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A Sophisticated Study of QoS Ranking Frameworks in Cloud Computing

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Abstract— Cloud computing is a rising field providing computation resources. The number of cloud providers is increasing day by day. Users can choose the Cloud provider according to the needs, but choosing a provider is very time consuming and difficult task. Quality of service parameters can be used to select the best possible service provider. The providers can be ranked according to the Quality of services. In the paper different frameworks are compared and the description about the framework and limitations are gathered in a tabular form which is easy to understand.

Keywords— QoS, Ranking Services, Cloud Computing, Ranking Framework, Cloud Architecture.

I. INTRODUCTION

Cloud computing [1] is the delivery of computing as a service relatively a product, where mutual resources like information, infrastructure, platform, software are provided to users and other devices over a network. It is a rising field with a lot of hopes and possibilities in each and every sector whether it is corporate, IT, finance. Everyone wants to keep their information in safe hands and to get the resources used in an efficient and effective manner. The time is not consequently very far-off when the overall working environment would shift to cloud. In such a case it becomes a critical need to analyse the cloud server whether it suits our need or not.

The concept of cloud computing has gained pace in the past few years. The customers of cloud services outsource the computational power and storage facilities to the public cloud providers on pay per usage basis [2][3]. In comparison to the existing computing models that has a dedicated infrastructure, cloud computing has the benefit of saving money and is reliable. The cloud customers need not to bother about the large cost of purchasing hardware, installing and to see through peak times of resource demand. The main advantage of cloud computing is the method of paying only the amount of service used and resources can also be scaled according to the need. There is no headache to the customer for the maintenance of servers and other components. The companies that are providing cloud services are Rackspace, Microsoft, Amazon, Google. Different providers offer a large variety of services which offers services at different price, different level of performance and different features. For example, a provider provides PaaS that is Platform as a Service in which a customer of cloud builds an application with the use of Application Programming Interface that is provided by the cloud, in the same way other provider avails IaaS that is an Infrastructure as a service where cloud customer can run application inside the virtual machines, with the use of Application Programming Interface which is made available by the other guest OS. Different providers also have different rates for the same services. For instance, the number and duration of virtual machine instances used by the customer is a way to calculate the price by Amazon's AWS, whereas the number of CPU cycles consumed by an application of customer is a way used by Google's App Engine. With a variety of cloud providers a question arises that which cloud provider works well? The answer to this question is both beneficial to customers and the cloud provider. For a prospective cloud customer, the answer to the above question helps in selecting the provider that suits best with the cost and the performance aspects. For example, customer may select a provider for storing of intensive applications, whereas a different provider of computing intensive applications. These answers to selection of cloud provider can help in the direction for improvements. For example, a provider needs to provide more resources for the optimization of the table storage in case the performance of the store is less than the competitors. Each provider has its own different personal way of performing and measurement of prices, thus makes it difficult for the customer to find out the best one [2].

A. Service Models

Service models of cloud computing are shown in Figure I and different service models are briefly described below :

1. *SaaS*

Software as a service can be defined as the cloud providing software to be used by the customers which need not be installed on the user machine but is installed on the cloud. This software provides services to large number of users instead of being deployed on each user's machine. This way of using software helps in reducing the cost as user pay only for the use. The most common known example of Software as a Service is the salesporce.com, although numerous other

examples do exist like the Google Apps which pay contribution to traditional services in business environment such as word processing or e-mails[17]. Though salesforce stated the definition of cloud computing some years ago, it nowadays operates by leveraging its friend friend.com , which can be defined as PaaS (Platform as a Service). [1][3][5]

2. *PaaS*

The service model that provides computing platform to users on cloud like providing operating systems, databases, web applications, programming environments etc. The developers of application can develop their application without the need of installing the platform on their machine as it is available on cloud platform which helps in reducing the cost involved in installation of developing platform. The application that is developed can be run on the cloud platform itself without the need of management of the hardware / software layers. Microsoft Azure are the providers of platform and provides user with environment where there is no need to allocate resources to the systems manually, it is automatically granted to the systems that needs the resources [1][3][5]. This automatic allocation of resources provides the real time environment. This model encapsulates a layer of software and this layer coated provides services to services of higher level.

