INVOKING WEB SERVICES WITH SOFTWARE AGENTS

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ABSTRACT

Recent progress in the field of web services has made it practically possible to publish, locate and invoke applications across the web. The ability for efficient selection and integration of inter-organizational and heterogeneous services on the web at runtime is an important requirement to the web service provision. In particular, if no single web service can satisfy the functionality required by a user, there should be a possibility to combine existing services together in order to fulfill the request. This trend has triggered a considerable number of research efforts on the Web services composition. Another trend in modern web provision is related to making web services pro-active. This means that services can be engaged into complex conversations instead of just their simple invocation and response with some result.

In this paper we describe solution for pro-active Web service selection and composition. We consider a logic-based method for services composition and marketplace-based system architecture supporting agent communication and negotiation.

1. Introduction

Now a days amount of products and services available on the Web increases dramatically and goes beyond user's ability to analyze them efficiently. At the same time the number of potential customers available via the Internet is also increases significantly. If no new solution will be applied the amount of potentially unseen relevant services and non-contacted potential customers will grow dramatically. This problem is related to personalization and pro-active service selection. Another important issue related to development of Web services is their integration and composition. The challenge is that Web services can be created and updated on the fly and it is often beyond human capabilities to analyze the required services and compose them manually. Web services descendsfrom the following two sources: 1) it is not always easy to define selection criteria for a web service; 2) Web services can be developed by the different organizations, So the ability of efficient integration of possibly heterogeneous services on the Web becomes a complex problem.

Web services are considered as self-contained, self-describing, modular applications that can be published, located and invoked across the web [1]. Several initiatives in the Web services provide platform and languages for

integration of heterogeneous systems. In this paper we are focusing on general conceptual solution to the problem of enabling Web services composition with software agents.

2. Related work

There is several works on the incorporating agents into Web service system. In particular, Gibbins [2] demonstrated usages of web services description within agents. Another step toward incorporating Web services into agents is proposed by Ardissono [3]. Their main contribution is support for more rigorous web service execution protocols. The main difference between our approach and the above methods is that we propose a unified solution to Web services composition. In particular we consider loosely coupled services networks, logic with higher expressive power and a framework where methods from both above mentioned categories will work together. Additionally usage of the logic with higher then classical logic power allow us formally express and utilize richer semantically information.

3. General Approach

Our approach to supporting Web service composition is based on providing advance communication and decision-making agent based environment, which employs the concept of network of market places [4]. A functionality of marketplace should include a matchmaking, negotiation, communication and coordination support. The platform implementing the marketplace should have open architecture and allow customization of the default functionality. We would like to mention that marketplaces are quite usual means for implementation of selling/buying activities for services. We apply marketplace to service composition. In our approach marketplace is an infrastructure element, which may support a coherent behavior of agents or serve conflict resolution via negotiation. There can be many market places for service provision and selection and they can be interconnected. Marketplaces can be used for customers and/or service providers' coalition formation for asking a service/product details, for matchmaking, for discrepancy resolution as well as for giving bids and providing special offers. Marketplaces provide a support for composition of services based on flow models and AI planning. In particular, the proposed network of marketplaces gives a novel solution to the composition process flow model.

For AI planning based composition of Web services we employ program synthesis-based approach. If we consider services as software components then the Web service composition can be presented as a software synthesis problem. In comparison with software components, Web service may present a higher abstraction level and they are more loosely coupled. This method allows us to construct a composite service based on a functional specification, without taking into account low-level technical details, such as operational environment or communicational proto col.

We propose a method for automated Web service composition, which is based on the proof search in multiplicative intuitionistic fragment of linear logic (MILL)[5]. The fragment is sound and complete and this guarantees us that the composed services are correct

and that all compo sable services solution will be found. Choice of Linear Logic [6] as a formalism for service composition is based on high expressive power of LL for representation of different aspects of web services.

