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Flexible Model Driven Approach for Quality Aware Web Service Selection

Rashmi Phalnikar
Department of Information Technology,
MIT College Engineering,
Pune, India

Devesh Jinwala
Department of Computer Engineering
SV National Institute Of Technology,
Surat, India

ABSTRACT

We describe a flexible web service selection model that will rate the web services based on Quality of Service (QoS) constraints. To maintain the QoS factors the non functional requirements (NFR) of a web service such as response time, throughput, reliability and security are crucial during web service selection. The performance depends not only on satisfying functional requirements, but also fulfilling the client's NFRs. Since NFR are never completely satisfied and meeting one NFR may lead to inconsistency in another NFR, it is vital to study the NFR, their conflicts and how they influence web service selection process. Our study suggests that the existing methods have not understood the effect of conflicting NFR on QoS values. The proposed method will detect these conflicts using Ontology, Unified Modeling Language (UML) and UML Profile. To explain our idea we consider a remotely monitored patient. The method is expected to greatly reduce the development cost, operational time and provide flexibility for fine tuning.

General Terms

Software Engineering, Model Driven Architecture, Non Functional Requirements.

Keywords

Conflict Detection in Non Functional Requirements, UML Profile Ontology, Web Service Selection

1. INTRODUCTION

The area of Web Service Discovery and Selection is a vast area of research under distributed computing, Service Oriented Architecture (SOA) and its related fields. In SOA, software resources are packaged as web services. They are well-defined, self-contained modules that provide business functionality. Web services integrate a set of protocols and standards for interchanging data among software applications that are developed using different programming environments and languages. Several existing open standards for eg. XML, SOAP, HTTP, WSDL and UDDI ensure interoperability and execution on different platforms.

The central issue of this field is the discovery methods of web services which depend on the functional requirements of the users. However, in the last few years the importance of NFR has been highlighted. The NFR refer to the quality of service (QoS) i.e. behavioral characteristics that the web service exhibits for a given functionality. As many Web Services that exhibit similar functional characteristics may exist, it is important that web service framework is improved so that non functional characteristics of a web service can be determined at run-time and consumers are bound to a service that best meet their functional as well as non-functional requirements. However as NFR are known to conflict they need to be investigated as to how they can affect the system's consistency. Our work concentrates primarily on detecting the conflicting NFR and their effect on the system behavior.

The current QoS-based web service discovery and selection efforts only differ in the manner that the NFR are expressed. The efforts are not able to model the conflicting NFR and the extent of their effect. There is a need to express the NFR conflicts syntactically and completely as it has a direct effect on QoS-based web service discovery and selection methods and algorithms.

There are a lot of challenging problems associated with web service selection. From our study, we can broadly discuss the pros and cons of the current approaches. One of the traditional methods is to search through the published description of web service's Web Service Description Language (WSDL) file on Universal Description, Discovery and Integration (UDDI) [1][2]. Use of information retrieval approaches in web service selection consists of keyword search on UDDI. The name of a web service or web service provider or a tModel must be known to get further details. A suite of algorithms for similarity evaluation between two WSDL descriptions have also been developed. They are based on information retrieval and component matching method.

Another approach makes use of agents or brokers for locating available web services [3][4]. The agents interact and share information, allowing applications to be dynamically configured at runtime and adapting to user preferences. Use of user rating or feedbacks to locate the best suitable web service has also been explored [5]. User rating, user feedback and active monitoring mechanisms followed by prediction methods have been used to locate the most suitable web service. QoS matching algorithms consider and compare the user's QoS with the web service. Methods explore collaborative filtering, fuzzy c means and tress type data structures. However, the accuracy of matching is not certain and is limited to a particular domain. Application of ontology concepts to store the description of NFR specific to the domain has been tried and has given good results [6][7]. Ontology can provide standardization and increase in machine understanding.

The remaining of the paper is as follows. Section II gives literature survey of related work. Section III discusses the need of a new web service selection method to provide flexibility and transparency. Section IV introduces the proposed method. Section V concludes and gives direction for future work.