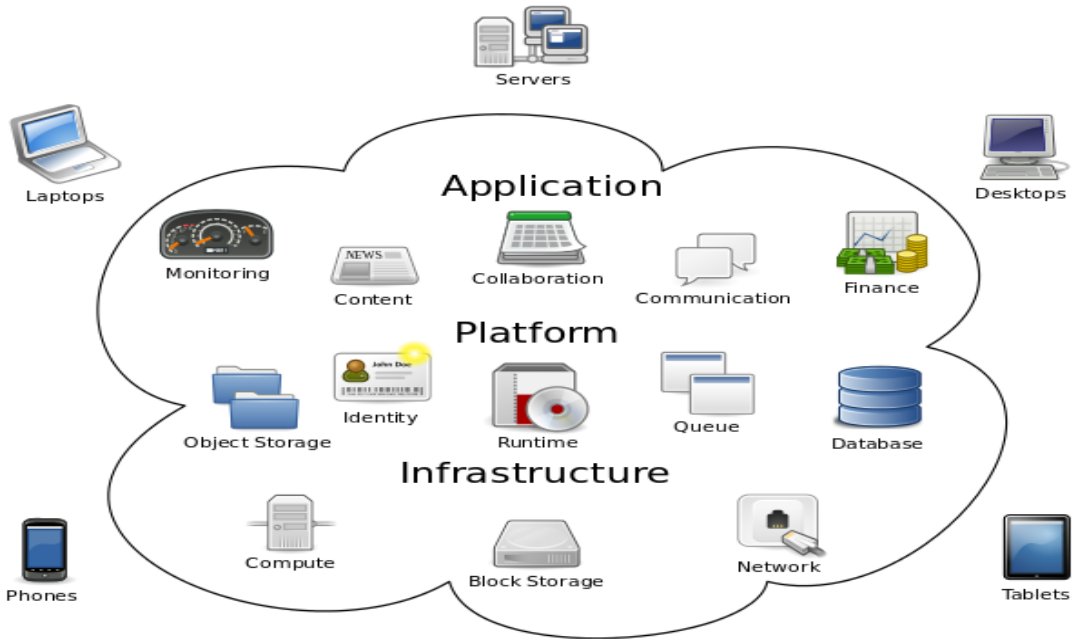


Figure I. Cloud Computing [16]

3. *IaaS*

IaaS can be defined as providing infrastructure that is hardware and making it completely virtual that is storage system, servers etc. Generally organizations pay on monthly basis or annually basis of storage system required, servers etc [2]. This helped in diminishing the requirement for heating or cooling of data centers and the maintenance of hardware [1][3][15].IaaS provides computing capabilities, storage capacity over the network. This model provides components like servers, switches, storage components to applications that require different computing capabilities. Servers, storage systems, switches, routers, and other systems are collected and made available.

B. Deployment Models

1. *Public cloud* :When the services are available openly to public for use is known as "public cloud". Services offered by this cloud may be at no cost or presented on a pay-per-usage form. In principle there may be slight or no differentiation between public and private cloud architecture, however, safety concern may be to a large extent diverse for services that are made accessible by a service supplier for a public spectators and when message is effected over a non-trusted network.

2. *Private cloud:* The cloud infrastructure that is used solely by a specific organization which can be managed within or through a third-party, and hosted either inside or on the outside is known as a private cloud. [1][6][7]

3. *Hybrid cloud :*The combination of two or more types of clouds like private, public or community that are different but works as a one entity and contributing profit of different deployment models [1][6][7].

4. *Personal Cloud:* It can be defined as a small server in home or can be used in small organizations which can be used through Internet. This type of cloud provides user with the facility of viewing and streaming of videos and pictures from devices connected over internet. This is similar to private cloud but this provides facilities for personal use only and easy install-ability [1].

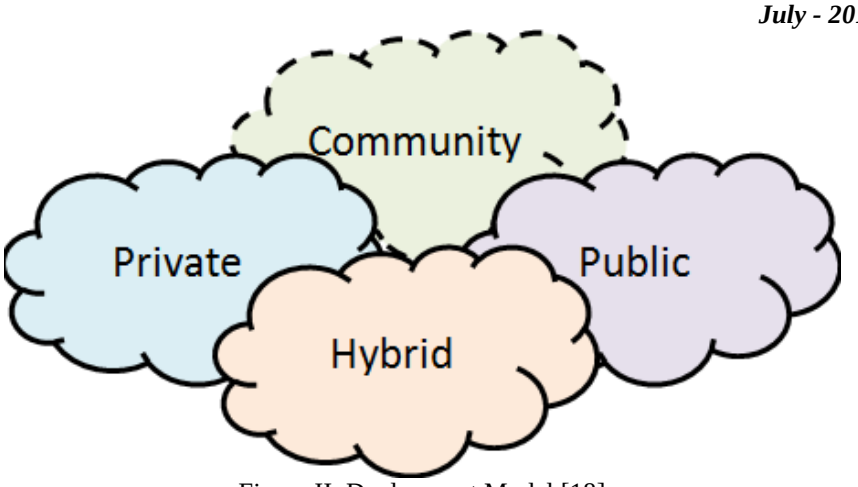


Figure II. Deployment Model [18]

