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Comparative Study Of Web Services Selection Techniques

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Abstract

Web services have become indispensable part of our daily lives which is the major reason of exhaustive research in the field of web service selection. There are endless numbers of techniques for semantic web service selection. When a user searches for a web service, many web services with similar functionalities are retrieved. Choosing the "best" from the suggestions is the motive of the selection techniques. This selection cannot be based merely on functionality matching but non-functional properties (QoS) are also to be considered. In this paper a comprehensive outline of various categories of Web Service Selection in the literature is propounded and hence drawn the comparative analysis for the techniques based on non-functional properties i.e. Quality of service.

Keywords: Dataset; OWL; QoS; RDF; Semantic Web Service.

1. Introduction

Web services are software applications supporting distributive computing. They are interoperable, irrespective of the platform and technology used over a network. Web services work on standard internet protocols (HTTP) which enable access of different resources. SOAP provides an envelope to the data on Internet, WSDL is a format to describe the web service and UDDI provides the registry of available web services. WSDL and SOAP are limited to service's syntax only. Facilitating semantics on web allows substantial access to the content as well as the services. Semantic markup languages define the data and create ontologies. The computational devices use these ontologies for parsing and hence understand the meaning of data. The most basic assertion model is RDF, the Resource Description Framework [1]. DAML+OIL, OWL and OWL-S are the languages built on RDF. RDF Schema describes RDF vocabularies. OWL [2], the Web Ontology Language, provides for more expressive vocabularies than RDF-Schema; and OWL-S, is the Web Ontology Language for services [3]. The semantic web concepts applied in web service technology forms Semantic Web services. [4] Integration of business, applications and customers can be achieved effortlessly through the dynamics and automation of semantic web services. To automate the various tasks in web services, the formal specification of requests and service publications are required. OWL-S, WSDL-S [3] and WSMO are the three major technologies to describe the semantics of Web services. Web services are published, discovered and bind. They are stored in a centralized directory of services. A Web service provider is required to create a web service and then publish its details in its registry. When a client requests a web service it uses registry and invokes a suitable selection technique to fulfill the request.

2. Characteristics of Web Service Selection Process

- **Flexibility:** to cater substantial number of services providers.
- **Accuracy**: the selection algorithm ought to be accurate in matching the user requests across different interfaces.
- **Scalability:** to cater magnificent number of non-functional requirements.
- **Generality:** to cater divergent users and their requirements, instead of specific types of users.
- **User personalization**: to take user preferences automatically and provide the correct service to the user.

3. **Categories Of Various Selection Techniques:** We can group the approaches of selection into several categories:

3.1 Matchmaking Selection Techniques:

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3.2 This category of services works on the principle of assigning ranks to services. Ranking is facilitated through the calculation of degree of similarity between the services requested and the provided ones. [7] provides a description logic ascertaining dynamic discovery of services based on semantic comparison between a client request and available services. Motive is to find the best match. In this approach, a description logic D is expressed as a set P of e-services and a query Q. A set of e-services M should be found, such that Q and M should have maximum matching information and least extra information with respect to Q. Description of services (UDDI) and algorithm for the purpose are used for the discovery task.

[8] provides an algorithm based on description matching, that assign ranks for the level of matching to services with requirements. Ranks are calculated from individual elements of the DAML-S description and then aggregating the individual degree of matching. The best possible service can be chosen autonomously from an ordered list of services. Two scenarios are considered: First, a server is used centrally for storage and processing of services i.e. centralized approach. Registration of web services is done on server repositories. A service requester specifies his query and description of the requirements and the server processes this request by matching the requirements with the available description of services. Servers also provide interface to matching algorithm. This is comparable to the UDDI setup. Second, matching is performed by requester by acquiring the DAML-S description and address of the service from the repository. User finds the eligible services, processes the descriptions and ranks the service by their level of matching. It is a distributive approach.

