UF-Framework: A User Favourable Framework for Cloud Service Ranking

Saroj S, Dileep V K

Abstract— Cloud computing is an umbrella term used to refer the internet based application development and their services. There are many cloud service providers; they share their resources and services over the internet. These services are available to the cloud users on a subscription basis. Due to the vast availability of cloud service providers and their services, it is important to rank the services. Therefore the ranked list of services help the user to choose the most appropriate service that satisfying the user's requirement. To choose appropriately between different Cloud services, users need to have a way to identify and measure key performance criteria that are important to their applications. Many methods including traditional methods and multi-criteria decision making methods are there to evaluate the cloud services and ranking them. But currently there is no such framework that can allow the cloud users to evaluate the cloud services and rank them based on their ability to meet the QoS requirements of the user. The proposed framework and mechanism that measure the quality and prioritize Cloud services. Such a framework can make a significant impact and healthy competition among Cloud providers to satisfy their Service Level Agreement (SLA) and improve their QoS. In this method the ranking of services are done by using AHP (Analytical Hierarchical Process) method. The applicability of the ranking framework is shown by using a case study: SaaS (Software-as-a-Service) provisioning framework.

Index Terms— Computing, Service Ranking, Analytical Hierarchical Processing (AHP), Cloud Service Broker (CSB), Service Level Agreement (SLA)

1 INTRODUCTION

The term Cloud Computing refer to the internet based application development and their services. Cloud is a shareable concept and the resources in cloud delivered to the users are similar to the traditional utilities such as electricity, water, etc [1], is referred to as *Utility Computing*. Therefore users only need to pay for what they want to use. It serves everything as a service in cloud computing. The Cloud Service model includes three main services. Firstly, *Software as a Service (SaaS)* provides complete access to the software applications. Secondly, *Platform as a Service (PaaS)* provides the platform for developing other applications i.e., a run time environment for other applications. Finally, *Infrastructure as a service (IaaS)* provides on-demand storage and scalable computing resources to the end users. In which it provide complete access to the fundamental resources such as virtual machines, virtual storage etc. The platform provides the users, *on demand services,* that always on, anywhere, anytime and anyplace. It allows creating, configuring, and customizing the applications online.

There are hundreds of cloud service providers they share their resources and services over the cloud. Available services can be used by the cloud users on a subscription basis. Due to the vast availability of the cloud service providers and their services, it is important to rank them to choose the most appropriate service for the user. But currently there is no such framework to rank the available cloud services. In this paper, we proposed a framework for ranking the cloud services, mainly for SaaS provisioning. The UF-Framework (User Favorable Framework) for Cloud Service Ranking helps the user to choose the most appropriate service that satisfying his requirements.

1.1 Motivation

There are hundreds of cloud service providers they share their resources and services over the cloud. Available services can be used by the cloud users on a subscription basis. Due to the vast availability of the cloud service providers and their services, it is important to rank them to choose the most appropriate service for the user. But currently there is no such framework to rank the available cloud services. In this paper, we proposed a framework for ranking the cloud services, mainly for SaaS provisioning. The UF-Framework (User Favorable Framework) for Cloud Service Ranking helps the user to choose the

2 RELATED WORK

Initial There are only few works based on this area. But there are many methods and techniques related to it. They are discussed in this section. The Cloud Service ranking is based on different attributes such as QoS attributes, performance attributes etc. The selection of service can be done based on different attributes. It can be a Single valued attribute, double valued attributes also it can be multi valued attributes. In early times we have used only single valued attributes for the service selection. Hoi Chan and Trieu Chieu proposed a frame

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work for Ranking and Mapping the Applications to Cloud Computing Services by SVD [2].

By taking advantage of the past usage experiences of other users, it is possible to identifies and aggregates the preferences between pair of components to produce a ranking of components. Based on this concept a QoS-driven collaborative quality ranking [3] framework for cloud components called CloudRank is proposed by Zibin Zheng, Yilei Zhang and Michel R. Lyu, it requires additional invocations of the cloud components.

Challenges Sun Le, Hai Dong, Farookh Khadeer Hussain, Omar Khadeer Hussain, Jiangang Ma and Yanchun Zhang proposed a hybrid fuzzy framework for Cloud service selection [6], addressing the challenge using three approaches: a fuzzy-ontology-based approach for function matching and service filtering, a fuzzy AHP (Analytic Network Process) technique for informed criterion weighting and a fuzzy TOPSIS (Technique for Order of Preference by Similarity to Ideal Solution) approach for service ranking. This explore problems in Cloud service selection, summarizing the unique requirements of Cloud service selection problems, identifying the deficiencies of the present Cloud service selection techniques, and proposing possible solutions. The SLA assured brokering framework [7] which matches the requirements of the customer with SLA offered by CSPs using similarity matching algorithm and willingness to pay capacity for the services. It also measures the services offered by CSPs for certifying and ranking the CSPs.

