An Integrated Framework for Semantic Service Composition using Answer Set Programming

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ABSTRACT

Notwithstanding the advancement of service computing in recent years, service composition is still main issue in this field. In this paper, the authors present an integrated framework for semantic service composition using answer set programming. Unlike the AI planning approaches of top-down workflow with nested composition and combining composition procedure into service discovery, this proposed framework integrates designed workflow with nested composition. In addition, the planning is based on interface variables with validation through pre and post conditions. Moreover, a unified implementation of service discovery, selection, composition and validation is achieved by answer set programming. Finally, the framework performance is demonstrated by a travel booking example on QWSDataset.

Keywords: Answer Set Programming, QWSDataset, Service, Service Composition

1. INTRODUCTION

Service computing has been extensively studied, and major issues include formalizing the specification of service, service discovery, selection and composition (Rao & Su, 2005; Dustdar & Schreiner, 2005). There are two primary paradigms for service composition: top-down and bottom-up paradigms (Bartalos & Bielikova, 2011). For top-down paradigm, the complex workflow is designed manually. Hence, the workflow could be refined in terms of requirements. Nevertheless, bottom-up paradigm can composite services automatically by AI method. Furthermore, mixture paradigm architecture is proposed in (Paik, Chen, & Huhns, 2014), in which, unlike top-down paradigm, HTN to plan workflow is utilized instead of designed workflow, and like top-down paradigm to discover services, the best service is selected. If no existed service is matched, same as bottom-up

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paradigm, the nested composition procedure will be triggered to fulfil the requirement. Nevertheless, full automatic approaches usually are not the best solution for world-wide problems. Especially for human dominant activities, AI planned workflow is not correct all the time. Even though nested composition compensates this deficiency when planning service is coarse-grained, it would be failure when dependent services are decomposed incorrectly. Hence, medium solution and efficiency AI approach should be exploited. Regularly, service discovery and composition are regarded as two separate processes (Syu, Ma, Kuo, & FanJiang, 2012). In (Küster, König-Ries, Stern, & Klein, 2007), they proposed an approach to combining composition procedure into discovery process in compliance with multiple effects, and the effects coverage must be computed foremost. Therefore, the approaches to computing coverage are required implicitly.

In order to address these related issues of service-computing, we propose an integrated framework for semantic service composition using answer set programming (FSSC), which includes the following features:

1. **Modified mixture composition paradigm.** Our approach combines top-down and bottom-up paradigms by designing a workflow for discovering and selecting service foremost, when no service is matched or discovered, a bottom-up nested composition procedure will be triggered.

2. **Unified procedure for service discovery and composition (using simplified service description).** In order to boost planning and validation, we apply simplified service description to divide goal service (i.e., to discover and composite service) into source and target services. Hence, service discovery and composition can be cooked in the identical procedure. Only one difference is the length of composition chain. An outstanding feature of this approach is not required to compute the multiple effects.

3. **On-the-fly planning and validation by answer set program.** Using interface variables for unified planning, whereas, Hoare logic (pre/post condition) for service validation. Our paper aims at employing answer set programming (ASP) (Brewka, Eiter, & Truszczyn’ski, 2011) for planning, declarative programming oriented towards difficult search problems. ASP allows for a unified representation of the problem including rules and constraints except the solution algorithms, in terms of features such as solid logic foundations, high-expressiveness, nondeterminism and high-declaratively.

The remainder of this paper is organised as follows: Section 2 overviews FSSC. Section 3 presents the formal specification of service as well as ASP implementation. Section 4 defines the service compositionability formally, and then Section 5 discusses unified service discovery, selection and composition and validation base on the formal specification. Section 6 shows the performance of FSSC with a travel booking example. Section 7 discusses related work, and finally, Section 8 concludes this paper and outlines future work.

### 2. OVERVIEW OF FSSC

In this section, the informal definition of service is introduced first, and then the low level composition methodology is discussed. Accordingly, the high level mixture design paradigm and details of generation engine are presented.

To illustrate our framework, after checking all the examples in file OMG BPMN 2.0 example¹, we choose the travel booking example shown in figure 1, which includes 4 sub-processes, 6 gateways, 18 activities and 26 events with error handling and compensation mechanisms. Thus, the complexity of this example is adequate for evaluating the performance of proposed framework.

This example provides travel booking services to clients. A client requires to interact with the system by following this process for his or her travel booking. The process includes
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