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Method and supporting framework for business domain-oriented web service discovery

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Abstract: This paper proposes a new business domain-oriented web service discovery method and framework to solve the low precision results caused by UDDI (universal description, discovery and integration) syntactic discovery and the difficulty in selecting from among functionally equivalent web services. When requesting services, service clusters are extracted from concrete services in terms of functional requests; then, through business information properties consultation, the most suitable services are determined and finally bound to user requests. The whole process is transparent to users. This framework is also tested and supported through a prototype based on a travel domain, IPVita (intelligent platform of virtual travel agency).

Key words: service discovery; service cluster; business information; domain ontology

Web services are available via standard interfaces and protocols such as SOAP, WSDL and UDDI. However, current techniques cause two problems: 1) Syntactic discovery mechanisms causing low precision results; 2) Difficulty in selecting from among multiple services appearing to implement similar functionalities. Combing the semantic web with web service technologies is an approach to solve the first problem by providing more precise results, such as OWL-S[1], WSDL-S[2], and OWL-S/UDDI Matchmaker[3]. The second problem can be solved by taking into account non-functional properties (NFPs)[4], such as QoS[5].

In this paper, we introduce a subset of non-functional properties, in which business information is used as a discriminating factor among functionally equivalent web services, and we present a business domain oriented framework for service discovery. First, in accordance with user demand for the functionality, the candidate services will be organized into a simple and unified service cluster; secondly, in accordance with user domain attributes, they will automatically consult and return the best service; finally, the access mechanism of the best service is provided, shielding service diversity and variability of complexity.

1 Service Discovery Supporting Framework

1.1 Service architecture

On the basis of user functional requirements, services are organized to two different layers which can be exploited to enhance service discovery, concrete services and service clusters.

Concrete services, which can be directly invoked and usually featured by their public WSDL interface, can also be grouped on the basis of their functional similarity.

Service clusters, on the upper layer but not directly invoked, represent the functionalities of sets of similar concrete services. Each service cluster is associated with a corresponding cluster of similar concrete services; service cluster functionalities are obtained from the concrete service operations by means of an integration process; mapping rules are also needed to be maintained among the original concrete services. Service clusters give users an abstract functionality perspective, not a variety of concrete services. Domain information requirements further refine and filter the set of candidate concrete services which are organized into service clusters. A selected service will be determined as a result.

1.2 Service query process

Step 1 A service requestor sends a request to a service broker, such as UDDI, but different from the traditional UDDI mechanism, the query result is not delivered to the service requestor directly.

Step 2 In this process, the service broker needs to deal with the concrete services and filters out unrelated or little related services through functional similarity matches, and the remaining services are organized into a service cluster which is an abstract representation of the concrete services.

Step 3 The service broker filters the service clusters through business domain information constraints, and as the result of consultation, one service whose satisfaction value is the largest will be determined.

Step 4 Finally, the user sends out the call request to the service cluster, and the service cluster will bind the call request to the determined service and return the results to the user. In all the process, the service requestor only can see an abstract presentation of the service, and will not be bored by so much detail information about concrete services. Fig. 1 shows the process of the service query.

2 Implementation Methods

2.1 Similarity computation between services

Domain ontology is used to annotate I/O parameters and operation names, and supports computing semantic relationships among services based on similarity. The detailed definition and computation of functional similarities between services[6] are suitable for our computation. For the understandability and consistency of the problem, we introduce the computation process in brief.

The domain ontology can be constructed as a graph where nodes represent concepts and edges represent relationships

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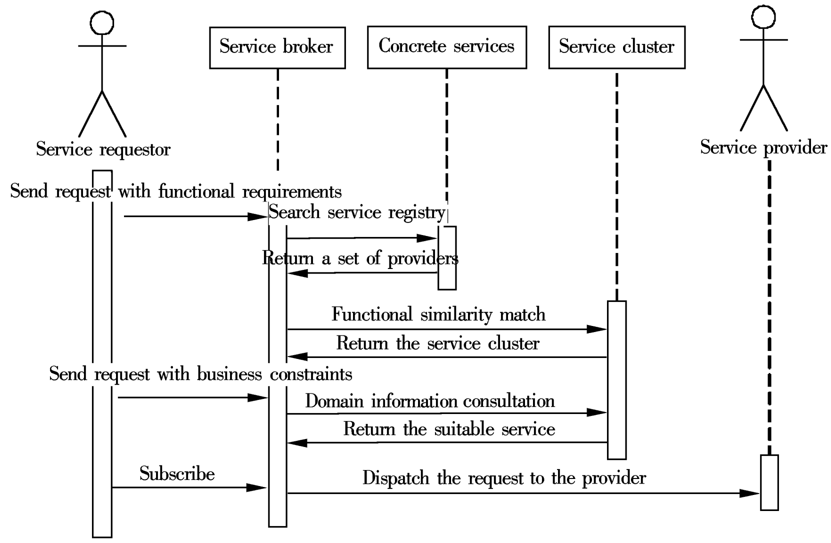

