MobiDisc: Semantic Web Service Discovery Approach in Mobile Environments

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Abstract. Over the last decades, Internet has grown dramatically. As a result of this growth, a huge amount of Web services and applications have emerged to fulfill consumer's requirements. At the same time, the mobile network industry has become ubiquitous as most consumers are now inseparable from their mobile terminals. The combination of mobile technology and web services provides new paradigm called mobile web services. In order to find services fulfilling the client's requirement, a discovery mechanism is needed. However, discovering services from devices is still a significant challenge due to terminal constraints such as screen resolution, smaller memory, CPU, mobility of consumers and the lack of service descriptions. Thus, the challenge is to increase the accuracy of the relevant discovered services that meet the user's need. In this paper, we present MobiDisc, our mobile web service discovery approach.

Keywords: Mobile web service discovery · OWL-S · Context · QoWS

1 Introduction

With the emergence of new generations of smart phones and mobile devices, consumers run more and more applications and web services anytime and anywhere. The combination of mobile technology and web services provide new paradigm called Mobile web services. Mobile web services has seen an explosion in interest [1], especially the discovery of relevant web services in such environment that still presents a challenge due to terminal constraints, the lack of enriched semantic web service description, the mobility of consumers while invoking web services. To our Knowledge, in the discovery process, researchers customize query by adding only mobile constraints or QoWS properties, if not, customize the web service description. In this paper we lay out the foundations of MobiDisc approach that allows mobile web service discovery according to context and QoWS-awareness. The ultimate objective is to enhance web service composition in mobile environment which constitute the second part of our work. In this paper, we only discuss MobiDisc which is based on three main contributions: the first one, is to extend the query and the web service description not only by

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semantic enrichement but also by contextual informations. This is done using the OWL-S ontology integrating QoWS, terminal constraints and user profile. The second one is to perform a matching algorithm based on an exact comparison between ontologies. Finally, Mobile web service will be developed to enhance the discovery of Mobile web services by ranking services according to service provider's reputation. The remainder of the paper is organized as follows: Sect. 2 introduces the related work, Sect. 3 discusses the proposed approach, Sect. 4 presents an implementation of the approach, finally, conclusion and future work are given in Sect. 5.

2 Related Works

Several approaches in the literature have addressed the subject of discovery of web services in mobile environments. We have classified theses approaches into two categories according to Context-awareness and QoWS-Context awareness. In the first category, Doulkeridis's [5] defined context as *"the implicit information related to both the requesting user and service provider that can affect the usefulness of the returned results"*. [2,5] identified three types of context: (i) user context which includes user profile, user preferences and location; (ii) Service context that contains provider identity, cost, payment method and (iii) physical context that includes terminal constraints: memory, screen resolution, OS, process speed, audio display, video display, bandwidth and battery. Peng et al. [4] wrote the query as service profile ontology of OWL-S by adding user profile and terminal constraints (terminal type, screen size, screen resolution, video display capability, audio capability). However, in this approach, researchers did not consider QoWS properties and some important terminal constraints like bandwidth and localization which are neglected. In [1], authors proposed MobiEureka, a WSDL syntactic description exploiting the standard CC/PP defined by W3C. Services are then ranked using DaRF [1]. This approach has used a syntactic description which suffers from expressiveness, additional to the lacks that CC/PP presents: Extensibility, expressiveness and automatic discovery. Finally,work in [6] proposed a mechanism called SeMoSD. It uses WSMO to describe semantically services and terminal constraints, but QoWS is not in their consideration.

In the second category, Mobile web service discovery Context and QoWS-awareness, approaches attempts to address the issue of discovery from two perspectives, functional and non-functional properties. This already presents a challenge. Non-functional properties are QoWS which are divided in [7] into two categories: runtime quality and business quality. Runtime Quality includes the response time, reliability, availability, accessibility and integrity. Business Quality refers to the cost, reputation and payment method. Mobile web service approaches QoWS-context awareness, take into consideration, QoWS, user context, physical context and service context to find relevant services. Work in [8] extends semantic description WSMO to WSMO-M integrating functional and non functional properties, without insisting on terminal constraints and QoWS used, in addition, WSMO is an ontology that is heavy to execute. In [9], authors

