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QoS Aware Web Service Selection and Ranking Framework Based on Ontology

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Abstract: Consideration of QoS values for accurate web service Selection process has been highlighted in our previous survey paper. Further to that work, we claim that the best performance can be achieved by considering both functional and QoS properties. In this paper, we highlight the application of ontology to represent the non-functional requirements in web service discovery. We emphasize how Ontology if built and refined by domain experts can be used for web service discovery process with the purpose of reuse and improved design. Considering the importance of QoS and Ontology we present a new framework for web service selection which considers dimensionless matrix for web selection and promises to deliver desired ranking of web services according to user preference QoS.

Keywords: Non-Functional Requirements, QoS, Web Services, Service Discovery, Ontology.

I. INTRODUCTION

The web service discovery scenario is dependent on the QoS values provided by the services. Our study and survey [1] of the various algorithms highlights the importance of QoS in the web service discovery. As a number of web service that offer similar functionality increases, QoS properties become a crucial issue during the selection and ranking of accurate web services. The Service Oriented Architecture (SOA) is "essentially a collection of web services. These services interact with each other on the network. A web service is a method of communication between two electronic devices over the network. It has an interface described in a machine-process able format (specifically WSDL). Other systems interact with the Web service in a manner prescribed by its description using SOAP messages, typically conveyed using HTTP with an XML serialization in conjunction with other Web related standards. Web Services are self-independent application that shows modular and distributed concepts. Web service description is provided in the WSDL document, it can be accessed from the internet using SOAP protocol. Services are described, published, discovered and can be assembled to create a complex service based systems and applications. Service discovery is the activity of deciding consumer requests in terms of (advertised) services. Some requests may only be resolvable by a (complex) combination of services. Service discovery involves matchmaking of services, prioritizing (ranking) of services and then the selection of appropriate services. Service discovery can be done manually, automatically. As more number of web services increase on internet whose provides the same functionality. At that time Service discovery is a process of finding the desired service.

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Discovery is the most dominant task in the web service model because web services are unfeasible if they are not discovered.A service description provides service related information which can be published by a service provider and searched during the service discovery process. Fig. 1 shows the interaction between Service Requester, Service Providers, and a Service Discovery System.

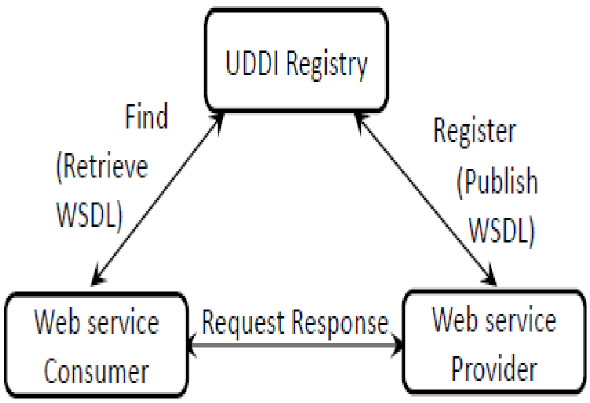


Figure 1. Web Services Publish-Find-Bind Model [1]

In recent times, most of the cases web services provide the same functionality, and then Quality of Service (QoS) is the deciding criteria for service discovery. QoS is defined by a set of non-functional attributes like service throughput, reliability, response time and availability. The current Universal Description, Discovery and Integration (UDDI) registries support web services discovery based on the functional features of services only. QoS information is not able to hold in the UDDI registries. This paper presents the new approach where QoS will be consider as second criteria for selection and ranking of web services. Rest of the paper is organized as follows: Section II discusses the literature survey. Section III focuses how to use ontology to describe QoS. Section IV describes the proposed framework for selection and ranking. Section V describes experiment and verification. Section VI concludes with a summary.

II. LITERATURE SURVEY

There are various approaches available for QoS based discovery. Based on our study and survey [1] we conclude that an Ontology based approach offer the best results. Further study made us realize that Ontology for web service discovery has been used earlier and we provide a summary of our study below in Table 1.1.

