Matching Request Profile and Service Profile for Semantic Web Service Discovery

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Abstract

OWL-S Service Profile provides a way to describe services offered by providers and services needed by requesters. But some items in the Profile are not very suitable for describing a requester's demands while some important information about the requester himself such as his identity which may play important role in precondition match are not considered in the Service Profile. In this paper we define an OWL compatible Request Profile ontology especially for service requesters to describe their special properties and their expectation about a service. Then a match algorithm is proposed to match service request described in Request Profile with service advertise described in Service Profile. The experiment results show that the match algorithm is efficient.

Introduction

With the proliferation of web services it is becoming increasingly difficult to find a web service that will satisfy our requirements(Wu 2005). Universal Description, Discovery and Integration (UDDI Version 3.0.2) is an industry standard developed to solve the web service discovery problem. While UDDI becomes an appealing registry for web service, its discovery mechanism does not make any use of semantic information of a service yields coarse results with high precision and recall errors(Huajun 2006).By combining semantic web with web service, researchers can build service ontology to describe capability information about a web service and find services more approving(Zhongzhi Shi 2006). Ontology Web Language for Service (OWL-S)(The OWL Services Coalition 2004) is a prevalent language for building service ontology. OWL-S Service Profile provides methods to define capabilities for services. Although Service Profile in OWL-S is designed for both service providers and service requester, some items in the Profile such as service provider, service preconditions and effects are not very suitable for describing a requester's demands while some important information about the requester himself such as his identification and credit record which may play important role in precondition match are not considered in the Service Profile. It degrades the quality of match between the provider and requester. In this paper we define Request Profile ontology especially for a service requester to describe his special properties and his expectation about a service. The original OWL-S Service Profile is only used to describe service advertised by providers. The Request Profile is designed to compatible with OWL-S Service Profile as much as possible to facilitate the matching. Then a match algorithm is presented to match between Service Profile and Request Profile.

OWL-S Service Profile

OWL-S Service Profile describes a service as a function of three basic types of information: the provider information, the function description and a host of features that specify characteristics of the service.

The Provider Information consists of contact information that refers to the entity that provides the service. The function description describes the capabilities of the service in terms of inputs, outputs, preconditions and effects (IOPEs). An input is what is required by a service in order to produce a desired output. An output is the result which a service produces. A precondition represents conditions in the world that should be true for the successful execution of the service. And an effect of a service is its influence to its environment. A host of properties that are used to describe features of the service include category information and service quality(Nicole Oldham 2006).

Request Profile and Service Profile

From the content of OWL-S Service Profile, we can conclude that it is more suitable for a service provider to advertise his service and not very suitable for a service requester. For example, the information which describes the requester himself is insufficient though this information is usually important in service matching. For instance, a

requester who holds no credit card may not match a book sell service and a requester of 70 age may not suitable for some plane ticket book service etc. The preconditions and effects about a request service are not expectable for a requester in most circumstance.

So in OWL-S Service Profile, we keep service input, output, category , quality and contact information for a requester to express his expectation about a service and add the requester contact and identity information to express his specialties. These specialties often play important role in precondition and effect match. For instance, a requester who holds no credit card may not match a book sell service and a requester of 70 age may not suitable for some plane ticket book service etc. we call the modified Profile as Request Profile. Figure1 is the Request Profile Ontology we have defined.

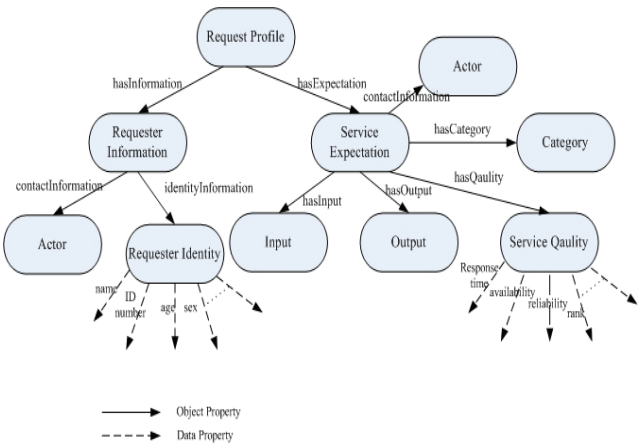

Figure1: Request Profile Ontology

The Request Service ontology includes two parts: requester information and service expectation. Requester information express the information a requester owned for service discovery and the service expectation express the requester's expectation about a desired service.

The requester information includes: the Actor ontology with the properties of requester name, address, Web URL, phone, email, and fax to express the contact information of a requester. An identity ontology with properties of a requester's ID number, affiliation, age, sex, occupation, preference, etc. It is an unbounded list about a requester's special properties.