5. *Federated Cloud:* Federation of cloud can be defined as the deployment, management of number of internal and external computing services required to match the needs of business. Union of various parts that work together to achieve a common goal is known as Federated Cloud [1].

6. *Distributed Cloud:* Scattered set of machines which are running at different locations connected via network provides cloud computing. BOINC is an example of distributed computing platform. The resources are shared willingly through Cloud@Home [1][7].

7. *Community Cloud:* The feature of both private and public cloud model is combined in the community cloud. The software, storage and computing resources which are used by various organizations in the same way as in public cloud. The number of organizations which knows each other uses the same infrastructure in concept of community cloud.

II. RANKING AND BACKGROUND

A. Ranking

Ranking can be defined as categorizing and assigning weight to some choices. Ranking is a new concept in Cloud Computing field which attracts the attention of users. Ranking of services in cloud computing is a different concept from other fields as in this field is due to existing infrastructure. The infrastructure is connected through Internet to different components that are having a different connection speeds [6]. This leads to the different level of QoS received by users for same service. Therefore a framework is required to rank services such that different users can get service according to the QoS. Ranking needs to done in order to select the best possible service which is effective and efficient. Quality of service parameters are used by companies in order to rank the different services, and customer can select the service by comparing the rank of the different services.
Also, it is needed to consider following items for ranking of selected services [6].

1) Which attributes should be selected for ranking?
2) How the value of each attributes is determined?
3) Which algorithm should be applied for ranking?
4) How to get the received result? How to present them to the user?

B. Quality of Service Parameter

1. *Service Response Time*
   Service response time is the parameter that is used to measure Cloud service's efficiency and it is calculated in terms of the total time taken in responding. For example: in Infrastructure as a Service, efficiency of service is measured as how fast service is available for use. [11]
   Service Response Time = $\frac{\text{Maximum promised Response Time}}{\text{Actual Response Time}}$

2. *Reliability*
   Reliability is used to measure operation of a service such that it measures how reliable a service is that is how a service operates without failing for the duration of a given time and condition. Reliability is measured in terms of MTTF that is promised by the cloud provider according to SLA and record of past failures faced by the users. MTTF is defined as mean time to failure.
   Reliability=$(probability\ of\ violation)*p_{mttf}$
   $= (1 - \frac{\text{numfailure}}{n})* p_{mttf}$

Where
numfailure= no. of users who encountered a failure
n= no. of users,
p_{mttf} = promised mean time to failure.

3. *Scalability*
It is compulsory to assess in order to find out if a system can handle a series of application requests simultaneously or not. The main feature Elasticity in Cloud computing has ability to scale resources. It has two dimensions: horizontal and vertical scalability that means increasing resources of same time during a time when it is high in demand. Horizontal scalability is also known as Scale Out. For example, initiating the number of VM during peak load. Ability to increase the capacity of a service is called Vertical scalability such as VM by increasing resources like network bandwidth, CPU speed and physical memory [11.]It is very essential parameter for companies that want to move to cloud.

4. *Suitability*
It is defined upto which the requirements of user are fulfilled by cloud provider. In case there is more than a single provider which can fulfill both the requirements may it be essential or non essential, then any provider can be selected as all are suitable. In another case if there is no provider who can fulfill the essential requirements and non essential requirements, then a provider who fulfills essential requirements is selected. Therefore in the second case, suitability is the extend to which services match up with user requirements [11].
Suitability $=\frac{\text{Number of non essential features provided by service}}{\text{Number of non essential features required by the customer}}$
If only essential requirements are fulfilled
= 1 if all requirements are fulfilled.
= 0 otherwise.