TABLE 1.1 Comparative Study

Author	Wen Junhao and group [3]	Zhigang Chen and group [4]	Demian Antony D'Mello [5]	Eyhab Al-Masri and Group [6]
Matchmaking technique	presents four types of match degree whichare exact, plug in, Subsumes, fail.	propose optimal matching matrix should be constructed to evaluate comprehensively the best candidate services	The broker performs the process of web services selection mechanism which is defined on the tree model of QoS Constrain.	propose optimal matching dimensionless matrix to evaluate the best candidate services
Using Ontology	Yes	Yes	No	No
Considering QoS	Yes	Yes	Yes	Yes
Efficiency	High	High	Low	Medium
Accuracy	High	High	Medium	No
Scalability	Medium	Medium	Low	Yes
Ontology used for functional requirement	No	Yes	No	No

As number of web services increases over the web; it is difficult to choose correct one for the consumers. He needs to use tools to search for suitable Web services available throughout the net. UDDI is the first step towards meeting these demands. But UDDI provides only syntactic search as well as search is based only on functionality. As number of web services more and more on net that provides the same functionality that time UDDI was insufficient to give appropriate result. Discovery result may not satisfy the service requester's future requirements. This leads to a bit of manual work for choosing the proper service according to its semantics. To make Web service discovery more dynamic, it requires domain specific knowledge. The semantic web technology is a promising solution for automatic service selection process. It requires that data be not only machine readable, but also machine understandable [10]. Yang Zhang [2] and group suggest a method of Web Service Discovery based on Semantic Message Bipartite Matching. Basically the algorithm was design for healthcare domain. But author does not consider the Non functional requirement as selection criteria. Whereas the Demian Antony D'Mello [5] and group proposed the algorithm which is QoS broker base. Authors extend the basic framework with three functional blocks: Service Selector, Service Publisher and Quality Manager. Broker may misguide the requester. But this algorithm does not use the ontology to represent which is effective way to represent the QoS properties. DAML-S [7] aims to enable automated Web service discovery, invocation, arrangement and monitoring. However, the specification has not provided a detailed set of classes, properties and constraints to represent QoS descriptions. Chen Zhou and group [8] have tried to develop a proper QoS Ontology design pattern for the formal specification of QoS constraints and QoS metrics as a complement to the DAML-S. This novel QoS Ontology is based on DAML+OIL and named DAML-QoS. Eyhab Al-Masri and Group [6] proposed the algorithm which considered the QoS factor as selection criteria. But this algorithm does not uses the ontology to represent the QoS. This algorithm uses the dimensionless method to represent the QoS values. On the other hand Wen Junhao and group [3] suggest the algorithm on the basic of the QoS ontology; authors design the semantic web service selection algorithm. Combining the QoS semantic matching and personalized selection method, it can select the best web service for the users. He focused on the principle of design QoS ontology: Easy to use and reuse, supporting service discovery. This algorithm used OWL as the ontology building language. Matching can be in one of six levels as Exact, Plug-In, Subsume, Enclosure, Unknown and Fail. Algorithm uses the ontology for non-functional requirements only not for the functional properties. Zhigang Chen and group [4] proposed the algorithm which is also based on QoS Ontology. Algorithm describes both functional and non-functional properties using ontology concept which improves the discovery process and ultimately selection and ranking. To select the appropriate web services as candidate service set provided by semantic matching, a method for web service selection with QoS constraints is proposed. Initially, the Four-Level Matching Model for Semantic Web Service based on QoS Ontology is presented, and the QoS ontology for web service is designed. Then, the method extends the QoS description information with the QoS concept in OWL-S (Web Ontology Language for Services) model, and the extensible OWL-SQ model for service description with service semantic and QoS description is presented, and it is QoS supporting and constraining. Then based on decision theory and normalized algorithm, the dimensionless method for QoS properties of un-numerical value type and numerical value type in OWL-SQ model is proposed. Finally, the algorithm for constructing matching matrix of QoS and the service selection method are presented, to evaluate and select optimization candidate web service comprehensively. Authors proposed ontology based algorithm for both functional and non-functional requirements. As there are number of algorithms available for discovery some of them consider functional properties some of them consider QoS as well as functional properties. We have studied few of them mostly considered QoS properties. After study, we found QoS properties are very important to consider as there are increasing web services having similar functionality. QoS is defined by a set of non-functional attributes like service response time, throughput, reliability and availability. The current Universal Description, Discovery and Integration (UDDI) registries support web services discovery based on the functional aspects of services only. The problem with UDDI is not able to hold the QoS information and also who will give the guarantee of the published QoS information. QoS information published by the service providers may not always be appropriate and updated. Our in depth survey suggest that semantic technology based on ontology can be used as an efficient approach in related domain for web service discovery as it gives relatively accurate results. In the highly competitive industries, customers turn their eyes on QoS.