propose an approach which exploits CC/PP into an ontology called PBCO based on OWL (Ontology web Language) and DCO (Delivery Context Ontology). Even, this approach presents the advantage of the adaptive display on mobile devices. The construction of an ontology seems to be handmade and not standardized which poses problem of interoperability. Work in [12] extends the ontology OWL-S into two representations: EASY-Language and EASY-Matching. The EASY approach offers an efficient mechanism for service discovery only applied in a pervasive environment In order to fulfill the aforementioned gaps, we introduce our context and QoWS awareness approach. In addition to the enrichement of ontologies with QoWS properties and terminal capabilities, this approach adds an historization step to accelerate web service discovery.

3 Semantic Web Service Discovery Approach in Mobile Environment

As stated, our approach MobiDisc aims at increasing the accuracy of web service discovery process in mobile environment. To this end, our proposal is based on four steps. The first step is dedicated to the rewriting of the user query. Indeed, the discovery of adequate mobile web services suffers from a lack of environmental information regarding the user and the used device. Thereby, initial user query should be rewrited by adding for instance its terminal constraints, its profile and the expected QoWS properties as depicted in Fig. 1. In fact, the rewritten query adopts the service profile schema of OWL-S in order to facilitate the matching of the user query and mobile web service characteristics. In the second step, Web services are described using functional and non-functional properties. Functional properties represents especially physical context(service context and terminal context) and non functional properties represents QoWS features. We used and extended OWL-S service profile to describe the personalization of the web service description. Figure 2 is a snapshot of the enriched ontology. The third step is intended to perform a matching algorithm based on a comparaison of exact similarities between charateristics of the ontologies. The fourth step consists in a customization but also an enhancement of the mobile discovery process. Indeed, nowadays it's difficult to have confidence in all services given the large number of providers and of provided web services. In this context, our idea is to also consider the web service provider reputation and let user choose his/her criteria.Thereto, we base the computing and evaluation of web service providers reputation according to performance, security, quality of the services but also feedbacks and social networks. Knowing that those collected information are in constant change and frequently incomplete, we plan to use Bayesian networks. Indeed, Bayesian learning takes a probability-based approach to reason and infer results. Each training example that is encountered can change the probability that an hypothesis is correct. Moreover, rather than using knowledge from the current data set or training examples only, prior knowledge can be combined with the observed and incomplete data to meaningful achieve better results [11].

Select ?ServiceName,?ServiceURL	Select ?ServiceName, ?ServiceURL
Where	Where
{	{
?BookName &xsd:#string	?BookName: &xsd:#string
?Author &xsd:#string	?Author &xsd:#string
?DateEdition &xsd:#Date	?DateEdition &xsd:#Date
}	!Battery &xsd:#Concept
	!Audio_display &xsd:#Concept
	!video_display &xsd:#Concept
	!screen_resolution &xsd:#Concept
	!screen_size &xsd:#Concept
	!process_speed &xsd:#Concept
	!Memory &xsd:#Concept
	!OS &xsd:#Concept
	Filter
	!response_time <5s
	!Cost<30euro
	!Latitude ???
	!longitude???
	!bandwidth>100 Mbps and bandwidth<500Mbps

Fig. 1. Rewriting user's request example

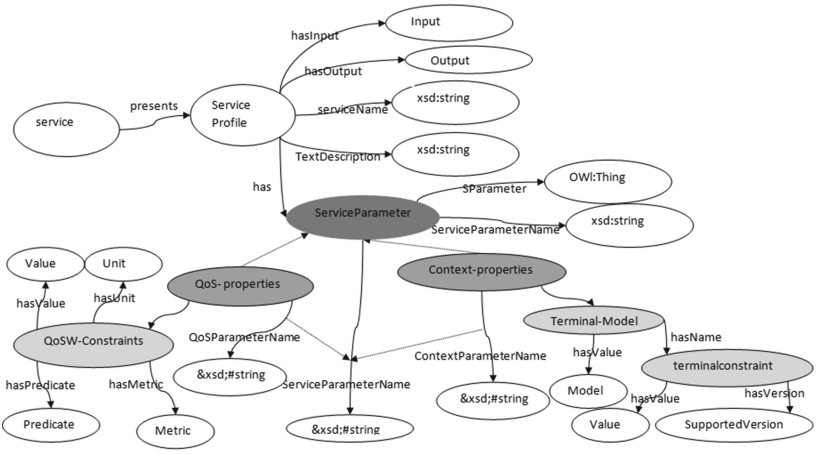

Fig. 2. Partial representation of the enriched OWL-S description with terminal constraints and QoWS

