

Chapter 3

Semantic Web Services Composition with Case Based Reasoning

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ABSTRACT

Web service development is encouraging scenarios where individual or integrated application services can be seamlessly and securely published on the Web without the need to expose their implementation details. However, as Web services proliferate, it becomes difficult to matchmake and integrate them in response to users requests. The goal of our research is to investigate the utilization of the Semantic Web in building a developer-transparent framework facilitating the automatic discovery and composition of Web services. In this chapter, we present a Semantic Case Based Reasoner (SCBR) framework that utilizes the case based reasoning methodology for modelling dynamic Web service discovery and composition. Our approach is original as it considers the runtime behaviour of a service resulting from its execution. Moreover, we demonstrate that the accuracy of automatic matchmaking of Web services can be further improved by taking into account the adequacy of past matchmaking experiences for the requested task. To facilitate Web services composition, we extend our fundamental discovery and match-making algorithm using a light-weight knowledge-based substitution approach to adapt the candidate service experiences to the requested solution before suggesting more complex and computationally taxing AI-based planning-based transformations. The inconsistency problem that occurs while adapting existing service composition solutions is addressed with a novel methodology based on the Constraint Satisfaction Problem (CSP).

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1. INTRODUCTION

The last decade has witnessed an explosion of application services delivered electronically, ranging from e-commerce and Internet information service, to services that facilitate trading between business partners, better known as B2B relationships. Traditionally these services are facilitated by distributed technologies such as RPC, CORBA, RMI, and more recently Web services. The application of automatic composition of Web services has received a great deal of attention from the industry and research groups as the composition of services adds a new dimension to Web services advantages. Web service composition refers to the technique of composing arbitrarily complex services from relatively simpler services available over the Internet (Chakraborty, 2001; Maigre, 2010). Web services composition technology is ever increasingly being adopted by the industry (Yen, 2009; Zhang, 2008). Large software houses such as Microsoft, IBM and Sun have implemented Web services protocol stack as part of their main computing platforms (<http://java.sun.com/javaee/>, <http://www.microsoft.com/NET/>, <http://www-01.ibm.com/software/websphere/>).

As Web services are being increasingly adopted as the distributed computing technology of choice to securely publish application services beyond the firewall, the importance of composing them to create new, value-added service is increasing. Thus far, the most successful practical approach to Web services composition is based on the Business Process Execution Language (BPEL) (Andrews, 2007). Largely endorsed by the industry, this approach borrows from business processes' workflow management theory to achieve the formalization necessary for describing the data and control flow in the composition process. The BPEL specification solves the immediate problems that the IT industry is facing regarding the use of Web services for enterprise application integration. However, in its present form the specification overlooks the possibility of integrating applica-

tion services and performing flow management on the fly, hence it only specifies how the service composer can perform both activities manually.

One of the solutions to this problem are the hybrid approaches attempting to enrich the BPEL specification with machine processible semantic descriptions. However as demonstrated by Mandell (2003), Osman (2005), and Traverso (2004), enriching BPEL specification with semantics achieves limited level of automation. Generally in order to automate Web services composition, two problems have to be resolved: automatic discovery and selection of Web services and automatic compilation of flow management for the selected services (Thakker, 2005). These hybrid approaches address the Web service discovery problem, but rely on the flow management provided by the BPEL process model and hence on the understanding of the service composer to design the flow management; therefore human developers are still largely involved in the Web services composition task.

The root of the problem is related to building the process model on top of WSDL, which is an XML grammar. XML cannot define concepts or relations between concepts, which is the most important factor for the intelligent reasoning required for the automation. The issue related to the current discussion is the use of non-semantic grammar for the composition specification. For the composition engine to provide automatic discovery and flow management, the process model needs to have the consideration of the semantics in the specification. The addition of semantics within an XML centric standard like BPEL will not achieve the sought-after automation as that would require an intelligent reasoner that can interpret the semantic description.

The second approach to Web services composition aspires to achieve more dynamic composition by semantically describing the process model of a Web service and thus making it comprehensible to reasoning engines or software agents. Our approach builds on this premise and proposes an

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