III. ONTOLOGY TO DESCRIBE QoS

The (QoS-based) web service discovery process is decomposed [3] into two sub-processes: matchmaking and selection. In the first sub-process, the (QoS-based) web services descriptions (advertisements and request) are matched and the outcome is a list of web service advertisements that completely satisfy the constraints of the request. In the second sub-process, this output list is sorted based on given weights of QoS metrics of the web service requester. Both of these sub-processes depend on the (QoS-based) web service descriptions. The whole discovery process is carried out by a reasoning engine. When an integrated semantic service request is sent to the reasoning engine, the engine will first determine the candidate Use of ontology is very efficient way to represent the QoS. Ontology is a controlled representation vocabulary and also framework for sharing a precise meaning of symbols. Ontology based policy description allows service providers and requesters to describe their policies with respect to common ontology in terms of meaningful concepts and relations. Gruber [11] defines Ontology as "Ontology is a formal representation of a set of concepts within a domain and the relationships between those concepts". The importance of ontology in web services have been increasing because of the efforts on the development of next generation of web services, called semantic web services, which is closely related to the next gesture of the web, the semantic web. Semantic web services are those ones that are not only machine readable, but also machine understandable, facilitating then the following aspects:

i. Automatic web service discovery
ii. Automatic web service invocation
iii. Automatic web service composition

Figure 4 shows the QoS Ontology model. This model is created using protégé 4.0. We have used this model for our system.

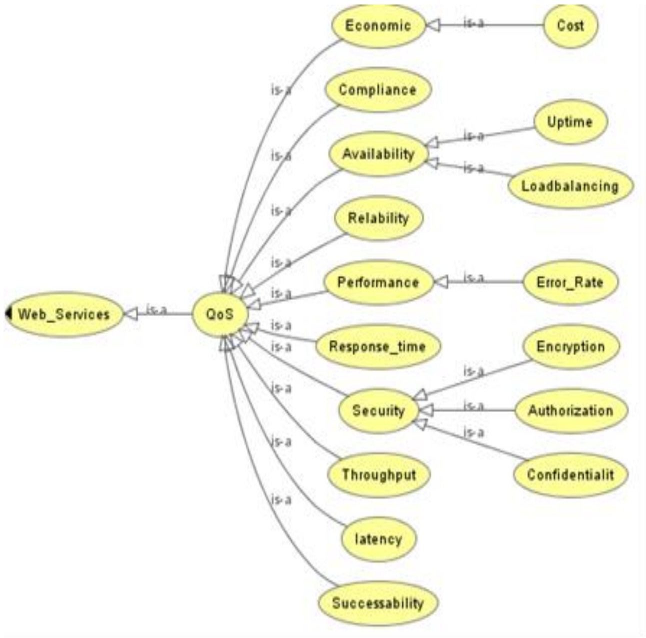


Figure 3. QoS Ontology Model

Ontology-based for semantic web services selection can reduce the number of target services effectively, and then improves the efficiency of query. It uses semantic information to limit services during the process of searching services information. Ultimately it can get more accurate search result which compared with the previous method of matching keywords. It improves the quality of the whole discovery process.

IV. PRPOSED FRAMEWORK

Considering the problem in current discovery we proposed framework "QoS aware web service selection based on ontology". After study we have concluded that QoS factors are very important for selection. We have used Ontology to describe the web service QoS properties. The importance of ontology in web services has been increasing because of the efforts on the development of the next generation of web services, called semantic web services, which is closely related to the next gesture of the web, the semantic web. Semantic web services are those ones that are not only machine readable but also machine understandable. Ontology-based for semantic web services discovery can reduce the number of target services effectively, and then improves the efficiency of query. It can get more accurate semantic information which compared with the traditional method of matching keywords. Our approach focused on QoS for selection. Mainly target services are chosen by discovery. Target services are nothing but candidate services. We have used Ontology to retrieve the QoS properties from query. User can specify one property with different name in that case ontology will help to retrieve the exact property name from query.

