Web Service Collaboration Analysis via Automata*

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Abstract. It is evidenced that formal analyses are helpful for web services interactions. However, most current web services choreography proposals, such as BPEL4WS or WSCI, only provide notations for describing the message flows in web service collaboration, lacking of reasoning mechanisms to verify the process of interacting among them. In this paper, we present a formalization of web services interaction based on WSCI using the approach of automata. The method can check whether two or more web services are compatible or not in their collaboration.

Keywords: Web services, WSCI, Automata.

1 Introduction

Recently, web services have emerged as a new paradigm that supports loosely coupled distributed software systems. However, in most cases, a single web service can hardly satisfy practical applications. For a complex business process, collaboration of multiple web services is required to achieve the preset goal. At present, several proposals, such as BPEL4WS \[1\] and WSCI \[2\], have been used to describe the process of collaboration. But most choreography proposals only provide notations to describe the message flow in the collaboration, lacking of some reasoning mechanisms to verify the interaction between web services. As a result, a predefined process is likely to behave abnormally due to web services interacting incorrectly. To deal with this issue, it is needed to provide a formal method to verify the soundness of underlying web services’ collaboration.

Frankly, there exist several verification methods \[3-9\]. They are based on the global information interaction between web services. The main task is to find out whether or not the interaction process matches the given model, which can verify the correctness of global conversation between services. However, these verification methods don't take it into account whether the behaviors of a service are compatible with the global information interaction. Consider two web services, one for online shopping and the other for customers. Suppose that they are syntactically compatible in invoking interfaces, but not negotiate well in collaboration protocol. The online shopping waits

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for payment before sending the product while the customer believes Cash-on-Delivery. It is certain that the collaboration between them will lead to a deadlock, no matter how well they are compatible in invoking interfaces. Thus, for given global information interaction which has been verified correctly by above methods, there still might exist a web service of which the behaviors are not compatible with it. This collaboration will fail finally in practice.

In this paper, we propose a verification method of collaboration between WSCI-based web services. Here we employ a formal method, say automata, to formalize WSCI. Based on the automata, we can verify the compatibility between the behaviors of web services through a client/server model. Such compatibility is important to guarantee the successful completion of collaboration of web services.

The paper is organized as follows. After this introduction, section 2 surveys related works. In section 3, we discuss how to model web services based on WSCI with DFA. Section 4 describes how to analyze the process of collaboration, and followed summary and future works.

2 Related Work

Recently, verification of web service collaboration has been attracting much attention. The main methods include MSCs, FSA, logic, Petri net etc. In [3], a model-based approach is proposed by the authors for verifying Web service composition, using Message Sequence Charts (MSCs) and BPEL4WS. In [4-6], the authors established a conversation oriented framework to specify web service compositions and reason about their global behaviors. In [7], the authors use CTR-S (Concurrent Transaction Logic) to specify the contracts in semantic web services, and a proof theory for CTR-S can illustrate the use of this logic for modeling and reasoning about web service contracts. In [8] the author describes an approach to modeling web services specified in the language BPEL4WS with the help of Petri nets, then further model check the correctness requirements of a process. Although above approaches can effectively verify the process of interacting of web services, they don’t take into account the inner behaviors of each web service.

In [9], the authors use CCS (a kind of process algebra) to formalize WSCI, and then be in a position to check whether two or more web services are compatible to interoperate or not, and if not, whether the specification of adaptors that mediate between them can be automatically generated. Though this approach can effectively formalize WSCI, but the verification is not intuitionist.

In this paper, we will show the benefit of using automata to formalize WSCI. We verify the compatibility among web services through a client/server model. We will show that it guarantee the soundness of collaboration of web services.

3 Modeling Web Services Based on WSCI with DFA

The Web Services Choreography Interface (WSCI) defines the overall choreography describing the messages between Web services that participate in a collaborative exchange. In intuition, we can use automata to formalize WSCI because the