2. RELATED WORK

One of the earliest significant works by Ran [1] suggests four roles in his proposed model: Web service supplier, Web service consumer, Web service QoS certifier and the new UDDI registry that stores the functional description of the Web service and its QoS. Further relevant proposals in the field of web service discovery use an extension of UDDI that contains WSDL specifications. In this way, dynamic retrieval through common terminology and shared meaning is enabled. Al– Masri et. al. [2] suggests three approaches type, keyword-based and ontological to model QoS tModel (Technical Model) for storing QoS in UDDI and aggregating QoS values.

Dong [8] describes an approach based on matching on term association analysis. In information retrieval approaches to web service discovery, a query consists of keyword that is matched against the stored descriptions in the extended UDDI. Wang [9] optimizes the design of Unmixed Semantic UDDI Model and uses clustering technology to preprocess the user preference.

Another method for locating the most appropriate web service makes use of a middleware agent or broker. Maxmillen and Singh [3] proposed a multiagent approach where agents represent applications and services. The agents interact and share information, allowing applications to be dynamically configured at runtime and adapting to user preferences. Rajendran et. al. [4] proposes the multi-Agents, response agent, certification agent and query agent based architecture for both services registration and service discovery.

Some web service discovery methods rank the web service based on QoS values and its reputation. The weak link here is the integrity, reliability and trust-worthiness of the agencies. Esfahani [10] proposes a broker and service level agreement (SLA) template repository. The broker helps find services that meet the functional and QoS requirements specified by the consumers and these are ranked based on ranks generated by reputation administrator. D'Mello et.al. [11] suggests a repository to store, retrieve the QoS information by use of a QoS broker and ranks them based on the requester's requirements. Xu et.al. [12] first sets up the requirement model, clusters them according to users' common requirements and obtain corresponding web services' QoS values. Xie et.al. [5] proposes a dynamic framework that uses Collaborative Filtering (CF) to predict the QoS values and enables the evolution of Web Services. In this framework, the QoS values of current users can be predicted using the past QoS data of similar users.

The web service discovery work is supported by QoS ontology to describe NFR [6][7] and promote consensus on QoS concepts. It provides a model which is generic enough for reuse across multiple domains is analyzed to reduce misunderstanding. The problem that arises here is how to map the quality preferences of the consumers with the quality categorization in QoS ontology.

The match making algorithms must be able to handle both 'design time' and 'run time' value of QoS. Matching algorithm suggested by Baocai et.al. [6] makes use of domain ontology and reasoner for matching semantic and then numeric values. Hunaity et.al. [13] designs a new framework that enhances retrieval algorithms by combining syntactic and semantic matching of services. Kritikos [7] makes use of and promotes Mixed-Integer Programming (MIP) as a matchmaking technique. Other methods proposed include use of tree-form data structure [14] and computes the semantic similarity between the Web Services. Torres [15] uses a modified fuzzy c-means module that allows providers to automatically organize themselves around the QoS levels.

3. MOTIVATION

Our study of various methods makes evident the shortcomings of these strategies. We provide a brief description below.

The problem with methods that use WSDL for Web service discovery is that WSDL syntax is designed to give descriptions detailing its functional aspects, implementation interface etc. It is not designed to store or publish the non-functional aspects.Even though UDDI allows search on limited attributes of a service, namely, Service Name and key Reference, it doesn't have the provision to store the run-time performance parameters. Hence, an extension of the UDDI is required and keyword-based searching techniques can be used.

In strategies where user's feedback is used to rank the web service, it is observed that it is difficult to capture the user feedback about the service and store it to analyze and improve on these valuable metrics. Besides this, authenticity of the feedback is doubtful. Active monitoring also adds to high overhead since QoS must be checked constantly for a large number of Web Services. On the other hand, an approach that relies on a third party to rate or endorse a particular service provider is expensive and static in nature. The unavailability of a Universal Registry where all Web Services are published makes it difficult to compare the performance, scalability and statistical gathering of data.

In certain heterogeneous domains such as health care, different formats may exists for exchanging data. Domain-specific terms and concepts differ between vendors, causing non-uniformity in the way data is published. Technical differences exist between web services with similar functionality implemented on different platforms.

To overcome these drawbacks, we suggest the use of UML Profiles and its extensions supported by Ontology to select the best web service for a remotely monitored patient. The Model-Driven Architecture (MDA) approach defines system functionality using a platform-independent model (PIM). The MDA model is related to multiple standards, including the Unified Modeling Language (UML), the Meta-Object Facility (MOF), XML Metadata Interchange (XMI) to name a few. MDA separates the design from architecture.