Fig. 1 Process of service discovery

associated with a special weight. The highest weight product of the path between two nodes denotes the affinity coefficient. The operation similarity coefficient between the two services contains name affinity, the ratio between the total affinity value of the input/output parameter, and the cardinality of the input/output parameter set, respectively. The functionality-based similarity coefficients are computed as the ratio between all operation similarities and cardinalities of the corresponding operation set. If the value is equal to or greater than a threshold given by experience, grouping the services into the same cluster will be done.

2. 2 Service cluster generation

The generation of the service cluster is performed functionally similar to the requested one with the above-mentioned similarity coefficients. Requested service is expressed as the desired operation and input/output entities, with the support of the domain ontology.

The service cluster interface is obtained by an integration process performed on the interfaces of the concrete services belonging to the same cluster. It is necessary to record the description information of a cluster, such as name, functional description, member service list and mapping relations. Mapping relations are defined to relate operations in the cluster with the corresponding ones in the concrete services. A table is built to represent the mapping relations for each operation of the cluster. The first row is a record with the information about the cluster, and the following ones record the information about the concrete services in the corresponding clusters. Because of the unified cluster interface, requestors will not have to be concerned about how to invoke services, no matter how the concrete services are implemented.

2. 3 Business properties consultation

Non-functional properties are regarded as selection and ranking criteria, while modeling these properties and attaching them to services and goals is an essential and complicated job. For example, similar properties may be expressed by different names, or the same name may refer to different properties in different domains or situations. Moreover, some properties are not independently assigned and evaluated. Because of the various and complex characteristics, we use domain ontology.

First, service descriptions require to be enhanced with a special section on business properties. The owl-s profile provides supporting information about the service, and the service parameter part can be enriched to contain each business property name and corresponding value.

Secondly, user requirements and preferences are expressed as a list whose items contain not only the property name, the expected value, but also the degree of importance concerning relevant properties. The larger the degree, the higher the priority the property has.

Thirdly, there are the methods and techniques of selection between requests and offers in the service cluster. However, the values of the properties can be purely qualitative, or quantitative, or even in different units. So there is a demand for different kinds of solutions according to different situations. While service providers and requestors may have different understandings of qualitative properties, we consult definitions in WSQM and an approach of a range of values[7]. Properties should be addressed one by one in terms of user defined priority. Then the service cluster will generate an ordered list of services according to user preferences. So the service on the top of the list will be the selected one.

3 Experiment

Based on the above service discovery framework, we have built a prototype system called IPVita (intelligent platform of virtual travel agency). However, it differs a little from some previous work with regard to travel domain. The aim of the prototype is to work out a suitable schedule (for example, flight, hotel) to satisfy a user's diversified requirements. So the mechanism of service discovery needs to be flexible and comprehensive enough to deal with all aspects of user requirements.

We implemented the prototype with extended Java implementation of UDDI/OWL-S matchmaker. In previous work we have built simple web-based user interfaces, through which users can submit their travel demands and obtain a detailed plan generated by an intelligent travel agency.

4 Conclusion and Future Work

This work proposes a new web service discovery framework and addresses the need for semantic business-based web service description filtering services. Business related service information is a new aspect of non-functional properties, and it is worth being studied.

In the future, we will extend service functional match mechanism with pre- and post-conditions, and enrich the descriptions and selection rules based on business properties to fit all kinds of situations.

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一种面向业务领域的 web 服务发现方法以及支撑框架

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摘要:针对 UDDI 关键字匹配带来的服务发现精度低,以及难以从功能相同的多个 web 服务中选择合适服务的问题,提出一种新的面向业务领域的 web 服务发现方法和相关框架.当用户请求服务时,根据功能请求从实际服务中抽取出服务簇,然后由业务信息属性等非功能性属性进行协商,确定出适合的服务并与用户请求绑定,而整个发现过程对用户来说都是透明的.通过建立一个基于旅游领域的原型系统 IPVita 来测试和支持此框架.

关键词:服务发现;服务簇;业务信息;领域本体

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