ABSTRACT

Service computing has become a key-enabling technology to support collaboration and interaction among business partners and customers. With the development of new emerging service-related computing paradigms such as Cloud Computing and Mobile Internet, more and more services are provided by different providers. These services are becoming increasingly complex. Aiming at recommending high-quality and trustful services in the complex service computing environment, this paper presents a trust-aware search engine by integrating service functionalities, QoS (quality of service) and service trust. The proposed search engine primarily contains four components: keyword-based service matching, service QoS evaluation, service reputation evaluation and a hybrid ranking method which combines the results yielded by the previous three components to produce final service recommendations. To evaluate the performance of the authors’ service search engine, comprehensive experiments are conducted using a real Web service dataset. The experimental results show that our approach outperforms conventional QoS-based service selection methods. Finally, a prototype is also presented to validate the authors’ trust-aware Web service search engine.

Keywords: Complex Service Computing, Quality of Service (QoS), Reputation, Search Engine, Service Ranking, Trust

INTRODUCTION

Service computing, which provides flexible computing architecture to support modern service industry, has emerged as a promising research area (Zhang, Zhang et al., 2007; Papazoglou, Traverso et al., 2008). With the prevalence of service computing, more and more services are deployed on the Internet to provide rich functionalities. The number of services and service users are increasing rapidly. On the other hand, with the development of emerging

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computing paradigms (e.g., Cloud Computing, Internet-of-Things, and Mobile Internet), pervasiveness, context-awareness, and complexity of services are also increasing rapidly. Service computing is becoming more complicated than ever in terms of service creation, deployment, discovery and composition (Zheng, Zhu et al., 2013). There is a strong need for a solid platform which enables efficient and effective service searching and service selection in the complex service computing environment, as those that have emerged in the traditional e-commerce area (e.g., eBay and Amazon). To meet this need, a number of online Web service portals have emerged in recent years, such as Seekda, ProgrammableWeb, WSIndex, XMethods and so on. These portals have become the mainstream way of service discovery, which fill the gaps left by the closure of the traditional publishing and discovery mechanism, i.e., UDDI (Universal Description, Discovery and Integration) registries. For example, Seekda has collected metadata from more than 28,000 Web services which are deployed by different service providers; ProgrammableWeb currently has collected more than 9000 Web APIs and more than 7000 mashups. The number of services in these portals is still increasing drastically.

Services can be seen as tradable goods. Service users and providers are brought together to trade services engaged in business interaction (Cardoso, Voigt et al., 2008). In this regard, Web service portals are service marketplaces. In service marketplaces, trust is among the most important factors that influence service selection. On one hand, to gain the largest profit, service providers may exaggerate the QoS (quality of service) of their services. Therefore, QoS of services can be incredible, and trust becomes a major concern in service selection. On the other hand, service users can give feedback ratings to the services they consumed. Reputation of services can be obtained from user ratings, which can improve a user’s confidence in service selection. But meanwhile, malicious users may provide unfair ratings to services which certainly will affect the actual reputation of services. Existing service portals, however, usually use keyword search engines which rank services only based on functional matching of services with user input keywords. Therefore, these Web service search engine cannot work well in identifying high-qualified Web services for users.

To addressing the above challenge, this paper presents a trust-aware search engine for ranking services in complex service computing environments. We focus on Web service marketplaces consisting of services, service providers and service consumers, as well as interactions among them. The main contributions of this paper are as follows:

1. We proposed a brand new Web service search approach for complex service computing environments where service QoS may be untrustworthy. Different from previous service discovery approach, the approach takes trust of services into consideration and ranks services via integrating their functionalities, non-functionalities and their trust attributes;

2. We conducted a set of experiments on a real Web service dataset to evaluate our approach. The experimental results demonstrated that our approach can recommend high quality Web services to users, outperforming previous Web service search and ranking approaches;

3. We developed a prototype based on the proposed Web service search approach. The prototype can be accessed online. To our knowledge, it is the first practical Web service search engine system that ranks Web services via leveraging their functionalities, QoS and trust attributes.

The rest of this paper is organized as follows: Section II firstly presents a Web service searching scenario for illustrating the motivation of our proposed search approach, and then gives an overview of our proposed approach. Section III elaborates the procedure of the proposed Web service search approach, which is composed of keyword service matching, QoS evaluation, trust evaluation and final ranking of services.
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