



Personalized Framework for QOS Ranking in Cloud Service and Recommendation System Using Collaborative Filtering Approach

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Abstract – Constructing Quality applications in cloud environment become tedious. QOS prediction is essential to invoke the services at real time. The term QOS (Quality of service) used to reveal the nonfunctional attributes of cloud services and act as important segregation point. The QOS attributes of cloud services are throughput, response time, failure probability, availability etc. At present there is no framework used to measure cloud services with their ranking. To select optimal service among functionally equivalent service in the cloud environment, the QOS ranking can be used. This paper presents a personalized framework and a mechanism that estimates the quality in terms of non-functional attributes and ranks them accordingly. This personalized framework has the advantage of past service usage used to minimize the consumption of time and expensive service invocations. Two ranking algorithms (CloudRank algorithm1 and CloudRank algorithm2) are used to predict the QOS ranking through preference value and confidence value calculation. These two algorithms make sure that the cloud services are ranked accurately based on their non-functional attributes. After ranking, cloud service recommendation system can be used to exhibit similar services to similar users by using the collaborative filtering approach.

Keywords – Cloud Service, CloudRank1, CloudRank2, QOS Ranking, prediction, Recommendation.

NOMENCLATURE

QOS – Quality of service

NDCG – Normalized Discounted Cumulative Gain

WSRS – Web Service Recommender system

KRCC - Kendall Rank Correlation Coefficient

I. INTRODUCTION

Cloud computing is an important paradigm to provide services according to several fundamental models such as infrastructure, platform, software, etc. The consumer of the cloud can obtain the services through the network and it is very difficult for them to build high Quality applications in cloud environment. Constructing best preferable service in cloud technology becomes important research topic. Among several services it is difficult to suggest that which service is more valuable and preferable by service users. In such cases QOS values show a critical role for sorting out the optimal service selection among functionally equivalent services.

II. PROPOSED SYSTEM

Proposed personalized framework can be used to fix QOS Rank based on Non-functional attributes of individual service among several functionally equivalent services in cloud environment. This framework supports two algorithms namely CloudRank1 and CloudRank2 through which the preference and confidence value can be measured to do rank accordingly. This framework also supports Recommendation system to exhibit similar services to the similar users.

Recommendation is done by two collaborative filtering approaches 1) User Collaborative approach predicts the QOS values of cloud services by considering past usage experience of service users and 2) Item based User Collaborative approach works based on the item feature. Benefits of proposed system is Ranking can be made according to QOS value, Preference value and confidence value through Cloud Rank Algorithms. Most attention of this framework is after measuring the quality it will prioritize the Cloud services. This framework provides QOS based ranking not Rating Oriented service. Ranking accuracy can be made through the enhancement techniques such as Random walk, Data smoothing and Matrix Factorization.

A. Need for Optimal Service Selection

QOS is significant research focus in cloud computing environment. In cloud environment several functionally equivalent services are available so picking quality service becomes important. In order to select quality service among several service candidates QOS value prediction technique can be used. For optimal service selection QOS can be measured at both client and server side.

B. QOS calculation and cloud service Rank

QOS calculation at Server side provides the capabilities of services and client side QOS calculation provides precise calculation about user usage of service. Commonly used QOS prediction at client side is response time, failure probability, Throughput etc. This personalized framework mainly deals with the QOS calculation at client side.

In cloud environment several ranking techniques are available among such cases QOS ranking plays important role. Generally ranking is the process to reveal quality service. In cloud environment QOS Ranking is to predict quality service based on the nonfunctional characteristics. This ranking approach minimizes the time to acquire the quality service since invocation of services in cloud will be charged.

III. PROPOSED FRAMEWORK

To rank the service, this framework involves cloud service creation-active user can create various services which are functionally equivalent, similarity computation-similar users and services can be obtained through KRCC, cloud Rank-the preference and confidence value of the service can be acquired by two cloud rank algorithms. Finally Recommendation system-by using user and item based collaborative filtering approach used to provide the similar services to the similar users.

