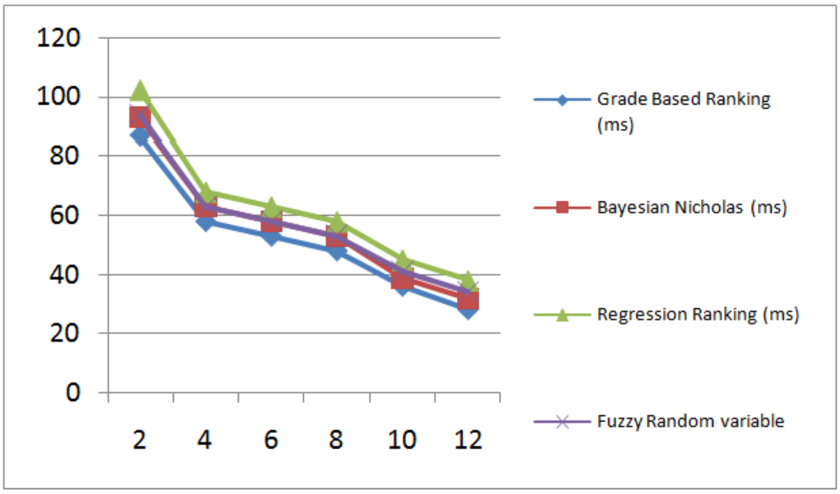
Figure 2: Block Diagram for Trust on the service provider

The Figure2 explains the certain Trust model which was constructed for modeling those probabilities, which are subjected to uncertainty. This model was designed with a goal of evidence based trust Model. It has a graphical, intuitively interpretable interface. It focuses on a) how the trust can be derived from the parameter evidences? B) how trust can be represented through software design? A relationship between trust and evidence is drawn on Bayesian approach. It is arrived from the means of deriving a subjective probability from collected evidence and prior information [10].

VI. Simulation Results And Discussions

Simulation experiments were implemented on the JADE 4.3.0 platform [] and on a computer whose configuration was an Intel Core i5-3337UCPU 1.80 GHz, 4.0GB RAM, Windows 7 (64 bits) operating system, Service Pack 1.Average response time and throughput was computed and the performance was also analyzed. The parameters considered for the simulation are number of users, number of cloud service providers, deadline of tasks etc. The execution time for each task is assigned randomly between 0.1ms to 0.5ms. Number of users considered are 1000, 5000 and 10000 at a time. Number of service providers available is fixed as 100, and deadline for each request is fixed as 0.5ms. Every cloud service provider has 50 computing hosts and a time-shared VM scheduler. Cloud broker on behalf of user request consist of 256MB of memory, 1GB of storage, 1 CPU, and time-shared Cloudlet scheduler. The broker requests instantiation of 25 VMs and associates one Cloudlet to each VM to be executed. There are two experiments were conducted and performance is analyzed with existing approaches. The experimental results prove that the proposed ranking model performs better in terms of average response time compared to the without ranking model in the Federated architecture. Simulation results are shown in Table 1: Average response time of selection based with and without ranking model.

Number of users	Selection based on Ranking Model (ms)	Selection Without Ranking Model (ms)
1000	1.80	2 .08
5000	1 .93	2.24
10000	4.56	7.92



Graph1 – Average Response time compare to other Ranking Models

The Graph -1 shows the average response time of selection based on fuzzy random variables. The result shows that the assigned cloud provider satisfies the requirements in terms of trust, security and performance. The overhead of the ranking mechanism depends on its implementation. The attributes in levels are assigned with constant and the execution time for performing ranking mechanism for 100 providers is 50ms.

VII. Conclusion And Future Work

Cloud computing has become an important technology for outsourcing various resource needs of organizations. Proposed broker based federated cloud mechanism helps to resolve the difficulties of selecting the optimal cloud provider for the service based on fuzzy random theory. The various mechanisms such as fault tolerant and risk based access control are proposed to ensure the believability of the federated cloud environment and characterizing the importance of each SMI attributes suggested by the cloud consortium. Fuzzy random theory based ranking model was simulated; the performance was compared with out ranking model and found that the proposed idea provides improved status to broker based federated cloud architecture. Future research will focus on mathematically formal frameworks for reasoning about trust, including modeling, languages, and algorithms for computing trust.

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