K.Saravanan and M Lakshmi Kantham have proposed a novel framework for ranking and advanced reservation of cloud services [10], which are based on a set of cloud computing specific performance and a Quality of Service (QoS) attributes, provides an automatic best fit and a guaranteed delivery. In this method it considers only some specific performance and a Quality of Service (QoS) attributes for evaluation.Linlin Wu, Saurabh Kumar Garg and Rajkumar Buyya have proposed SLA-based admission control for a Software-as-a-Service provider in Cloud computing environments [12]. Software as a Service (SaaS) provides the users to access the applications over the Internet. SaaS providers utilise resources of internal data centres or rent resources from a public Infrastructure as a Service (IaaS) provider.

W_SR approach for cloud services, which requires quality features and for service ranking receive three inputs, which selects services that satisfy user's requirement. W_SR (Weight Service Rank) is an approach for cloud service ranking that uses from QoS features [13]. Two personalized QoS ranking prediction approaches have proposed in [18] by Shraddha B.Toney and N.D.Kale. Application of Cloud Rank Framework to Achieve the Better Quality of Service (QoS) Ranking Prediction of Web Services [15]: This framework requires no supplementary invocations of cloud services when making QoS ranking prediction. The personalized QoS ranking prediction approaches are; *Cloud rank 1 (CR1) and Cloud rank 2 (CR2).* These two ranking methods are used to identify and aggregate the preferences between pairs of services to produce a ranking of services.

3 PROPOSED METHOD

There are many cloud service providers; they share their resources and services over the internet to their customers. Cloud service providers come with different levels of services and performance characteristics. The user applications provided by the cloud service providers having specific requirements, (e.g. availability, security and computational power etc.). Many methods including traditional methods and multi-criteria decision making methods are there to evaluate the cloud services and ranking them. Traditional methods are focused only on single value criteria or pair wise value comparisons etc. It does not consider multiple attributes for the service selection. Therefore the selected services need not be the best one, which satisfying entire requirements of the client. Multi-value decomposition methods are there to evaluate the available services. It includes outranking method, AHP, SMI, PROMETHEE, ELECTRE etc. All these methods are used for different applications. Ranking of Cloud services is one of the most important features of this framework. The UF-CSR framework provides a holistic view of QoS needed by the customers for selecting a Cloud service provider based some QoS attributes. Another important method that can be used for the service selection is that Analytic Hierarchy Process (AHP). In AHP, this multi-criteria decision making approach that simplifies the complex, non-structural problems by arranging the decision factors in a hierarchical structure. The pair wise comparisons of decision criteria make more suitable for making the selections. AHP decomposes a decision problem into its constituent parts and builds hierarchies of criteria similar to KPIs in this framework. AHP also helps to capture both subjective and objective evaluation measures. Thus to develop a framework for ranking the cloud services, AHP is the best choice for ranking the services.

3.1 Framework for SaaS Provisioning

As shown in Figure. 1, a user can query for his requirements and obtain ranked list of services from the UF-framework by providing observed QoS values of some cloud services. More accurate ranking prediction results can be achieved by using AHP Algorithm in this framework. UF-Framework, have three modules. The first module is the service provider module. This part is responsible for service registration, service description etc. Second is User module, Service discovery is the main functionality of the user part. The third module is ranking and filtering of services. Web-based user interface provide a way to query and retrieve the services by users and also the service registration by the service providers. This section will describe the proposed architecture for SaaS provisioning and give the details on how it's realized. And also we provide illustrations of overall system design and include any worth mentioning details.