The service expectation includes: the provider information in OWS-L, the inputs, outputs, category and quality information in OWL-S Service Profile. The provider information expresses the requester's expectation for a desired service about its name, contact style, geography information etc. The inputs, outputs, category and quality information express the input, output, category and quality expectation about the desired service each.

Matchmaker between Service Profile and Request Profile

After defining the Request Profile, the original OWL-S Service Profile is used for service provider only. The match relationship of every item between Request Profile and Service Profile is described before match algorithms is applied.

Match Relationship between Different Parts of Service Profile and Request Profile

A match relationship can be concluded after every element is described in Request Profile and Service Profile. Figure2 is the match relationship between different items of Service Profile and Request Profile.

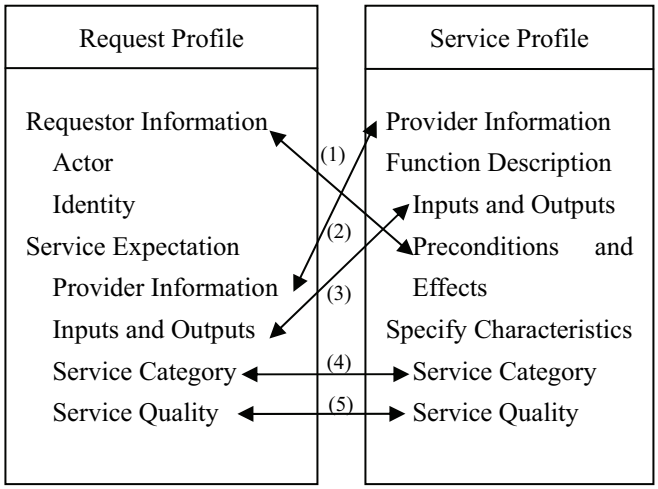

Figure 2: The Relationship between Different Items of Request Profile and Service Profile.

In Figure2 there are five match relations marked from (1) to (5) between Service Profile and Request Profile. The match algorithm is built on the similarity of these five parts.

Match Algorithm

We classify the above five match relation into four groups. One is group P which includes relation (2) in Figure2. One is group I which includes relation (1), (3) and (4) in Figure2. The other one is group Q which includes (5) in Figure2. Deferent match algorithm is applied in deferent group according their information express and the final match result is calculated by combining three results from three groups(Hu 2005).

Definition: If R is the Request Profile from a requester, S is the Service Profile from a provider, the similarity between R and S is:

$$Sim(R,S) = \zeta_1 Sim_P(R,S) + \zeta_2 Sim_I(R,S) + \zeta_3 Sim_Q(R,S)$$

$$\sum_i \zeta_i = 1 \qquad 0 \le \zeta_i \le 1, i = 1,2,3 \qquad (1)$$

$Sim_P(R,S)$, $Sim_I(R,S)$ and $Sim_Q(R,S)$ are the similarity formula of group P, group I and group Q respectively and ζ_i is the power of its similarity formula.

String-based Match for Group P

If there are i items to express provider information in Request Profile, j items to express provider information in Service Profile, then

$$Sim_P(R,S) = \sum_{i=1}^{\max(i,j)} \mu_i Sim_{P(i)}(R,S)$$

$$\sum_i \mu_i = 1 \qquad 0 \le \mu_i \le 1, i = 1,2,3,..., n \qquad (2)$$

$Sim_{P(i)}(R,S)$ is a similarity value based on string match.

Numerical Value-based Match for Group Q

As described in 4.2.1, It can be deduced that

$$Sim_Q(R,S) = \sum_{i=1}^{\max(i,j)} \mu_i Sim_{Q(i)}(R,S)$$

$$0 \le \mu_i \le 1, \quad i = 1,2,3,..., n \qquad (3)$$

$Sim_{Q(i)}(R,S)$ is a similarity value based on numerical value match which can be calculated with formula (4) ,(5),(6),(7).

$$Sim_{Q(i)}(R,S) = \sqrt{Sim_{\min} Sim_{avg} Sim_{\max}} \qquad (4)$$

$$Sim_{\min} = (1 - abs(R.Q(i)_{\min} - P.Q(i)_{\min}))/P.Q(i)_{\min} \qquad (5)$$

$$Sim_{avg} = (1 - abs(R.Q(i)_{avg} - P.Q(i)_{avg}))/P.Q(i)_{avg} \qquad (6)$$

$$Sim_{\max} = (1 - abs(R.Q(i)_{\max} - P.Q(i)_{\min}))/P.Q(i)_{\max} \qquad (7)$$