Extension mechanisms in the UML allow refining standard semantics in strictly additive manner, and cannot contradict standard semantics. Profiles are defined using stereotypes, tag definitions, and constraints that are applied to specific model elements, such as Classes, Attributes, Operations, and Activities. The UML Profiles come with following benefits:

- The MDA approach offers productivity gains and flexibility. It raises the level of abstraction, and lessens or avoids disruptions to the system.
- Use of UML Profiles makes invariants explicit and formal and can be expressed independently of specific implementation technologies. It is easier for business experts to validate them and to re-implement the same logic over different implementation technologies.
- It enables re-usable code to be easily coded with highest

efficiency, reducing software development costs.

- Detects loopholes in design so that right decisions are made early reducing software development costs.
- It provides an enterprise-level view of the system and as a result, more memory and processor efficient systems can be designed.
- It enables ease of maintenance by providing more effective visual representations of the system. Consequently, maintenance costs are reduced.

4. PROPOSED METHOD

Our area of interest for studying NFR conflicts during web service selection is remote patient monitoring (RPM) in e-health care domain. The RPM system transfers vital statistics of the patient being monitored, to a health care professional in real time over the network. Medical practitioners are alerted as soon as a medical problem crops up, letting them respond faster. This aids them to adjust medication quickly or otherwise intervene in case of emergency. The benefits of remote monitoring of patients include:

- Reduces the number of hospitalized patients
- Saves healthcare costs
- Improves the treatment efficiency

Based on our detailed study and the shortcomings of the approaches, we propose the use of UML Profiles (stereotypes, tagged values and constraints) and Ontology for selecting best suited web service. We assume that the services which satisfy the functional requirements are previously shortlisted. The task ahead now is to select the best suited web service so as to:

i. Achieve the highest QoS factor
ii. Detect any conflicts between the NFR of the user and service provider to avoid unpredictable and ambiguous state of the system
iii. Identify how the selected web service may affect the QoS factor
iv. Design an extensible QoS that allows addition of new quality criteria without affecting the algorithm for the overall computation of QoS values.

As the new generation Web Services develops, selection of web services is driven by business requirements. One cannot limit the search to a motorized approach that considers web services as objects that are not likely to provide the level of quality needed. A possible approach for supporting the fine tuning is to provide an alternative that presents the designer with a range of options to choose from depending on the user's requirements.

Thus, we would achieve a higher degree of development process automation with a degree of flexibility. Use of SOA architecture is beneficial for our system as it easily allows addition of new features without modifying the existing ones. Because these are based on existing services, the code reuse is maximal, and the development and testing time is minimal.

The following figure Fig. 1 shows the framework of our proposed Web Service Selection model that is based on MDA.

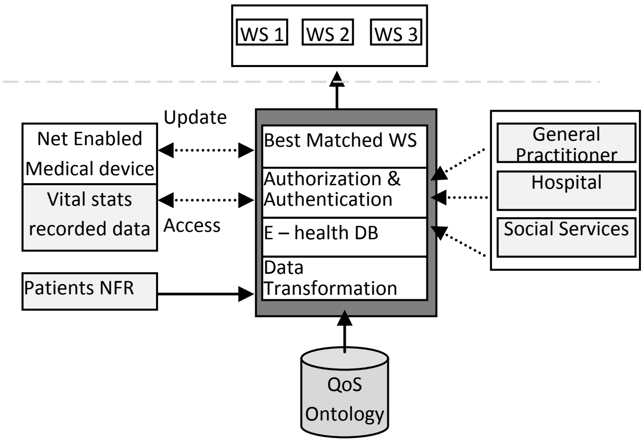

Figure 1: Proposed Framework

As the vital statistics of the remote patient are recorded and transferred to the health care professional, the security of data is the prime concern. Besides satisfying the personal constraints of the patients, constraints related to security must also be satisfied. Finding such an Web Service is the prime concern of our web service selection model.

The problem is to find the best provider of web service that satisfies the request for service. To solve this, the following steps are required:

- Submit the query with terms and values of quality within their context.
- Shortlist services that satisfy the non functional requirements.
- Study each web service NFR and detect conflicts between the provider's NFR and patients NFR.
- Select the best web service that gives a high QoS.