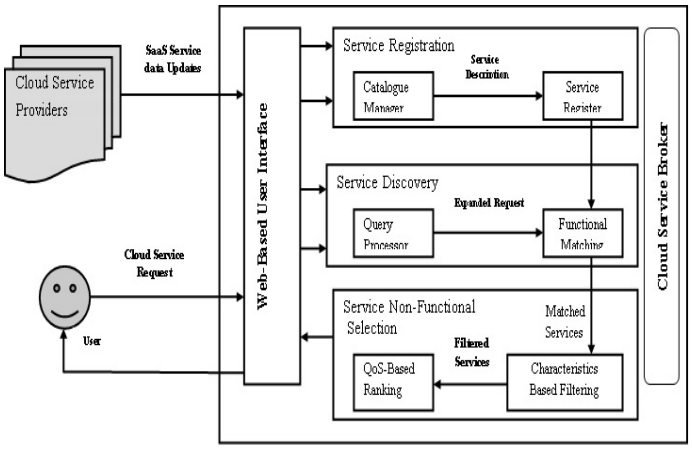

Figure 1: A Framework for SaaS provisioning

CSB (Cloud Service Broker): The Cloud Service Broker (CSB) is a mediator service that decouples service users from SaaS providers. It receives the user's request for an application. It collects all their requirements and performs the discovery and ranking of suitable services. The cloud broker helps to calculate the various QoS Metrics which are used by ranking system for prioritizing the Cloud services. The framework is implemented over the cloud broker.

Service Registration Sub-system: Service Registration module is doing the registration of SaaS providers that are willing to provide some types of service. This sub-system is composed of two modules: the catalogue manager and the service register modules.

Catalogue Manager Module: Cloud service providers register their services through a user-friendly web-based interface based on predefined parameters: service provider name, service name, description, URL, application domain, price/month, and characteristics. The catalogue manager is responsible for the pre-processing stage of the service description. Firstly, it applies tokenization to break the service description into tokens. Secondly, it applies stop words removal to eliminate the common words irrelevant to the service operation. Thirdly, it applies stemming to obtain the root form of service description tokens. Pre-processing aims at the unification of the service descriptions before the matching process. The catalogue manager is also responsible for accepting updates of the registered services.

Service Register Module: This module is responsible for grouping the service offers based on their similar functionalities in order to expedite the retrieval of the most relevant SaaS services. It starts with each service in a separate group and recursively merges two or more of the most similar clusters. A service matchmaking algorithm is introduced to measure the similarity between two groups of services. If the resulted similarity is above a threshold value, then they belong to the same group.

Service Discovery Sub-system: This sub-system is composed of two modules. *Query Processor and Functional Matching Modules.* Query Processor Module and Functional Matching Module. In Query Processor Module the user enters his/her keyword-based query using a web-based interface. Similar to the service description, the query processor pre-processes the user query. Finally, in order to improve the recall of the proposed system, the request is expanded using its token synonyms. The expanded user request is then passed to the functional matching module. The functional matching module is responsible for matching the expanded user query against the group services in order to find the group that best matches the user requirements. Services that belong to the group with the maximum similarity are retrieved to be processed by the selection sub-system.

Service Non-Functional Selection Sub-system: Several cloud taxonomies describe the common cloud service characteristics. Existing research work focus on QoS-based selection only and neglects the other cloud service characteristics. To extend the existing work, both characteristics and QoS metrics of SaaS cloud services are employed in the selection phase. This sub-system is composed of two modules: characteristics-based filtering and QoS-based ranking modules.

Characteristics-based Filtering Module: The discovered services are filtered according to the characteristics that the user is interested in. The user specifies his required service characteristic values from a predefined set extracted. Consequently, the user enters his priority weights for the selected characteristics such that the weights sum up to 1. The characteristics based filtering involves comparing the user required values R to the service characteristic values matrix V to filter the discovered services. In this module, the Analytical Hierarchy Process (AHP) [18] is used to assign weights to QoS attributes considering the interdependence between them, thus providing a quantitative basis for the ranking of discovered services with matching characteristics.

The steps in SaaS provisioning is shown below;

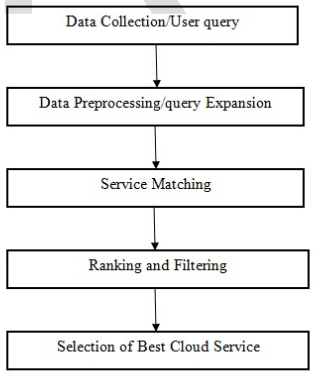

Figure 2: Steps in SaaS provisioning

4 ALGORITHMS FOR SAAS PROVISIONING

4.1 Analytical hierarchy process (AHP)

Selecting the best service for satisfying the user's requirement is one of the main and important processes. SaaS selection can be considered as quite error prone. The user's problem is decomposed into many clusters, and then the attributes are used for pair wise comparison. Then decision problems can be solved with reduced cognitive load in an easy way. For this purpose AHP (Analytic Hierarchical Process) used, which is developed by Saaty. AHP is a most powerful

and effective technique to simplify the multiple criteria problems into hierarchy [1]. In AHP, the process of decomposition of the decision problem is starts with hierarchy development. The hierarchy is allows focusing judgment separately on each of the several properties, which is essential for making a decision. AHP has a 9 point scale for pair wise comparison that helps the decision making process. Each element is compared with every other element to decide the importance of one element over the other on a 9 point scale. User assigned weights using AHP's standard method [18].