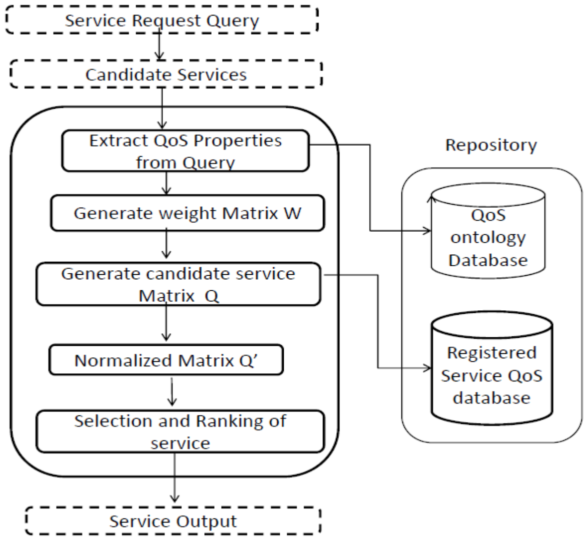


Figure 4. Framework Architecture

Ontology helps to find correct QoS property from the Query. Ontology-based for semantic web services selection can reduce the number of target services effectively, and then improves the efficiency of query. It uses semantic information to restrict services during the process of releasing and seeking services information. It can get more accurate semantic information which compared with the traditional method of matching keywords. Using NLP we have extract the weightage from query. Its location service is much more accurate, further enhancing the precision and improving the performance of web services discovery. For the sake of discussion and understanding of our algorithm, we have assumed that the web service that satisfy the functional requirements are already listed out or discovered. The next step is to select the web service that satisfies the non-functional properties and delivers the best QoS. This identification is done using our proposed algorithm.

The detailed discovery framework is given below:

Methodology

The detailed selection and ranking framework is given below:

Input: Candidate services with QoS and their weight.

Output: selection and Ranking of candidate web services according to user preference QoS

Algorithm:

1. Accept Query from User including QoS preferences.
2. Extract the QoS properties from query using Ontology
3. Assign the weight of those QoS properties using NLP from query.

Algorithm:

i. Input query to NLP
ii. Parse query
iii. Analyse Tokens
iv. Associate adjectives with keyword
v. Initialize max_score = o;
vi. Initialize keyword_scores[N] = 0;
vii. For i=0 to N

If keyword[i] belongs to high

Keyword_Score = 3;

Else if keyword[i] belongs to medium

Keyword_score=2;

Else

Keyword_score=1;

Max_score = max_score + keyword_score[i];

viii. For i= 0 to n

Find_keyword_score[i]=(Keyword_score[i]*100/max_score)

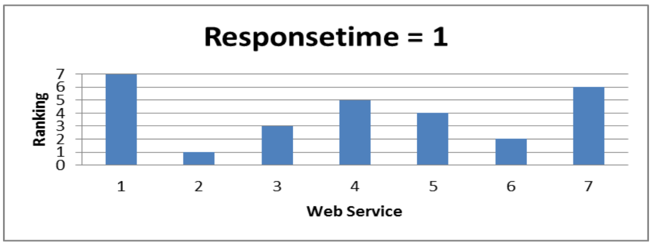
ix. End

4. Create the weight matrix w.
5. Consider the candidate services selected by discovery.

Suppose candidate service sets by functional match S = (S1, S2,, S3, ..., Sn), Si has m QoS attributes, $1 \leq i \leq n$, then get an n × m order decision matrix Q , where each row represents a candidate service correspond to each QoS property value, each column represents attribute values of all candidate services.

6. Normalization of the attribute:

Where Vi,j is the normalized results of jth attributes of the ith service; Vi,j is the maximum value of the jth column of the quality matrix Q, qjmax = max (qi,j), $1 \leq i \leq n$; qjmax is minimum value of the j-column of the quality matrix Q, qj max = min (qi,j), $1 \leq i \leq n$. For the formula (1) , if qjmax



– qj min ≠ 0 is an increasing function, qi,j is qjmin, the evaluation value is 0, qi,j is the closer qjmax. The higher the value is, when qi,j = qjmax, the evaluation value is 1; When qjmax – qjmin = 0, this shows that property values are equal, let the evaluation value be 1.

$$V_{i,j} = \begin{cases} \dfrac{q_{i,j} - q_j^{min}}{q_j^{max} - q_j^{min}} & \text{if } q_j^{max} - q_j^{min} \neq 0 \\ 1 & \text{if } q_j^{max} - q_j^{min} = 0 \end{cases} \quad (1)$$

