Expert Systems with Applications 37 (2010) 440–449

Contents lists available at ScienceDirect

Expert Systems with Applications

journal homepage: www.elsevier.com/locate/eswa

On optimal decision for QoS-aware composite service selection

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ARTICLE INFO

Keywords:
Web services
Services selection
QoS
LINMAP
Fuzzy linear programming

ABSTRACT

The increasing popularity of employing web services for distributed systems contributes to the significance of service discovery. However, duplicated and similar functional features existing among services require service consumers to include additional aspects to evaluate the services. Generally, the service consumers would have different view on the quality of service (QoS) of service attributes. How to select the best composite service in theory among available service (WS) candidates for consumers is an interesting practical issue. This work proposes a QoS-aware service selection model based on fuzzy linear programming (FLP) technologies, in order to identify their dissimilarity on service alternatives, assist service consumers in selecting most suitable services with consideration of their expectations and preferences. This approach can obtain the optimal solution of consensual weight of QoS attribute and fuzzy positive ideal solution (FPIS) by extending LINMAP method, developed by Srinivasan and Shocker. Finally, two numerical examples are given to demonstrate the process of QoS-aware web service selection. The experimental results demonstrated that it is a feasible and supplementary manner in selecting the of web services.

1. Introduction

Web services enable business applications running on distinct platforms and exchanging data over the Internet, to be applied in business and daily life regardless of the platforms or locations. It has created unprecedented opportunities for organizations to shorten software development time by composing existing services across Internet. Effective mechanisms for supporting service discovery have considerable contribution to the success of web service composition. An efficient web service can bring a serious competitive advantage to the service providers as well as carry social welfare to the consumers. An application assisting in service selection based on certified QoS, cost and trust can bring essential benefits to the service consumers. Practically, the service providers are supposed to guarantee QoS of WS, which are advertised on the Internet for service consumers. When service providers announce their available services, current advertising approaches of web services create a WSDL or OWL-S document to subscribe the web service profile and service grounding, then promote it through UDDI registration, or other web services registries such as ebXML.

For emerging e-commerce business, the selected services are aggregated to form composite services. The composite service is a service produced by a composition of other services to complete the desired service activities (Anane, Chao, & Li, 2005). For example, Google research application are accepted as a web service and integrated with other services, such as Gmail, AdWords, You Tube and Google Maps service, to provide an integrated environment for service consumers. Microsoft and Yahoo also provide the services analogous to that of Google for business competition. The other example, consumer likes to discover the composite service, such as flight booking, restaurant reservation, and rent a car at a time, as illustrated in Fig. 1. What is the optimal approach of linking each service request to an approximate service? This problem may be nontrivial if the user requests multiple services at one time.

A number of works on composite service discovery and selection have been carried out to locate the required services and compose them to meet requirements using ontology (Zhou, Chin, & Lee, 2004, 2005) or service matchmaking techniques (Chao, Younas, Lo, & Tan, 2005; Huang et al., 2005a; Huang, Chao, & Lo, 2005b). Ontology technology is developed to answer the semantic confusion problem which could be effectively solved by semantic registration and discovery, by defining the appropriate meaning of the service's functionality. Part of researches (Ankolenkar, Burstein, & Hobbs, 2002; Borenstein & Fox, 2003; Jorge & Amit, 2006; Zhou, Chia, & Lee, 2005) on semantic service discovery were investigated via Semantics Web Service (SWS) technologies to locate the required services and compose them to meet requirements, as illustrated in Fig. 2.

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doi:10.1016/j.eswa.2009.05.070

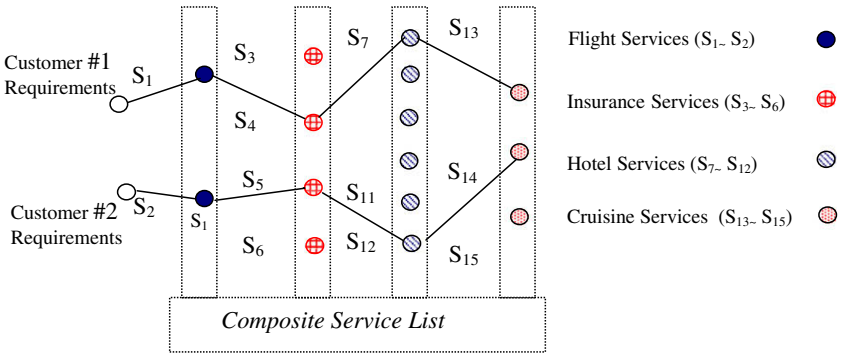

Fig. 1. The discovery and selection of composite services.