- Equal importance/quality 1
- Somewhat more important/better 3
- Definitely more important/better 5
- Much more important/better 7
- Extremely more important/better 9

4.2 SaaS Selection methodology

The methodology adopted starts with the literature study to understand the parameters satisfying the application requirements. These parameters are discussed with the experts in the next phase and, hierarchy is developed. The survey instruments of AHP are developed from this hierarchy. Two types of AHP survey instruments are developed for pair wise comparison. One is for comparison of parameters and the other for products comparison. The pair of comparison is judged on 1-9 scale. The survey respondents are only experts hence; number of responses required is limited. Five experts are selected for each survey [26]. The mandatory requirement for expert is to have experience in using the SFA products and should evaluate the product before responding the survey. Three-part methodology is adopted for the SaaS product selection. The first part covers the prioritization of parameters while second part is about product comparison. The third part combines the results obtained from first two parts to rank the products [28].

4.3 Algorithm Implementation

The algorithm considers only non-functional (mainly QoS) issues in the selection process. The CSB's QoS based Ranking Module evaluates an aggregate utility function and determines whether the offer of a SaaS provider is acceptable or not. To rank SaaS cloud services based on multiple QoS metrics, we proposing a ranking mechanism based on Analytic Hierarchy Process (AHP) [21]. There are three phases in this process: problem decomposition, judgment of priorities, and aggregation of these priorities. There are three modules also. They are Service registration, Service discovery, and Service ranking and filtering.

4.4 QoS Attributes for Service Selection

The selected QoS attributes for the SaaS service provisioning and Service selection [21] [26] are listed below;

- ***Performance:*** consists of response time (how long does it take to process a request), throughput (how many requests overall can be processed per unit of time), or timeliness (ability to meet deadlines, i.e., to process a request in a deterministic and acceptable amount of time).

Service provider

For new account Register
If already have account Login()

- ✓ *Ia=input list of data from service provider*
- ✓ *Id=input list of dimensions (Specific attributes such as performance, availability, Assurance etc.)*
- ✓ *Ib=output list of tuples*
- ✓ *a and b tuples*
- ***Function*** *ServiceRegistration*
- ***Foreach*** *a in Ia* ***Do***
  - ***Read*** *corresponding Id*
  - ***Set*** *QoS parameters Id, Ia*
  - *result=(Ia,Ib)*
  - ***Result#*** *Is*
  - *Register service*
- ***End Foreach***

Figure 3: Algorithm for Service registration

User:

For new account Register
If already have account Login()

- ✓ *Iq=input query*
- ✓ *Id=input list of dimensions (Specific attributes such as performance, availability, Assurance etc.)*
- ✓ *Od=output list of tuples*

Function *UserQuery*

- ***Foreach*** *q in Iq* ***Do***
  - ***Read*** *corresponding Id*
  - ***Search*** *for Input query*
  - ***If*** *found Then* ***Do***
    - ***QoS matching***
    - ***AHP ranking()***
    - ***Filtering()***
  - *Result= {ranked list of services}*
  - ***Result#*** *Od*
  - ***End If***
- ***End Foreach***

Figure 4: Algorithm for Service discovery

Ranking and filtering

- ✓ *Ia=input list of data from service provider*
- ✓ *Id=input list of dimensions (Specific attributes such as performance, availability, Assurance etc.)*
- ✓ *Ib=output list of tuples*
- ✓ *a and b tuples*
- ✓ *Wt: weight values in AHP Scale (1, 3, 5, 7 and 9)*
- ***Function*** *AHP_Ranking*
- ***Foreach*** *a in Ia* ***Do***
  - ***Read*** *corresponding Id*
  - *Decompose Ia*
  - ***Foreach*** *tuples* ***Do***
  - ***Compare*** *Ia with Ib*
  - ***Assign*** *Id and wt*
  - *result=(Ia,Ib)*
  - ***End Foreach***
- ***End Foreach***

Figure 5: Algorithm for Service Ranking and Filtering

- ***Reliability:*** is an ability of a system to keep operating over time without failure. Authors distinguish between Message Reliability and Service Reliability referencing standard SOA implementations.
- ***Availability:*** is a proportion of time a system or component is operational and accessible when required for use.
- ***Modifiability:*** is an ability to make changes to a system quickly and cost-effectively. These changes include adding new services and extending existing

services with or without changing the interfaces.

