Chapter 19
A Graph-Based Approach for Semantic Process Model Discovery

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ABSTRACT

One of the key tasks in the service oriented architecture that Semantic Web services aim to automate is the discovery of services that can fulfill the applications or user needs. OWL-S is one of the proposals for describing semantic metadata about Web services, which is based on the OWL ontology language. Majority of current approaches for matching OWL-S processes take into account only the inputs/outputs service profile. This chapter argues that, in many situations the service matchmaking should take into account also the process model. We present matching techniques that operate on OWL-S process models and allow retrieving in a given repository, the processes most similar to the query. To do so, the chapter proposes to reduce the problem of process matching to a graph matching problem and to adapt existing algorithms for this purpose. It proposes a similarity measure used to rank the discovered services. This measure captures differences in process structure and semantic differences between input/outputs used in the processes.

INTRODUCTION

Semantic web services envision a greater access to services on the web and a more automatic support to their management by providing the ability to describe their semantics in a formal and machine-processable manner. One of the key tasks in the service oriented architecture that semantic web services aim to automate is the discovery of services that can fulfill user needs.
Majority of approaches for semantic web services discovery are based on formal descriptions of both service advertisements (published by providers in a registry) and queries, i.e., the service that a user is looking for.

These descriptions are written in the same description language (for example, OWL-S (Martin et al, 2004)) and defined in an underlying decidable description logic based ontology language, such as OWL-DL, and OWL-Lite. This way, description logic reasoning can be used to automatically determine services that semantically match a given service request based on the terminological concept subsumption relations computed in the underlying ontology. Examples of such logic-based approaches to semantic service matchmaking are the OWL-S UDDI matchmaker (Kawamura et al. 2003) and WSMO discovery approach (Keller et al. 2005).

OWL-S is one of the proposals for describing semantic metadata about web services that is based on the OWL ontology language. OWL-S covers three main parts: the service profile for advertising and discovering of services; the process model, which gives a detailed description of a service’s actions and behavior; and the grounding, which provides details on how to cooperate with a service.

Current approaches for discovering semantic services take into account only the service profile, by exploiting the relations between inputs and outputs concepts in the ontology (Klusch et al. 2006). As we will see in next section, discovering services using only their inputs/outputs is not sufficient for some applications. For instance, when searching services for integrating in a given application, the process model specifying how to interact with the provider service has to be taken into account in the discovery process. Other application example is the scientific workflow discovery, where scientists look in a workflow repository for existing workflows that could support their research. Recent works (Goderis et al. 2006, Goderis et al. 2009) showed that scientists require tools for service discovery based on their underlying process model.

These applications show that the discovery based on the profile has to be complemented by integrating the process model. In our view, service discovery can be reformulated as a three-phase process (see Figure 1):

- **Phase 1**: profile-based selection which uses classical information retrieval techniques to select the first bunch of services based on keywords and vectorial model matching, possibly improved by some ontological knowledge;
- **Phase 2**: structure-based selection which exploits behavioral properties given in the business process specification, usually leading to graph or automata matching;
- **Phase 3**: service ranking of the results provided by the previous phase, based on constraints satisfaction and quality features.

This chapter is concerned by phase 2. We present matching techniques that operate on OWL-S process models and allow retrieving in a given repository, the processes most similar to the query. As process models are usually represented as graphs, the problem of process matching can be reduced to a graph matching problem. In this chapter we show how existing graph matching algorithms can be adapted and extended for this purpose. We propose a graph-based similarity measure that will be used to rank the discovered services. This measure captures differences in process structure and semantic differences between inputs/outputs used in the process. In this chapter we present our matching approach as a step in the process of service discovery, but it can be used in several applications (merging processes, delta analysis, auto completion mechanism for modeling processes, …) requiring the matching semantic process models.
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