Service Specification and Matchmaking using Description Logic[1]

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1 Extended Abstract

This is an extended abstract of [11]. Service-oriented computing is emerging as a new paradigm based on autonomous, platform-independent computational entities, called *services*, that can be described, published, and dynamically discovered and assembled. An important part of a service is its public interface, which describes the service and should be independent of the technique used for implementing it. A service's interface can describe various aspects of the service, such as the service's location and communication protocols that can be used for interacting with the service.

In [11], we confine ourselves to the investigation of those parts of a service's interface that describe the *functionality* offered to a service requester. Not all service specification approaches support this. Services that *are* endowed with such functional descriptions are often called *semantic web services* [6]. Semantic web services facilitate more effective (semi-)automatic service discovery and assembly, since the services' functional descriptions can be taken into account. In particular, such descriptions can be used for *matchmaking*, i.e., for finding a matching service provider for a particular service request.

Various techniques have been proposed for specifying semantic web services (see, e.g., [6, 7, 5, 4, 3, 9]). What most approaches have in common is that they suggest the use of *logical knowledge representation languages* for describing both service providers and service requests. Also, most approaches ([3] is an exception), including the approach we take in this paper, view semantic web services as *operations*, i.e., they can be invoked with some input, perform some computation and possibly return some output.

Where approaches for specifying semantic web services differ, is mostly the *kind* of knowledge representation language proposed, and the level of *formality*. In particular, in [4, 9], a formal service specification approach using first-order logic is presented, and in [6, 7] the use of so-called *semantic web markup languages* for service specification is proposed, but no formal specification language or semantics is defined. In [11], we are interested in a formal approach to service specification, based on semantic web markup languages.

Semantic web markup languages are languages for describing the meaning of information on the web. The most widely used semantic web markup language is the Web Ontology Language (OWL) [8]. OWL is a family of knowledge representation languages that can be used for specifying and conceptualizing domains, describing the classes and relations between concepts in these domains. Such descriptions are generally called *ontologies*.

The formal underpinnings of the OWL language family are formed by *description logics* [1]. Description logics are formal ontology specification languages and form decidable fragments of first-order logic. Research on description logics has yielded sound and complete *reasoners* of increasing efficiency for various description logic variants (see [1] for more background). The fact that description logics come with such reasoners is an important advantage of using description logic for specifying services, since these reasoners can then be used for matchmaking.

[1] This work has been sponsored by the project SENSORIA, IST-2005-016004, and by the GLOWA-Danube project, 01LW0602A2.

In [11], we propose a formal framework for specifying the functionality of services. Services are viewed as operations and we specify them using a particular description logic that corresponds to an expressive fragment of OWL, called OWL DL. As it turns out, we need to define several extensions of this description logic for its effective use in service specification. The formal tool that we use for defining the description logic, its extensions, and also the service specification framework itself, is *institutions* [2, 10]. The notion of an institution abstractly defines a logical system, viewed from a model-theoretic perspective. Institutions allow to define the description logics and the specification framework in a uniform and well-structured way.

In addition to defining a service specification framework, we also provide a model-theoretic definition of when a service request is *matched* by a service provider specification, and show that matching can be characterized by a semantic entailment relation which is formulated over our basic description logic. Proofs of matching can thus be reduced to standard reasoning in description logic, for which one can use description logic reasoners.

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