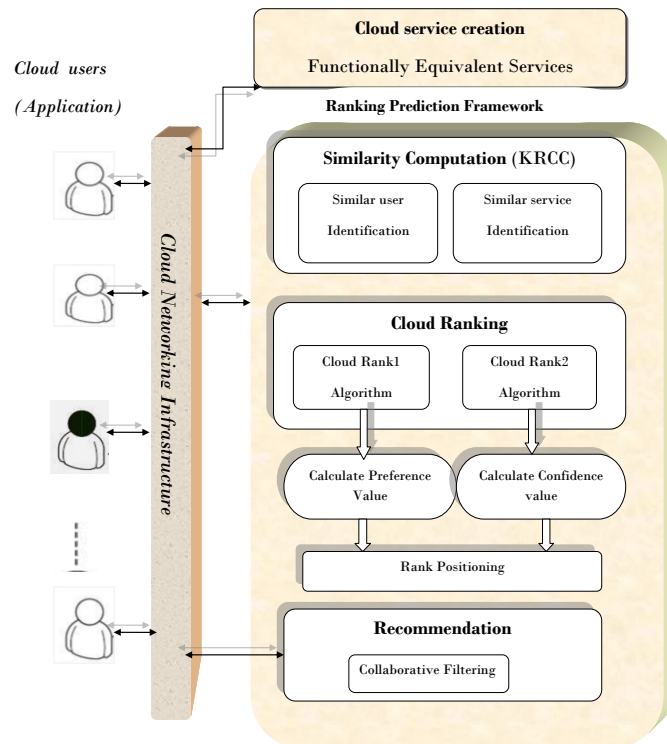


Fig.1. Architecture for CloudRank and Recommendation

IV. CLOUD SERVICE CREATION

The Cloud Services are primary source for constructing the software system. Recently the cloud services are increasing rapidly. This proliferation makes it very hard for us to select minimal service among functionally similar service in the cloud environment. In this module, the Active user can create various cloud services which are functionally Equivalent. Through the active services the users can communicate with each other. Some of the services are taken into the accountsuch services are Airline ticket reservation system, Hotel booking service, Tourism service etc.

V. SIMILARITY COMPUTATION

Once the services are created by active user, it is necessary to find similar user and similar services to do recommendation. Kendall Rank Correlation Coefficient (KRCC) is the method to estimate the degree of similarity. Based on number of inversions of service pairs the similarity can be estimated.

The KRCC value of user u and v can be calculatedby

$$sim(u, v) = \frac{C-D}{N(N-1)/2} \quad (9)$$

Where

- N - Total number of services.
- C - Total number of concordant pair of services.
- D - Total number of discordant pair of services.

By using the following formula similar users can be identified.

$$N(u) = \{v | v \in T_u, sim(u, v) > 0, v \neq u\} \quad (9)$$

- Where T_u - top k similar user to active user u.
- $sim(u, v) > 0$ removes the dissimilar user.

VI. QOS RANKING

Cloud Rank1 Algorithm:

CloudRank1 focuses ranking the cloud services based on their preference value. The two sets E termed as Employed service set and I termed as Full service set used to categorize the services. According to QOS values observed at client side rank the service in E. For Each service in I, sum of preference values can be estimated. Based on the preference value Rank the service which has the maximum QOS value.

Calculation of Preference value [9]:

```

F = E;
while F ≠ ∅ do
    t = arg maxi ∈ F qi;
    ρe(t) = |E| - |F| + 1;
    F = F - {t};
end
foreach i ∈ I do
    π(i) = ∑j ∈ I Ψ(i, j);
end
n = |I|;
while I ≠ ∅ do
    t = arg maxi ∈ I π(i);
    ρ̂(t) = n - |I| + 1;
    I = I - {t};
    foreach i ∈ I do
        π(i) = π(i) - Ψ(i, t)
    end
end
while E ≠ ∅ do
    e = arg mini ∈ E ρei;
    index = mini ∈ E ρ̂(i);
    ρ̂(e) = index;
    E = E - {e};
end
    
```

Fig.2. CloudRank1 - calculating preference value

Steps:

1. Consider two service sets E (Employed service set) and I (full service set). $\rho_e(t)$ stores ranking of service 't' in employed service set. The Value of $\rho_e(t)$ is in the range $[1, |E|]$. Smaller value indicates higher quality.
2. Sum of preference value can be calculated for the services in I using preference function $\Psi(i, j)$
 $\pi(i) = \sum_{j \in I} \Psi(i, j)$ larger value of $\pi(i)$ indicates the service i is highly preferred than others.
3. Services are ranked according to highest preference value to lowest value. $[n - |I| + 1]$ rank all other services in I. Finally the selected service t is removed from Full service set I.
4. Initial ranking is updated by correcting service ranking in employed service set E.