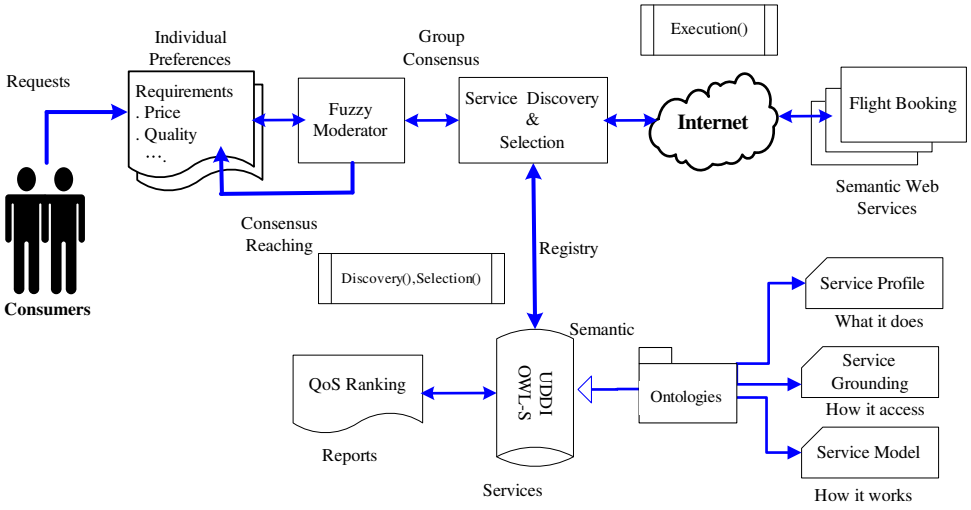

Fig. 2. The moderated fuzzy discovery, selection and execution using ontology.

The other approaches focus on fuzzy matchmaking technique that remains fuzzy semantics on terms and handle this problem via fuzzy theory. For example, moderated fuzzy discovery method (Huang et al., 2005a, 2005b), measures the similarity between services in terms of capability, syntax and semantics through a moderator initiates to minimize the differences among service consumers and providers.

For the consumer consensus of WS selection issue, service consumers and providers may have different expectations, experiences, and preferences about the services. Furthermore, consumer preferences often remain imprecise, uncertain or ambiguous on service QoS terms; the preferences over the QoS attributes are hard to be quantified especially in distinguishing the importance among these service attributes. Therefore, the adoption of fuzzy terms such as reasonable price, reliable service, and comfortable feeling in the requests becomes inevitable. Moreover, consumers usually have distinct view with providers for service terms, such as "*cheap flight ticket*", "*comfortable leg-room*" or "*delicious food*", simply because they have divergent perception of these terms.

From the consumers' point of view WS providers usually advertise on the Internet exaggerating the features of web services for appealing to customers, which might lead to misunderstanding or confusing about some service terms for WS consumers. In addition, the providers prefer to advertise their services to customers in subjective terms, which might be short of considering the consumers' expectations and preferences.

Hence, it is imperative to reach the consensus for service consumers on the specific specification terms (i.e., QoS), where they find and search WSDL document in the service discovery process. Based on these requirements, W3C working group has defined various QoS attributes for WS. That document comprises a number of generic and specific items for cross-referencing between the possible needs of service consumers and the functions supported by web services. Although regular QoS attributes have been listed, some unclear problems are yet to be clarified on selection of WS processes. For example, QoS attributes perception of importance is generally different from consumers and providers preferences. It is widely accepted that the consumers have been taking an active role in the expansion of e-commerce.

In this paper we consider optimal service selection based on a given set of service requests interacted with a set of service candidates using fuzzy linear programming (FLP) model (Li & Yang, 2004). This investigation leads to a need of developing a group consensus-centric approach to investigate QoS attribute preferences and determine the ranking order of service alternatives according to the distance from the positive ideal solution under group consensus. Consequently, service consumer is able to reduce redundancy in search, and service provider can improve the quality of services.

The remainder of the paper is organized as follows. Section 2 describes the existing QoS-aware selection of web service methods. Section 3 describes proposed method. Section 4 reports on two illustrational examples of selection of service alternatives. Finally, Section 5 illustrates the conclusion and the future work.