We focus on a chronic obstructive pulmonary disease (COPD) patient. A COPD patient can be successfully monitored at home with a high quality of clinical service, no hospitalization and no increase in cost. Monitoring of patient can enable more sophisticated home care, detect deterioration prior to symptom development and minimize the need for complicated and cumbersome patient transportation to hospita appointments. One needs to record and monitor the following vital stats:

- Oxygenation of a patient's hemoglobin
- Volume of air inspired and expired by the lungs
- Blood pressure
- Blood pressure that varies between a max (systolic) and min (diastolic) pressure.

For the current scope of our work, we focus on the security of data (NFR of patient) and how it may affect the response time of the web service. As the authentication process becomes more complex the response time reduces. Some points to consider would be:

- The patient's data has to be transferred online to the hospital/doctor for careful consideration.
- The access control needs to be defined at the hospital level.
- The device that has been given by the hospital to the

patient controls the functioning of the device.

- As the patient logs in to the device, her data is monitored by the hospital
- Chronically ill patients that are located at home require treatment with daily monitoring
- There is a need to clarify actual standards suitable for integration of information, and how patient-may enter data, including vital signs recordings and fitness and lifestyle details. These values can be shared between the patient, his/her relatives, training partners and the health care professionals.

To monitor patient's, we need a model that will take care of the patient's NFR and compare with the web service. The UML model will help to understand the NFR conflicts as well as the effect of conflicting NFR To the best of our knowledge, use of UML Profiles for detecting NFR conflicts is unexplored. Our study suggests it can give beneficial results to the area of web service selection where QoS specifications are crucial. Table 1 lists some situations under which NFR could conflict.

Table 1: NFR Conflicts

Situation	Actual Function	Conflicting NFR
Automatic update of patients data	Export and import of data	Security vs. Response time
Access to data	Indexing of data to locate data	Security vrs Response time
Secure login	Transparency, Authentication of user	Security vs. Availability
Patients travelling to new places	Variation in metrics or methods of data reading. standardization of data format	Integrity vs. Availability
Data should be in control of the patient and health professional		Security

4.1 UML Models

UML Models different aspects of the software system with the help of its diagrams. As the software system evolves, the diagrams get modified that leads again to possible inconsistency and incompleteness between the different versions of these diagrams.

Developers are faced with two main problems during a process of model construction :(a) the problem of consistency among different diagrams within a given model, and (b)the problem of consistency between two different models. We are interested in case (b) where we compare diagrams, one from the patients model and other from the web service model.

The model comparison is similar to the process of comparing two versions of source code. Two class diagrams can be compared and differences can be visualizes. The advantage of this specialized algorithm is the ability to find similar and identical elements and to describe the differences more accurately. We propose to study the use of other UML diagrams, stereotypes and their consequence of the mismatch between them.

To implement this , one could consider the type of elements , order of classes, attributes and operations within a class , names of classes, attributes, operations and parameters, stereotypes and their relations for understanding of conflicts. Further comparison may be based on types of relationships, types of metric values, complexity, and theoretical and empirical validation in cases where the dynamic values are important. As the two class diagrams (one of patient and other of the web service) match functionally , much of the conflicts refer to the NFR mismatch. If these conflicts are not discovered in this conflict detection process, they may be understood in the wrong context or be missed entirely.

5. CONCLUSION AND FUTURE WORK

This paper reviews various methods of Web Service discovery and selection, their benefits and shortcomings. The importance of QoS is also highlighted. The paper proposes a new Web Services discovery model where NFR are considered for service selection. The paper proposes the use of Model Driven Architecture (MDA), UML Profiles and its extensions for identifying the most appropriate web service. It is proposed after the discovered web services that satisfy functional requirements, are ranked based on the requester's constraints. The framework is expected to improve the effectiveness and accuracy of Web service discovery and can return the best matched services to meet user's both functional and NFR needs. NFR conflicts and its effect on the working of the system is also initiate. It can be used to support the dynamic discovery and selection of Web Services with QoS information. Further work is needed in establishing the matching algorithms between the desired and Web Service QoS. The method is flexible as it is not limited to specific service model. It also contributes to the improvement of service selection efficiency when service is retrieved in an automatic way.