5. *Availability*
It is the time a service is available to the customer in percentage. It is given as:
Availability$=\frac{(total\ service\ time - total\ time\ when\ service\ was\ not\ available)}{total\ service\ time}$

6. *Interoperability*
It can be defined as capacity of service to interrelate with another services provided by same Cloud service provider or by different Cloud service providers. It is considered as a qualitative parameter and is very important for users of cloud services [11]. It is given as :
Interoperability $=\frac{total\ number\ of\ platforms\ provided\ by\ provider}{total\ number\ of\ platforms\ required\ by\ user\ for\ interoperability}$.

7. *Adaptability*
It is defined as the capacity of the cloud service provider to adjust according to the changes in the services according to customer's requests. Adaptability can be computed as the time needed to adjust to the changes or upgrading services [11].

8. *Elasticity*
It can be stated as the ability of provider to scale services at peak times. The attributes helpful for computing elasticity are maximum capacity of service and mean time taken for expanding or contracting service capacity. Capacity can be defined as the number of resources that can be made available to user at peak times.[11]

C. RELATED WORK

Mohammadkhanli et al.[8] reviews the different approaches for ranking services in cloud computing in order to help user by selecting the provider according to the Quality Of Services so that the best suitable resource is selected. The overview of performance of different methods is given in the paper so that user can select the service according to performance. Important features of different ranking system are shown. He concluded that the standard criteria should be used for ranking. The proposed system can be used to solve many challenges according to user requirements.
Sobhika et al. [9] surveys different service ranking approaches in the cloud that is in use for optimally selecting the service. In the survey various approaches and the architectures of different approaches for selecting services which helps in ranking services. Quality of service ranking services methods such as Local optimization, ADF and neighborhood approach is defined which is very time consuming for selecting and ranking services. Quality of service ranking gives information for making a valuable selection from other candidates. Usage experience and past history about customers requirements is used. Main aim of the given approaches is to rank the services and select the optimal approach.
Yuvarani et al.[10] proposed two Quality of service ranking prediction algorithms named CloudRank1 and CloudRank2. Proposed framework make sure that the ranking of services is done properly. The main purpose of the proposed algorithms is the ranking prediction of Quality of services at client side, which varies with the different users of same cloud. At client site, proposed algorithm estimates every applicant service and services are ranked according to the

Quality of Service values. To build applications of high quality is a main problem nowadays. Quality of service describes the non-functional parameters. To obtain quality of service values, practical and in real world usage of services, other applicant is also required. No framework exist before the proposed framework that can help users in estimating services and which can rank services according to the quality of service values. The proposed framework has a benefit of past experience of other users. In the paper, author recommended a personalized Quality of service ranking prediction model which needs no supplementary service invocations while ranking Quality of service. With the benefit of past experiences of users, preference is aggregated between pair of cloud services which is required to produce a ranking of cloud services. In the end, performance is improved by efficiently using the cloud services.

Mukhopadhyay et al.[11] proposed a Web Service-Cloud and layered architecture. Non functional attributes like latency, availability, reliability etc are synthesized by the proposed framework that is WS-Cloud computing. Projection of the service consumer is to fulfill the Quality of service requirements as a part of Service discovery query. Proposed framework is capable of discovering and filtering the services available in Web and will rank services based on the preference of the consumer to fulfill service on time. Advancement in technology is always according to the requirement of the customer. Consumer always wants to get the service which matches best with his requirements. A large number of applications are available which stands on Web Services. Web service discovery is supported with Quality of Service. WS-Cloud Computing mentioned uniqueness and consequences in different ways. One is by adopting the method of service matching, filtering and ranking using Quality of service non functional attributes to meet the requirements of customer in an effective manner. Another way is based on Cloud computing perspective, facilitating Quality of service discovery, negotiation and composition is the effective approach.

Subha et al.[12] presents an extensive survey on Quality of service ranking techniques in Cloud Computing according to the limitations of the techniques and inferences. Quality of service parameters are used for evaluating non functional features of Cloud Computing. It is hard to decide which service to choose when services are dependent on Quality of service requirements. To obtain good quality services, it is important to choose services accordingly. In the paper, comparison is made between different techniques such that greedy algorithm treats both rated and unrated items equally therefore the service ranking is pure. Another algorithm named CloudRank Framework is used which gives same quality. Author concluded that optimal allocation of Virtual Machine can help in improving service quality.

Garg et al.[14] proposed a framework for ranking of Cloud services based on the AHP that is analytical hierarchy process. The standards of CSMIC is applied for extracting qualitative values which are used for ranking and comparing cloud services. Features and attributes are extracted in the first phase hierarchically. After that the attributes required by the users are obtained. Further services according to user requirements are extracted. Moving to next phase, QoS is monitored and finally ranking of service is performed through AHP.

