Formal Specification of Adaptable Semantic Web Services Composition

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ABSTRACT

This article proposes a formal specification method for Web services composition based on context-aware semantic planning graph technique. The authors first use a graph planning technique to conceive an adaptable semantic Web services composition. They use an ontology based context model for extending Web services descriptions with information about the most suitable context for its use. Then, the composition problem is transformed into a semantic context aware graph planning problem to build a set of best-composed Web services based on the user’s context. Because of the error-prone nature of the Web services composition process, and with the integration of context information in this process, the complexity of Web services-based systems is increasing, hence the need for formal specification and verification approaches of such systems. The authors seek to use CCA calculus, to formalize Web services composition expressed in terms of adaptable OWL-S, and transform the description of workflow patterns into the description patterns in terms of CCA, a calculus for context-aware ambients.

KEYWORDS

Adaptation, CCA, Context, Formal Specification, Graph Planning, Semantic Web Service, Web Service Composition

1. INTRODUCTION

Web services are promising and emerging technology for the development of Internet applications, via the exchange of messages based on XML standards, under the architecture of SOA (Service Oriented Architecture). The composition of Web services is one of the challenges of the SOA. The Web services composition refers to the process of creating a compound service offering a new functionality, through the process of dynamic discovery, integration and execution of simple services in a well-defined order in order to meet a specific need.

Generally, users are not interested in the same features and do not have the same profiles (context, preferences, etc.), therefore, Web services must develop adaptation mechanisms to provide the user with relevant adaptable services. According to (Abowd et al., 1999), “…context covers all information that can be used to characterize the situation of an entity. The latter can be a person, place, or object relevant to the interaction between the user and the application, including the user and the application themselves…” To ensure this need, it is necessary to integrate the context throughout the whole Web services life cycle. Many researchers propose their composition approach based on AI planning techniques, by describing a Web service as an action which is specified by its preconditions.

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and effects. Otherwise, planning is a costly computational approach and the size of the data involved in the planning process, will be much bigger than ones used in classical planning problems. Taking into consideration context information during selecting and combining services, can increase the acceptance and the effectiveness of composition. A service composition model which can integrate, and make use of context information to derive the optimal component services of the composite services is still an ongoing research problem.

In practice, web service composition is usually a complex and error-prone process, whether the composition occurs at design time or at runtime. Moreover, if an incorrect plan is executed without checking in advance, deploying the process often results in runtime errors, which must be repaired at high cost. Besides, with the integration of context into the lifecycle of Web services, the complexity of Web services-based systems is increasing, hence the need for formal approaches of specification and verification of such systems. These approaches, based on formal methods, make it possible to precisely model the behavior of the system and to verify that it works well.

In this perspective, using a means of context aware AI planning method to Web services composition is a central foundation of this work. For thus, the authors propose to exploit context information throughout the whole Web services lifecycle: in the description, discovery, composition (planning) and formal specification and verification steps. Furthermore, if the selected composed Web service is no longer functional, user can select another composed Web service from the list returned by the composition algorithm.

The other central foundation of this work is the use of a formal language, CCA a calculus for context aware ambients, to formalize the composed Web service by transforming the description of workflow patterns enriched with context information into the description patterns in terms of CCA.

The remainder of this paper is organized as follows. Section 2 highlights the related work about Web service composition based on AI planning and context-awareness. The related work about formal specification of Web services composition is also highlighted. In Section 3, an overview of the adaptable Web service composition method is given. In Section 4, the authors present mapping rules form adaptable OWL-S to CCA. In Section 5, evaluation of the composition technique is presented and the formalization of the adaptable OWL-S is illustrated by an example. Finally, Section 6 concludes this paper.

2. RELATED WORK

In this section, the authors give an overview of some research works in the field of context-aware Web services composition and formal specification of Web services.

In (Tari, Amirat, Chibani, Yachir, & Mellouk, 2010), the researchers proposed a layered design framework for service composition. The framework adopts a rule-based planning technique for generating plans, in order to adapt to the context’s changes. Nevertheless, user’s context is reduced to its preferences in terms of QoS. This approach needs the creation of abstract services directory and to grouping together services which can perform the same task. (Yu, Glenstrup, Zhang, & Su, 2010) described a goal-driven approach for context-aware composition of Web services. The researchers designed a Goal Description Language and Context Condition/Effect to describe the dynamic semantics of service capability and goal requirements. Based on the current contexts, a planner is designed to dynamically compose services, and a service runner is designed to invoke proper services based on interactions with users. However, the context is considered only in the composition step. It’s neglected in the description, the discovery, formal specification and verification and the execution steps. Moreover, researchers used their own Web service description language.

In (Li, Liu, & Bouguettaya, 2011), the aspect-oriented paradigm is used to support context-aware semantic service composition. The composition is performed by weaving context aspects within plain compositions to handle dynamic contexts. Thought, the authors do not focus on automatic composition. To become context-aware, context services are added to already existing plain compositions.
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