3.3 Quality of Service (QoS) Selection Techniques:

QoS is considered as most crucial property for service selection. QoS describes non-functional properties of web services like reliability, response time, flexibility, security, cost, throughput, reputation delivering etc. Current literature has exhaustive techniques based on these non-functional properties, among which some approaches are based on one dimension [8] [10] [11] and the others are multi-dimensional. Some common QoS parameters used in various approaches are:

- Reliability: In terms of Access rate, Bounce Access Rate and Fail Access Rate
- Cost
- Reputation
- Flexibility
- Availability
- Efficiency: In terms of Throughput and Response time
- Security

Quality of Service (QoS) Selection Techniques can further be grouped in the following major groups:

3.3.1 Based on QoS computing: Computation of QoS parameters involves an objective function which uses numerical calculations and technical standards to find the best among the registered services

[10] [11][9] [10] focuses on dynamicity of selection. Computation of QoS of different parameters is the chief requirement. The QoS information is stored in registries which are either given by the service providers, or by user's feedback, or computed from monitoring the previous usage of the users, or from the characteristics exhibited by each QoS criterion. Framework is proposed that aims at QoS modeling, computation and policing and gives QoS model that is extensible (allows domain specific criteria added without changing the base computation model), open and dynamic (i.e. services requester and providers both can access the runtime information).

[11] suggests a framework to extract the best service from a list of functionally similar services provided by different service providers at runtime. This selection is done in terms of certain QoS properties using three different approaches- RPC, mobile agent approach and circulating mobile agents approach to obtain the functionality.

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Based on Agents: the agents use matching algorithm, which performs a match between the requested qualities and the provided ones and presents the best service. In [12], agents work in collaboration to rate each service provider. They autonomously decide the extent to which they should give weightage to each other's recommendations. The work proposed a reasoning algorithm for agents using concept lattice. Evaluation on different datasets reveals the outcome of the best match. This dataset includes the feature preferences of users as well as the associated feature values from the service providers. Product selection and service selection were differentiated. Agents evaluate other agents on ratings while service providers on scores. Concept lattice provide interface for interaction between agents for service selection. Evaluation of service selection technique is done by Concept-Based Collaborative Evaluation. Metrics compare different methods of selection. Concept of proxy agents introduced for different algorithm calculates the reputation of services. These proxy agents collect and process the rating information of usage of web services [13]. DAML ontology for the service that is being proxied is used as dataset. Proxy agents too influence each other's choices and collaborate. Agents that do not have any knowledge of the required service choices yield optimal results. This is true for a homogeneous and distributed service-oriented architecture where services are changed and added continuously. [14] proposed a multiagent framework using QoS ontology and a model of trust. The framework permits service providers to advertise their services and users to specify their preferences or likelihood. Ratings of the services are collected, aggregated and shared. These are an important aspect for service selection. Ratings are based on quality generated automatically or through client's input. Agents here also work in collaboration. Agents work dynamically to get the best service for a client request. The concept of explorer agents is presented. Explorer agents keep a look out for new services or the services that behaved poorly in past but now function properly.

3.3.2 **Based on QoS ontology**: Ontology specifies the semantic description of the quality of web service. Ontology presents a vocabulary for quality. It facilitates the reasoning and collaboration between various agents. Broker agents are presented [11]. QoS ontology and mixed context both can be used for automatically selecting the best service [15].The paper frames a model for e-business and B2B interactions that works automatically for choosing the best service from various heterogeneous services.

3.4 Configurable Web Services based selection Techniques:

These selection techniques, helps in personalized selection of web services. The selection techniques assign ranks to various web services on the basis of user's preferences. These approaches facilitate maximum degree of interoperability among web services. Thus, they influence the current web standards. The techniques are implemented on prototypes and performance evaluation is done using simulation. The 'best' web service from various services with similar characteristics is selected as per the requester's requirements and preferences. In [16] the user particularizes the QoS parameter which should be given preference. When there is no specification from the requester then overall RankQoS calculated from the weighted sum of specified QoS parameters, is considered. The QoS parameters are formalized to increase the applicability of web service selection. Technique uses QoS mediator agent between clients and service providers to select suitable Web Service, which fulfill user's requirement and provide maximum automicity.

3.5 Communities based selection Techniques:

These selection techniques facilitate the registration of services to a community. Service providers should register their web services in a community and clients select the appropriate service either at design time or at run time.[17] gives review of different trust and reputation systems and their classification. Three types of classification have been suggested. It may be global or personalized, centralized or decentralized and agents or resources. These aspects elucidate the contrast between existing trust and reputation systems and direct the potential research directions in the field of trust and

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reputation for web services [18]. [19] implements QoS characteristics and ranking methodology to trust and management system for providing solution to the problem of false ratings. This technique helps to identify the dishonest providers and the false users as well.