- ***Usability:*** is a measure of the quality of a user's experience in interacting with information or services.
- ***Scalability:*** is an ability of SOA to function well (without degradation of other quality attributes) when the system's size and volume increase in order to meet user needs.

5 EXPERIMENTAL EVALUATION

The proposed method is implemented in java, MySQL and cloud simulator. Then the method is evaluated based on the AHP algorithm. The framework has an interface form which helps the *User* to choose their required services or the *Service Provider* to add new service by the service provider. Two options are there. First is to ***add a new service*** and second one is to S***earch through available services. T***he interface form shown in Figure 6.

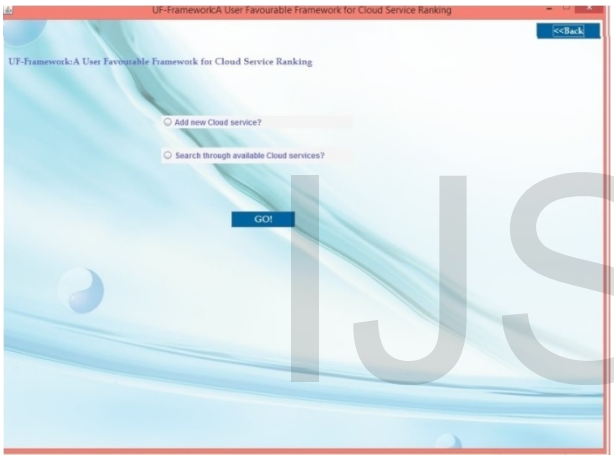

Figure 6: Interface form in SaaS Provisioning Framework

The services are registered to the cloud network with specified attributes. The priorities for the QoS parameters are assigned by the cloud broker dynamically. The QoS values are taken out of 100. And range of values determines their priorities. If n<20 then priority value become 1. If 21<n<40 then priority value become 2. If 41<n<60 then priority value become 5. If 61<n<80 then priority value become 7. If 81<n<100 then priority value become 9. Based on these assignments AHP 9point scale can be matched. And then ranking is done by Analytical Hierarchical Process [21].

Table 1 shows the evaluation result of selected QoS parameters for SaaS provisioning. S1, S2 and S3 are Service Providers. In this table it shows the primary configurable parameters of our algorithm. Everyone's requirements regarding the compulsory parameters usually vary. So we choose arrange of values to mimic different selections scenarios. In future work, we may conduct user survey to understand the most concerned factors for different type of users, for example we can exposed all possible constrainable parameters via the API but it may not be necessary and it will only overwhelm the users who only uses the visual interface. Default value column shows what we use when not specified. Finally the framework provides a ranked list of services to the user.

Top Level QoS Groups Weights	QoS Attributes (Weights)	Second Level Attributes (Weights)	S1	S2	S3
Performance (0.3)	Service Response Time (1)	Average Value (.5)	100	600	30
Assurance (0.2)	Availability	0.7	99.95%	99.99%	100%
	Serviceability	0.7	0	1	1
	Service Stability	0.3	13.6	15	21
Reliability (0.5)			0.90	0.95	0.92
Usability	Throughput	Average Value (0.5)	0.80	0.70	0.75

Table 1: Different parameters with Selected QoS Attributes

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6 CONCLUSION AND FUTUREWORKS

Cloud computing has become an important paradigm for outsourcing various IT needs of organizations. Currently, there are many Cloud providers who offer different Cloud services with different price and performance attributes. With the growing number of Cloud offerings, even though it opens the chance to leverage the virtually infinite computing resources of the Cloud, it has also becomes challenging for Cloud customers to find the best Cloud services which can satisfy their QoS requirements in terms of parameters such as performance and security. To choose appropriately between different Cloud services, customers need to have a way to identify and measure key performance criteria that are important to their applications.

We proposed a framework for ranking the cloud services mainly for SaaS provisioning. In this context, this work presents a user favorable framework, UF-Framework, to systematically measure the QoS attributes and rank the Cloud services based on these attributes. Analytical Hierarchical Process (AHP) based ranking mechanism is used in this work, which can evaluate the cloud services, based on different applications depending on QoS requirements. This framework only aims for SaaS provisioning. Our proposed mechanism also addresses the challenge of different dimensional units of various QoS attributes by providing a uniform way to evaluate the relative ranking of Cloud services for each type of QoS attribute.

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