Example 1: Let the candidate sets of Web services which complete task t is a total of 10, its execution time attribute value (in milliseconds) in the jth columns of the quality matrix Q, which indicate respectively qj = (180, 160, 90, 150, 100, 120, 220, 220, 260, 280), since the execution time is the type of reduction quality attribute, we use formula (1) to normalize, where qjmax = 280, qjmin = 90, after treatment of normalization, the attribute value of execution time is vj = (0.53, 0.63, 1.00, 0.68,0.95, 0.84, 0.32, 0.32, 0.11, 0.00).

7. Algorithm to find out weighted matrix N

If the QoS attribute is decreasing attribute

Then Apply

$N_{i,j} = [w-[v_{i,j}*w]]$

If the QoS attribute is increasing attribute then Apply

$N_{i,j} = [v_{i,j}*w]$ After calculation we get the Normalized Matrix

Where $N_{i,j}$ is the weighted results of j^{th} attributes of the i^{th} service.

8. Summation of matrix row wise
9. Rank the result in decreasing order.

That order is nothing but the ranking of desired web services as per the user requirements. When user gives input at the same time our System find out the terms which are related to the QoS using ontology. After identifying the QoS System calculate the weight for respective QoS.

V. EXPERIMENTS AND VERIFICATION

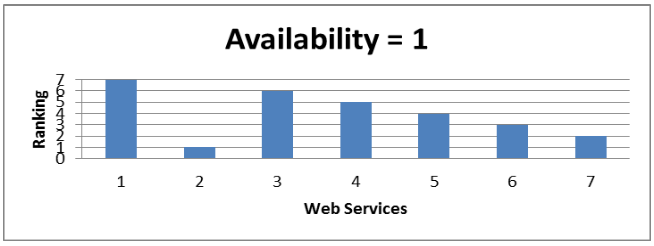
In order to verify the feasibility and the superiority of the semantic Web service selection algorithm with QoS constraints, we use the following examples to test. Our System provides different result on different input conditions. We have tested our algorithm on small dataset for analysis purpose. The graph shown below shows the output of ranking in various input condition. We have considered below dataset as input to our system. We have referred dataset from our base paper for comparison with referred algorithm [6]. This is shown in table 2.

TABLE 1.2 Input Dataset [6]

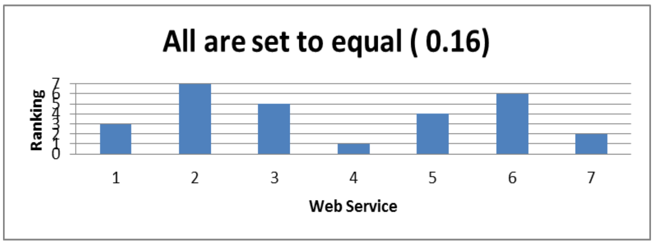
Serial Number	Response Time	Availability	Throughput	Successability	cost	Reliability
1	720	85	6	87	1.2	80
2	1100	81	1.74	79	1	100
3	710	98	12	96	1	100
4	912	96	10	94	7	100
5	910	90	11	91	2	70
6	1232	87	4	83	0	90
7	391	99	9	99	5	90

Below graph shows the different ranking in different condition.

Weight of Response Time Considered 1; Remaining QoS Weight is Set to 0



Weight of Availability Considered 1; Remaining QoS Weight is Set to 0



All are set to equal (0.16)

From graph we can conclude that our framework work for different scenario.

VI. CONCLUSION

As number of web services that offer similar functionality increases, QoS properties becomes a crucial issue during selection and ranking of appropriate web services. Exponential growth in Internet and in turn in web services demands a very strong QoS management system. In this paper we have studied various algorithms of semantic web service selection based on QoS properties. We have proposed a novel QoS aware web service selection and ranking framework based on Ontology. Using NLP processor we have given freedom to the consumer to specify their preference in natural language. We have used the dimensionless methods for defining QoS matrix which has given close to accurate results and it is good for comparison of QoS values of web services. Our result analysis graph ranks web services precisely on user preference like reliability, response time, throughput and availability. We can conclude that our algorithm improves the precision of web service selection process by 10% as compare to referred algorithm.

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