Domain Ontology-based Match for Group I

OWL-S/UDDI match algorithm(Massimo Paolucci *et al* 2002) is a flexible matching mechanism which can be used to match each pair of concepts in group I. Domain ontology should be applied in match procedure and the degree of match between two concepts depends on their relation in OWL ontology and four types match results are produced according to OWL-S/UDDI match algorithm. If outR, inR and preR stand for a request's output, input and precondition concept, outA, inA and preA stand for a advertise's output, input and precondition concept , the match results is(Naveen Srinivasan 2004):

degreeOfMatch(outR,outA):
if outA=outR then return exact
if outR subclassOf outA then return exact
if outA subsumes outR then return plugIn
if outR subsumes outA then return subsumes
else return fail

There are four degree match result in above algorithm:exact, plugIn, subsume and fail. If outA subsumes outR, match result is plugIn. If outR subsumes outA , match result is subsume. If outR subsumes outA, then the provider may or may not completely satisfy the requester, Hence subsume match is inferior than the plugIn match(Naveen 2004). the match between inA and inR is degreeOfMatch(inA,inR), the match between preA and preR is and degreeOfMatch(preR,preA).They are similar to the match of degreeOfMatch(outR,outA). Note that in degreeOfMatch(inA,inR), the order of parameters is otherwise with degreeOfMatch(inA,inR).

With group I, the domain category ontology is built to match concepts in inputs, outputs, category and precondition respectively. After getting the match results of each pair of concept according to OWL-S/UDDI algorithm, the formula (8) is applied to calculate the similarity of group I:

$$Sim_I(R,S) = \mu_1 Sim_{Input}(R,S) + \mu_2 Sim_{Output}(R,S) + \mu_3 Sim_{Precondition}(R,S) + \mu_4 Sim_{Category}(R,S)$$

$$\sum_i \mu_i = 1, \qquad 0 \le \mu_i \le 1, i = 1,2,3,4 \qquad (8)$$

If there are i concepts to express provider information in Request Profile, j concepts to express provider information in Service Profile, then

$$Sim_{Input}(R,S) = \sum_{i=1}^{\max(i,j)} \lambda_i Sim_{Input(i)}(R,S)$$

$$\sum_i \lambda_i = 1, \qquad 0 \le \lambda_i \le 1, i = 1,2,3,4 \qquad (9)$$

$$Sim_{Input(i)}(R,S) = \{\eta_1, \eta_2, \eta_3, \eta_4\}$$

$$0 \le \eta_i \le 1, \qquad i = 1,2,3,4 \qquad (10)$$

In formula (10), η_i is the numerical value for concept match result. $\eta_1 = 0$ for "Fail", η_2 for "Subsume", η_3 for "Plug in", $\eta_4 = 1$ for "Exact".

$Sim_{Output(i)}(R,S)$, $Sim_{Categoryt(i)}(R,S)$, $Sim_{Precondition(i)}(R,S)$ can be calculated in the same way as the $Sim_{Input(i)}(R,S)$

Simulated Experiments

In the simulated experiments, we compare the web service discovery results from three aspects: precision, recall, time lapse in three different web service discovery methods.

Three kinds of match method are introduced in the system. Method Ⅰdiscovers services only with group P match. Method Ⅱdiscovers services with group P and group I but without precondition match. Method Ⅲ discovers service with all three group match. Because the precondition match is seldom used in any other research. The comparison of three kinds of match method can reveal that the information about a requester's special characteristics is very helpful in service match.

Simulated Experiment Environment and Results

Service description is saved in SQL Server 2000, ontology is saved in an OWL file and algorithm implementation language is Java. 200 services are tested in the system. The simulate results is in Figure3.

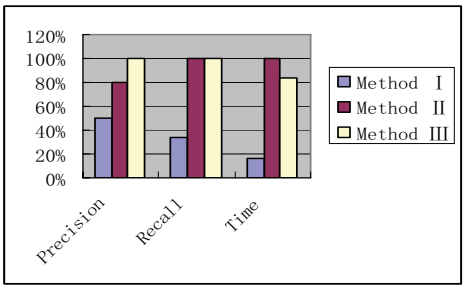

Figure3. Simulated Results

Through the results, we can conclude that: (1) Method Ⅰused only string based match is the most efficient and its precision but its recall is the worst in the three methods. (2)The precision and recall of Method Ⅱ and Ⅲ which use ontology based match are much higher than string based match, but it is also time consuming. (3) Method Ⅱis time consuming than method Ⅲ because after precondition match, the left records number is less. (4)The "Time" values in the test Figure3 are 20ms, 1200ms and 100ms for method Ⅰ, Ⅱ, Ⅲ respectively. They have been changed into percent accordingly.

Conclusion

The description about a service request is as important as the description about a service advertise in semantic web service discovery. This paper defines Request Profile ontology for a service requester to describe his special properties and his expectation about a service and designs a match algorithm to match information between Request Profile and Service Profile.

Acknowledgements

Our work is supported by the National Science Foundation of China (No. 90604017) and National Basic Research Priorities Program (No. 2003CB317004)

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