An Efficient User-Centric Web Service Composition Based on Harmony Particle Swarm Optimization

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ABSTRACT

Generally, the composition is the process of combining services to fulfill complex tasks based on their functional and non-functional values such as quality of services (QoS) and context attributes. However, to produce a composition with values that satisfy many requirements is a challenging focus. In this article, the authors proposed a new approach centered evolutionary algorithm called the harmony particle swarm optimization (HPSO) algorithm that leads to an efficient composition with better performance and execution time. The authors’ proposed method is a new hybrid version of the harmony search and the particle swarm optimization. The HPSO is designed to generate the best web service composition in a discrete search space. Furthermore, the method includes two filtering processes called Skyline operator and local consistency reinforcement techniques. These methods filter the search space and keep only the most representative candidate services. Results show the effectiveness and the accuracy of the proposed approach.

KEYWORDS

Context, HPSO, HS, PSO, Skyline, VCSOP, Web Service Composition

INTRODUCTION

Nowadays, web services are the technology that standardizes the communication between heterogeneous applications and systems via the Service Oriented Architecture (SOA). SOA has gained more and more attention as a means of robust and interoperable distributed applications. The SOA paradigm has been adopted by enterprises to implement challenging business processes. Where due to the complicated processes, it is difficult to find a single web service that is capable of handling a specific user request. So, business processes compose a large number of atomic services into so-called composite services to solve one problem. A common example is making travel arrangements for a trip, transportation, accommodations, e-health …. Yet, the rising number of web services providing similar or identical functionalities through the internet makes the process of service composition or selection a challenging task.

Furthermore, a service composition may be requested by multiple users, where each user has its specific requirements for the same process. Thus, the composition needs to be a flexible solution to each user requester. The flexibility of a response is measured by its non-functional factors especially

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the context information. In our present researcher, we extend the non-functional constraints with the user context information. Thus, this will improve the capability of web service composition in generating an intelligent user-centric response. For example, in an e-health service composition platform a user needs to find the nearest emergency service. This service should consider the *current location* of the requester and then propose the best *transport services* that are available at the *current time* to get access to the emergency. Thus, users couldn’t get the same responses as others requesters.

Knowing that our problem is an NP-Hard where to find a solution will exceed the limitation in real time. This critical challenge has been attacked by modeling the composite problem as a Valued Constraint Satisfaction Optimization Problem (VCSOP) in (Fekih, Mtibaa, & Bouamama, 2016). This VCSOP modeling will provide a well-organized representation of the constraints (functional and non-functional level) where it reflects the constraint satisfaction degree and offer a better compromise of constraints sorts.

In this paper, we will present a new user-centric web service composition approach that produces the appropriate solution for multiple users. The significant contributions of this paper are as follows:

- In order to reduce the size of the search space, (1) We investigated the Skyline (in the terminology of services) or the Pareto (in constraint terminology) method, to keep only the non-dominated service. (2) After that, the reinforcement of local consistency is used to improve the quality of the Pareto set (Fekih, Mtibaa, & Bouamama, 2017). The node and arc-consistency algorithms are both applied to enhance the satisfaction degree of service list.

- Next, to produce the optimal solution, locally and globally in an NP-Hard problem, a new evolutionary hybrid algorithm named the Harmony Particle Swarm Optimization approach (HPSO) will be proposed. Many types of researchers proposed the hybridization for the continuous problems nevertheless our proposed method is hybridization between Particle Swarm Optimization (PSO) and Harmony Search (HS) in a discrete search space.

The rest of this paper is structured as follows: we begin by deliberating the existing works in literature. Then, we proclaim the problem formulation to reflect all constraints sorts of our composition problem. After that, we discuss our enhanced approach by describing the filtering techniques used such as Pareto and the local consistency methods (node and arc-consistency). Next, we introduce the HS, the PSO, and the proposed HPSO methods. The results obtained in a real dataset are illustrated to show the effectiveness of our methods. We finally announced the conclusion at the end of this present paper.

RELATED WORKS

Web service composition has received extensive research attention as a complex and challenging task beyond human capability. Various approaches have been developed and applied successfully to solve and to compose a wide range of web services composition problems. Among them, we quote approaches based on biologically inspired optimization algorithms, such as Genetic Algorithm (GA) proposed by (Canfora, Di Penta, Esposito, & Villani, 2005) Ant Colonies Optimization (ACO) in (Zhang, 2010), Tabu Search (TS) and Simulated Annealing (SA) by Rosenberg, et al., in (2010). A new metaheuristic optimization algorithm is known Harmony Search (HS) also used by Jafarpour & Khayyambashi, in (2009), an adapted Particle Swarm Optimization (PSO) in (Zhang, 2014). Metaheuristic hybridization was also applied in many works such as (Yilmaz & Karagoz, 2014) proposed an approach to GA and HS mix. Xinchao, et al., in (Xinchao, et al., 2012) suggested the PSO and Human Immune System (HIS) hybrid, to generate the appropriate web service composition.
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