The composition process is as follows. First, a description of existing Web services is translated into extra logical axioms in LL, and the requirements to the composite services are specified in form of a LL sequent to be proven. Second, MILL thermo proved is used to determine whether the requirements can be fulfilled by the composition of existing atomic service. If it is possible then the last step is constructing flow models from the generated proofs. We assume that the composite service is ready to be executed when the flow model and description of each atomic service are given. In comparison with other composition methods our method also utilizes semantically information in addition to structural service information in service description. This is possible because of usage of logic with a high expressive power i.e. Linear Logic.

The proposed composition method is to be incorporated into the marketplace infrastructure as a default service provided by marketplace. Until now, we assumed only exact match of input and output parameters of atomic services in the composition process. However, in practice services can be composed even if the output parameter of one service does not match exactly input of other services. This can be done via semantic reasoning using Domain Ontology as it is shown in the following Figure 1.

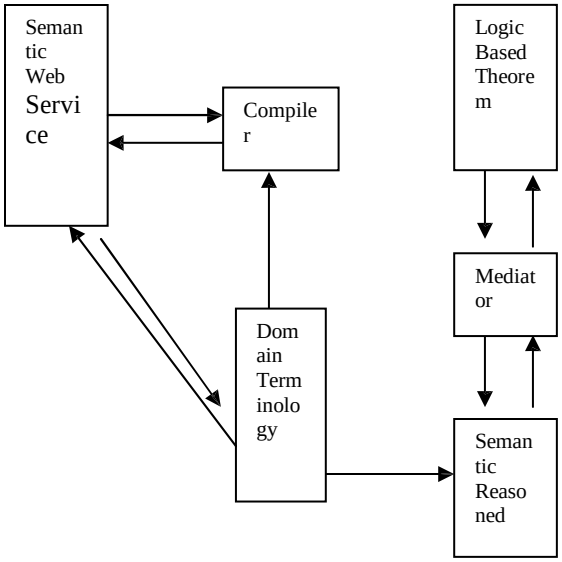

FIGURE 1.

3. System Components

In particular the basic marketplace was developed in early versions of the Agora system [7]. It supports both FIPA and KQML specifications for the agent communication language. We are currently working on extending the Agora system design, adjusting it to the needs of pro-active Web service selection and composition and improving its compatibility with modern agent platforms.

Symbolic negotiation method for service selection is presented in [8]. The method uses partial deduction on linear logic for recognizing new goals and missing services. It is going to be implemented into matchmaking component of marketplaces as well as into reasoning component of the agent execution engine.

An essential part of the presentation modules of the system for both customers and services is based on ontologies. They are used for structuring Web services information on the

provider's side and for description of the customers' profile. Ontologies also play a key role in semantic reasoning. In order to reduce discrepancies between ontologies used by different providers and customers we are working on ontology explanation and ontology mapping methods.

4. Application

Until now we are mainly focused on design and implementation of system components. For performing the system integration we are working on developing several application scenarios. Although our scenarios are from real application areas we didn't work yet on their practical implementation but rather consider them at the moment as test cases for the system.

The first scenario is using agents for facilitating mobile evidence-based medicine. The software agent may also communicate with other software agents to make informed decisions based on specific results and documentation. The second scenario is related to virtual enterprise formation. Another important work related to application of the system under consideration is related to experiments with composition of existing Web services. Since practically application composition requires sufficient amount of semantic knowledge about the composable services. We are working on semi-automatic annotation of non-semantic web services.

5. Conclusion and Future Work

In this paper we have shown our proposed solution to enabling Web services selection and composition with software agents. Usages of Agents allow a supporting pro-activeness and autonomy of the composition process where both parties-customers and providers can play an active role in the process via autonomous operation and negotiation. The proposed architecture allows a sufficient flexibility and extensibility indeveloping different solution while providing good set of embedded tools.

For the future work we continue work on integration of the system components and development embedded tool into the system. We also recognize a great importance of semantic enrichment of available services on the web and put a high attention to work on ontology mapping, ontology explanation and semantic service annotation.

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