III. SYSTEM ARCHITECTURE AND COMPARISON

The different frameworks used to compare frameworks for ranking of services are based on Analytical Hierarchy Process and CloudRank approach. The architecture of the approaches are demonstrated below. In Figure III, AHP Hierarchy using SMI is shown and in Figure IV, architecture for QoS CloudRank is shown.

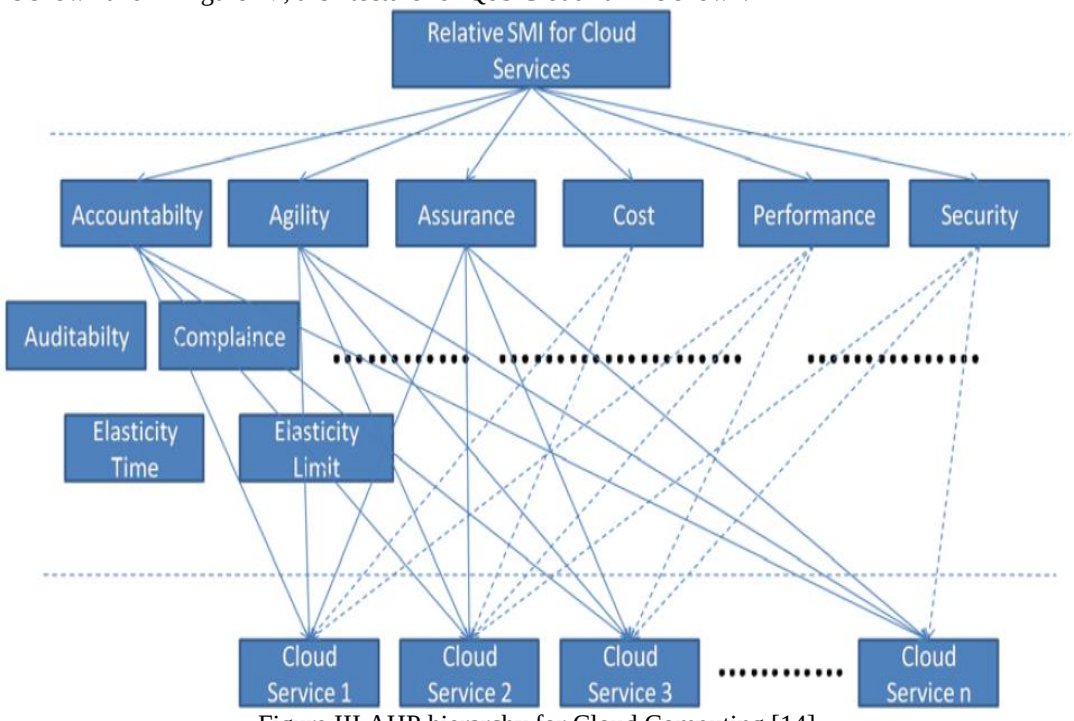
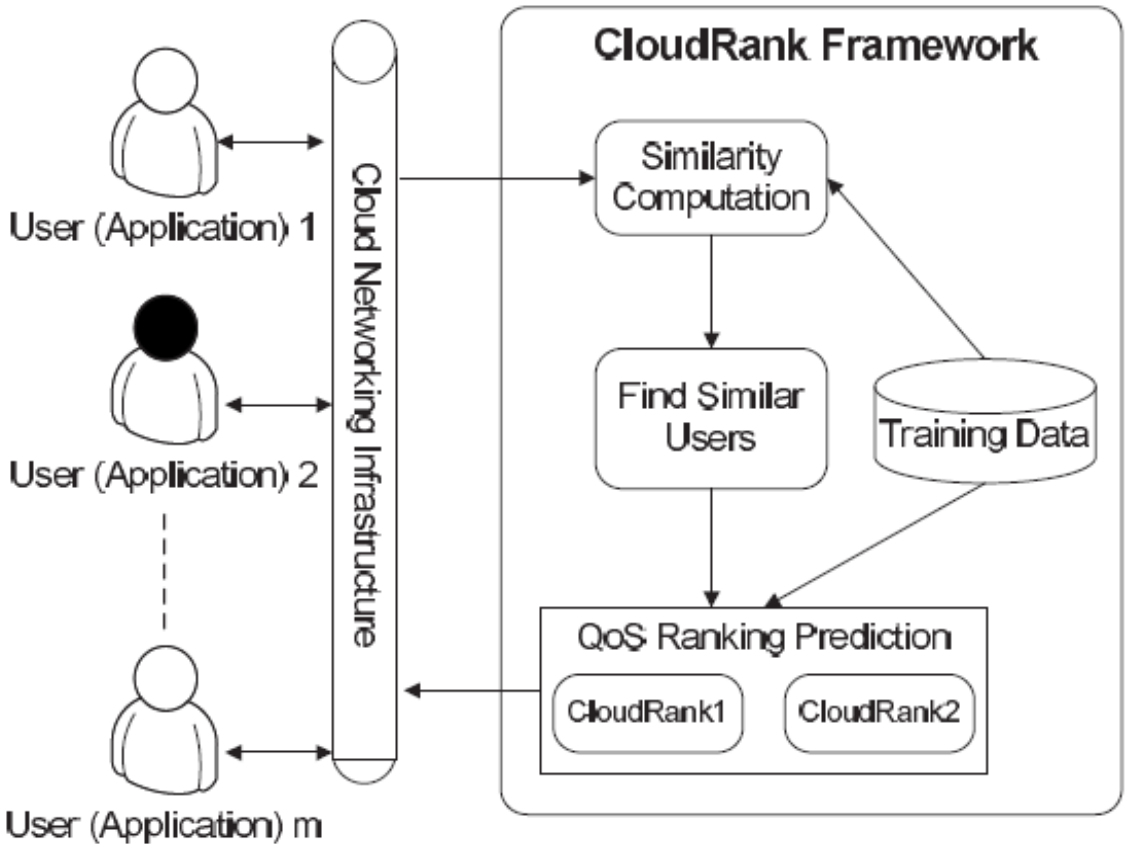