In future, we plan to extend QoS parameters to include information such as response time, availability, security constraints, reliability etc. Our future interest and work focuses mainly in three directions: a) investigating the NFR conflicts and its impact on the web service b) detecting these conflicts and c) extending our experimental setup with additional scenarios in the future.

6. REFERENCES

[1] Shuping Ran.: A model for Web Services discovery with QoS. J SIGecom Exch. 4, 1 2003

[2] Al-Masri, E.; Mahmoud, Q.H.; , QoS-based Discovery and Ranking of Web Services,In: 16th International Conference on Computer Communications and Networks, 529 – 534 , (13-16 Aug. 2007)

[3] Maximilien, E.M.; Singh, M.P. : A framework and ontology for dynamic Web Services selection, Internet Computing, IEEE , vol.8, no.5, 84- 93, (Sept.-Oct. 2004)

[4] T. Rajendran, P. Balasubramanie, : An Efficient Multi-Agent-Based Architecture for Web Service Registration and Discovery with QoS, European Journal of Scientific

Research, Vol.60 No.3 , 421-432 (2011),

[5] Qi Xie, Kaigui Wu, and Jie Xu. : QoS Driven Web Services Evolution. In: International Conference on Complex, Intelligent, and Software Intensive Systems (CISIS '11). 329-334 , IEEE Press Washington, DC, USA, (2011)

[6] Yin Baocai, Yang Huirong, Fu Pengbin, Gu Liheng, Liu Mingli, : A framework and QoS based Web Services discovery,In : International Conference on Software Engineering and Service Sciences (ICSESS), .755-758, (2010)

[7] Kritikos, Kyriakos, Plexousakis, Dimitris, Semantic QoS-based Web Service Discovery Algorithms, In :Fifth European Conference on Web Services (ECOWS 2007) 181-190, (2007)

[8] Wenli Dong,: QoS Driven Service Discovery Method Based on Extended UDDI, In: Third International Conference on Natural Computation, ICNC 2007, .317-324, (2007).

[9] Mo Wang, Xiaofeng Li, Xiuquan Qiao , Semantic web service discovery based on user preference cluster,In : International Conference on Broadband Network and Multimedia Technology (IC-BNM, 2010), IEEE Press ,939-944, (2010)

[10] Reihaneh Khorsand Motlagh Eshahani, Farhad Mardukhi, Naser Nematbakhsh, “Reputation Improved Web Service Discovery Based on QoS”. Journal of Convergence Information Technology , Voulme 5, Number 9, 206-214, (2010)

[11] D'Mello, D.A.; Ananthanarayana, V.S.; Santhi, T.,: A QoS Broker Based Architecture for Dynamic Web Service Selection, Second Asia International Conference on Modeling & Simulation, AICMS 08. 101-106,(2008) .

[12] Ziqiang Xu; Martin, P.; Powley, W.; Zulkernine, F., Reputation-Enhanced QoS-based Web Services Discovery, In : IEEE International Conference on Web Services, ICWS 2007., Pp.249-256, (2007) .

[13] Hunaity, M.A.R., : Towards an Efficient Quality Based Web Service Discovery Framework, In : IEEE Congress on Services - Part I, .261-264, (2008)

[14] Wuling Ren; Zhujun Xu,: A New Web Service Discovery Method Based on Semantic,In : Workshop on Power Electronics and Intelligent Transportation System, PEITS '08.,Pp.223-226, (2008) .

[15] Torres, R., Astudillo, H., Salas, R.,: Self-Adaptive Fuzzy QoS-Driven Web Service Discovery, In : IEEE International Conference on Services Computing (SCC), 2011 , .64-71, (2011) .

[16] Timm, J.T.E., Gannod, G.C.,: A model-driven approach for specifying semantic Web Services,In : IEEE International Conference on Web Services, ICWS 2005. 313-320 (2005)

[17] Ortiz, G.; Hernandez, J.; Sanchez, F., Model Driven Extra-Functional Properties for Web Services, In : Srvices Computing Workshops, SCW '06. IEEE Press, .113-120, (2006)

[18] Skogan, D.; Groenmo, R.; Solheim, I.,Web service composition in UML,In : Eighth IEEE International Enterprise Distributed Object Computing Conference, EDOC 2004. , 47- 57, (2004).