Cloud Rank2 Algorithm:

CloudRank2 focuses ranking the cloud services based on their confidence value. When the service has higher preference value then it has higher confidence level. If the service has higher priority on their confidence level according to their QOS values it will be ranked.

Calculation of Confidence value [9]:

```

F = E;
while F ≠ ∅ do
    t = arg maxi ∈ F qi;
    ρe(t) = |E| - |F| + 1;
    F = F - {t};
end
foreach i ∈ I do
    π(i) = ∑j ∈ I C(i, j) × Ψ(i, j);
end
n = |I|;
while I ≠ ∅ do
    t = arg maxi ∈ I π(i);
    ρ̂(t) = n - |I| + 1;
    I = I - {t};
    foreach i ∈ I do
        π(i) = π(i) - C(i, j) × Ψ(i, t)
    end
end
while E ≠ ∅ do
    e = arg mini ∈ E ρei;
    index = mini ∈ E ρ̂(i);
    ρ̂(e) = index;
    E = E - {e};
end
    
```

Fig.3. CloudRank2-Calculation of confidence value

Where

$$\Psi(i, j) = \sum_{v \in N(u)^{ij}} w_v (q_{v,i} - q_{v,j}) \quad (9)$$

w_v is weighting factor of similar user v can be measured by

$$w_v = \frac{sim(u,v)}{\sum_{v \in N(u)^{ij}} sim(u,v)} \quad (9)$$

Steps:

1. The confidence value can be obtained by using the confidence function $C(i, j)$ where i and j are the two services having different preference value.
2. Consider the three services i, j, k . The service i, j are invoked previously so the preference value can be obtained explicitly through past usage experience.
3. Different preference value shows different confidence level. The confidence of preference value can be computed by using the confidence function $C(i, j)$ here the confidence level of three services is in the form of $C(i, j) > C(j, k) > C(i, k)$ since i and j are invoked previously.

VII. RECOMMENDATION SYSTEM

Recommendation system is the base for information filtering system that looks for rating or preference that the user gives to an element. In this module, recommend the services to users with the help of approach called collaborative filtering which can be used to exhibits similar services to the similar user according to their QOS attributes.

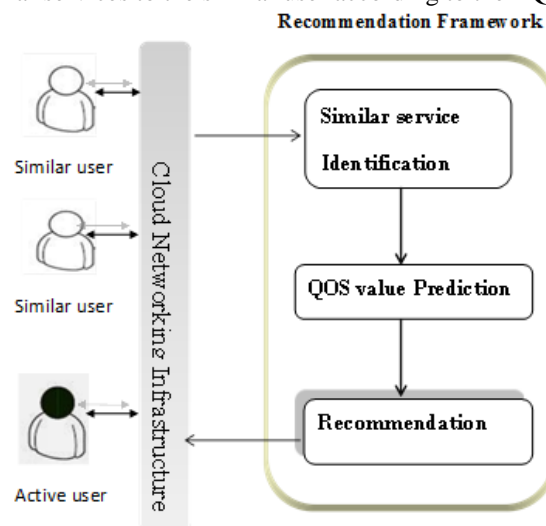


Fig. 4.Recommendation framework

Two formal types of collaborative filtering approaches 1) user collaborative technique used to calculate the QOS values of services by considering the service usage of users. 2) Item based Collaborative Mechanism works based on the item features.

VIII. EXPERIMENTAL RESULTS

Cloud Rank Algorithm Result

Preference value calculation:

The preference value for various cloud services can be obtained through the preference function. The past usage experience of cloud service can be measured through the preference value i.e., number of users prefer the service.

Table 1 Preference value prediction

SERVICES	PREFERENCE VALUE
Airline	15
Railway	25
hotel	10
hospital	6
tourism	4
shopping	3

Confidence value calculation:

The service of higher preference value will get higher priority in confidence level.