3.5 Some more techniques based on QoS:

[20] provides extensibility to prevailing QoS model by adding some advanced attributes depicting the performance of web services. These attributes use ANN, which gives a dynamic, on demand service performance prediction. Hence, present an efficient way to select the "best" web service based on user's preferences and service performance estimation. The framework takes user preferences (non-functional requirements) with other requirements and ranks the available services accordingly using selection and matching engines. There is a great dependency on matching and selection engine [21].Semantic web service selection is implemented in an interactive and incremental process. Users can formulate their requirements formally or semi-formally and hence provide the opportunity for model adjustments [22]. [23] provides a technique to extract WSDL documents and categorize them into QoS similar web service groups. It uses QoS values taken from the description files and calculates the similarity among the various Web services. Clustering increases the performance of service discovery considerably by analysing the best cluster value instead of analysing the huge amount of data. The works by first filtering the web service and extract their QoS values. These extracted values are grouped in clusters and then the selection technique finds the best service.

4. Comparison Of Selection Approaches Based On QoS

We can compare various QoS based approaches on the basis of the characteristics given in the table **1.**

Table 1: Comparison of various QoS based Semantic Web Service selection Techniques

	[13]Micheal Maximilien 2003	[10] Y. Liu 2004	[11]Padovitz et al 2005	[21] Y. Badr et al 2008	[15]Nabil Kaske et al 2010	[23]Karthiben 2014	[24] Joshi 2016
Modelling	**Not Specified**	**Extensible QoS Model**	**RPC, Mobile Agent and Circulating Models**	**Ontological Modelling**	**Multi agent model**	**Extensible QoS Model**	**QoS and QoE integrated Modelling**
Ontology of QoS Categorization	**Not Specified**	**Yes**	**Not Specified**	**Yes**	**Yes. QoS and mixed context**	**Yes**	**Yes**
User Preferences	**Yes**	**Yes**	**Only at initial stages**	**Yes**	**Yes**	**Yes**	**Yes**
QoS Evaluation	**Not Specified**	**Yes**	**Yes**	**Yes**	**QoS and Context evaluation**	**Clustering techniques**	**Qos and QoE and QoES are evaluated**
Aggregation of Evaluation of QoS	**Not Specified**	**Yes**	**Yes**	**Yes**	**Not Specified**	**Yes**	**QoS and QoE both**
QoS Properties	**Not Specified**	**Execution price, Duration, Reputation**	**Response time, availability**	**Execution, Security, Business**	**Interoperability, economy, universality, flexibility, reliability**	**Latency, Availability, response time, throughput**	**QoS and QoE properties**

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Extent of Autonomity	**Automated and Semi automated**	**Automated**	**Automated**	**Automated**	**Automated**	**Automated**	**Automated**
Co-ordination	**Centralized**	**Centralized**	**May or May not be centralized**	**Centralized**	**Centralized**	**Centralized**	**Centralized**
Agent Involvement	**Yes**	**No**	**No**	**No**	**Yes, 3 types of agents**	**No**	**No**
Ranking Algorithms	**Yes**	**Yes Using Normalization Matrix**	**Yes, acc. To user's requests**	**Weighting Coefficients**	**Yes, Probability Model**	**Yes, K-Means Algorithm**	**TOPSIS approach**

5. Challenges

As it is clear from the table 1, we see a drastic evolution in the techniques of selection. Starting from some of the QoS parameters to integrated QoS and QoE parameters evaluation have make the method of selection of web service quite efficient, but still there are many challenges to be addressed in the field. The existing service selection schemes are required to take into consideration the impact of size of dataset or the geographical location to support the recommendation web services. There is a possibility of the false ratings with respect to web services. If the ratings registered are false it would affect the results of selection considerably.

6. Conclusion And Future Work

With the increase in functionally similar web services the service selection becomes increasingly important. For selection, functional, non-functional and user based approaches should be appropriately used. From our study we conclude that abundant research in the field web service selection has paved a path for various approaches like vector and matrix based approaches, ranked based approaches, utility based approaches etc. The service selection algorithm needs to incorporate "data-dependent QoS attributes". For future, we would work with a selection approach which considers not only a service's QoS properties, but also the meta-attributes (e.g dataset size, data selection, datatype etc.)

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