Figure III.AHP hierarchy for Cloud Computing [14]

Figure III, demonstrates the different phases for ranking cloud services based on Analytical Hierarchy Process with the different parameters.



FigureIV .The architecture of CloudRank approach[10]

Figure IV depicts the architecture of CloudRank framework . Different components are shown in the figure. Similar users are found from the database that is Training Data who ranked the services of same kind in past and then the QoS ranking prediction is done.

TABLE I COMPARATIVE STUDY

TITLE	TECHNIQUES/APPROACHES USED	DESCRIPTION	LIMITATIONS	INFERENCES
SMICloud: A Framework for Comparing and Ranking Cloud Services	AHP based ranking mechanism	This technique is used to measure the quality of cloud services and prioritize the cloud services.	1. Quality of Service attributes that cannot be quantified are not used. 2. This technique is not compatible with many Quality of Service attributes.	1. Uniform way is provided through this technique to evaluate Cloud service rank for all Quality Of Service attributes. 2. To rank and measure Quality of Service of services are measured with the help of performance monitoring and analysis tools.
A framework for ranking of Cloud computing services	AHP hierarchy using SMI architecture	All Quality of service attributes are computed which are proposed by CSMIC	1.All Quality Of Service requirements are not fully met. 2.To rank infrastructure different Ranking Algorithms can be deployed.	1.Results showed that the cloud environment has high performance than source environment. 2. Order of magnitude in performance is

				required to improve current clouds.
CloudRank: A QoS-Driven Component Ranking Framework for Cloud Computing	CloudRank Framework	Service candidates are used in order to perform component ranking.	1.Expicitly rate items and unrated items are treated equally by Greedy algorithm. 2.All service candidates are evaluated equally by Personalized approach. 3. Large invocations of service users is not compatible with personalized approach.	1.Ranking of cloud components is evaluated by CloudSim tool. 2.Normalized Discounted Cumulative gain metric is used to obtain high performance.
QoS ranking prediction for cloud services	QoS Ranking Prediction Framework	Service candidates are used in order to perform service ranking.	1.Same quality of cloud services is provided by CoudRank algorithms. 2. All service candidates are evaluated equally by Personalized Quality of service prediction.	1.Ranking of cloud components is evaluated by CloudSim tool. 2.Normalized Discounted Cumulative gain metric is used to obtain high performance.

IV. CONCLUSIONS

In this paper, we have compared different ranking frameworks and different architectures for selecting a service according to the rank of the service. The main goal of the comparison is to compare the frameworks and giving information about the technique the framework is based on and the limitations of the different frameworks, so that the user can select cloud service according to the requirements. The framework used are very helpful in guiding customers about selecting the optimal service which are based on the quality of service parameters.

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