Table 2 Confidence value prediction

SERVICES	PREFERENCE VALUE	CONFIDENCE LEVEL
Airline	15	2
Railway	25	1
hotel	10	3
hospital	6	4
tourism	4	5
shopping	3	6

Cloud Rank Position:

The cloud rank result shows that the active services are correctly ranked. It ensures that the active services are ranked according to the preference value, confidence value and QOS attributes of throughput, response time and failure probability. It clearly shows that ranking made not only based on preference and confidence value but also the QOS attributes.

Final Ranking Result

Table 3 Ranking Prediction

SERVICES	PREFERENCE VALUE	RANK	THROUGHPUT (KBPS)	RESPONSE TIME (SEC)	FAILURE PROBABILITY (%)
Railway	25	1	40	4	5
Airline	15	2	50	5	8
hotel	10	3	35	7	14
hospital	6	4	38	10	26
tourism	4	5	35	17	29
shopping	3	6	32	15	40

QOS calculation for various cloud services

Throughput Calculation:

Among functionally equivalent cloud services, throughput for individual service can be measured in terms of Kbps. Throughput represents the data transfer rate among various cloud services.

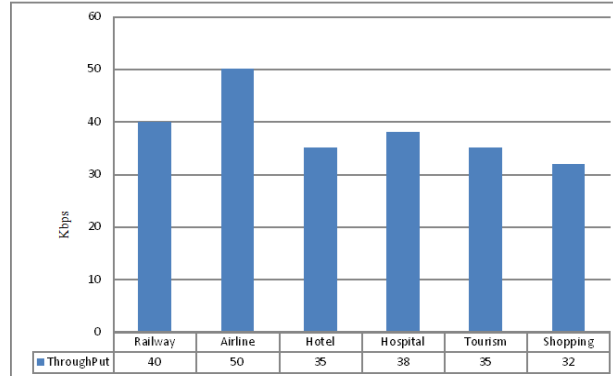


Fig.5. Throughput calculation

Response Time Calculation:

The efficiency of service availability can be measured in terms of response time. Response time refers to time duration between user sending out a request and receiving a response from the service. The result shows that the response time of various cloud service can be measured in terms of milliseconds.

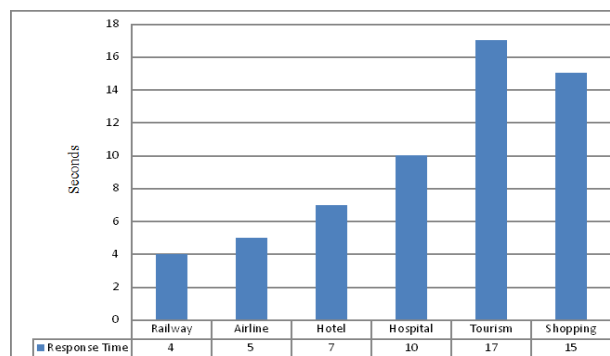


Fig .6.Response Time calculation

Failure Probability Calculation:

Failure probability can be measured as Percentage of time when service not available.

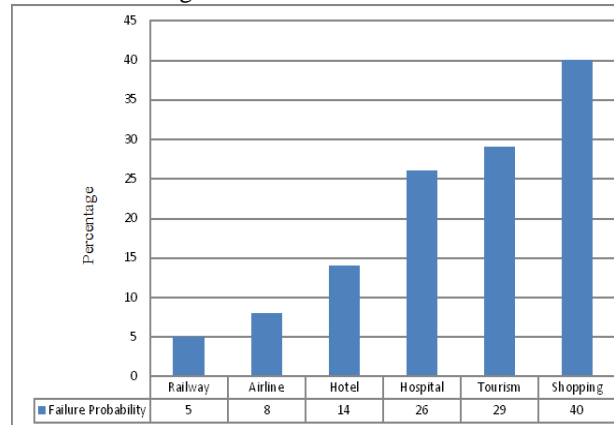


Fig .7.Failure Probability calculation

IX. CONCLUSION AND FUTURE SCOPE

This Personalized framework fixes rank for cloud services among functionally equivalent service in cloud environment. It takes the advantages of no additional service invocations and reduces time to invoke services. This QOS Ranking approach identifies and segregates the preference and confidence value between pairs of services to yield ranking. This Personalized framework proposes two algorithms through which the preference and confidence value can be obtained. To enhance the ranking precision data smoothing, random walk, matrix factorization techniques can be used. After fixing the rank according to their QOS value, we proposed for recommendation services to exhibit similar services to the similar type of users.

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