4 MobiDisc Architecture

In this section, we introduce MobiDisc architecture that takes advantage of the aforementioned features. The ultimate goal is to decrease the number of candidate web services to find the most relevant service that responds to user's requirements. Our architecture shown in Fig. 3 is composed of three layers. Each layer uses the result of the previous one. In this paper, we will introduce the first layer. To do this, we were inspired b the work in [3,10] that handles the discovery of web services QoWS awareness in a static environment. Thus, we developed an OWL-S extension of a QoWS-context aware web service description for both request and advertised services. In order to support semantic QoWS and context matchmaking, we differentiate between request profile of a user and an advertisement profile provided by a specific service provider. Meanwhile, a profile advertised by a service provider, should have the following characteristics: QoWS properties such

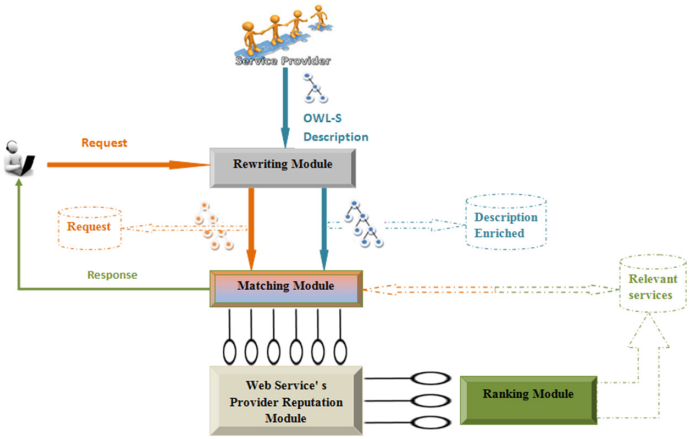

Fig. 3. MobiDisc's architecture

as reliability, cost, response time and disponibility, context properties related to terminal caracteristics includes OS, AudioDisplay, VideoDisplay, ScreenResolution, MemorySize, ProcessSpeed, Battery, Bandwidth. Therefore, upper profile ontology which satisfy the above requirements can be seen in Fig. 2. To implement the ontologies, we used Protege 3.5, including OWL-S tab editor. Then, OWL-S is connected to QoWS ontology and context ontology. To design this, QoWS-properties and Context-properties are two subclasses of OWL-S ServiceParameter. The service provider provides such an offer profile in its advertisement like: (response time, equal, 300, millisecond). Also, terminalModel is a subclass of ContextProperties which have also a subclass called TerminalConstraints. Service provider would provide such an offer profile in its advertisement service like: (iphone5S, ScreenResolution (1 136 $\times$ 640, Ecran Retina 4 pouces)). Request profile ontology is prepared in the same way, adding a third subclass of ServiceParameter which is UserProfile. This class contains a set of subproperties: login, password, payementmethod and localisation. After enriching of the query and the service description, a matching algorithm is needed to calculate similarities between the two ontologies and decrease the number of advertisement services. Also, the matching algorithm compare the enriched query with relevant service description based on a calculation of exact similarities. This is an historization step which aim at accelerating the discovery process and to constantly update relevant web service repository. Finally, Our architecture contains a third layer designed to rank web services based on bayesian networks. This is done by increasing the accuracy of relevant web services according to the evaluation of the web service provider's reputation.

5 Summary and Future Works

This paper has introduced MobiDisc, which is a new approach for web service discovery in mobile environment. This approach aims at finding the most relevant web service by extending OWL-S Ontology with functional and non functional properties, matching request and web service description, then ranking the resulting services after evaluating provider's reputation. The matching algorithm and the Ranking web service are under implementation, and a timing comparative study between mobile web service approaches will be done in the next work.

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