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QoS-driven selection of web service considering group preference

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ABSTRACT

The aim of this paper is to present an approach for selecting Web services during the process of building an orchestration/composition, on the basis of some Quality of service (QoS) features. The specific proposal is to consider decision maker's preferences, and aims at guaranteeing consistency of the selection considering such preferences. The composite service has multiple tasks and each task can be fulfilled by a group of services. Then the optimization is to select a service for each task so that the overall evaluation function can be optimized. With the traditional group decision method, the Technique for Order Preference by Similarity to Ideal Solution (TOPSIS) process, the decision makers must construct the decision matrix. Once web service candidates become unavailable or new web services emerge, the alternatives change, which means that the decision makers must reset the large number of evaluated values. In this paper, a group selection process named Group Decision Web Service Selection, GDWSS, was proposed. First, weights for each task are collected from the different decision makers and global optimization parameters are generated. Next, an easy preference setting named WSS-TOPSIS, adapted from the TOPSIS method, is proposed to reduce the amount of preference data input. Furthermore, GDWSS allows group decision makers to set preferences with a lighter workload and to consider group preferences for the system to reduce the exception difference existing among decision makers. Finally, the scenarios are replicated to illustrate the effectiveness of this approach.

1. Introduction

Web services have shown increasingly more demands [1]. One of the reasons for this increase is that web services can be combined dynamically to fulfill complex requirements [2,3]. With so many web services available, the system integration from different companies or departments across the supply chain, under effective and careful consideration of participants' needs, has become an important issue in system development [4–6]. However, many of their functions are similar. Besides, a single web service can provide only limited functions, so it appears difficult to fully meet users' complex needs [7]. Thus, it is preferable to combine web services that complement one another to satisfy complex needs [8]. In addition to selecting a web service oriented toward a single task process, global optimization should be considered to make web service composition more effective [9]. To solve this problem, Quality of service (QoS), in terms of such factors as execution time, price and reliability, is used as a selection criterion in web service selection [10]. But there are countless web service composition options and the QoS of composite web service is difficult to control [11]. Zeng et al. [12] contemplated the dynamic transformation of web services and selected web services using integer programming. Danilo and Pernici [13] further improved Zeng [12] to overcome the problem of confliction to the global limit occurring during the process of sub path merging. Huang, Lan and

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Yang [14] computed the QoS value of web service compositions using a different computing method based on composition process type and selected a web service composition that was globally optimized. Chang Guofeng [15] applied Bayesian Networks to obtain each web service QoS value to satisfy users' requirements. Lin, Lo, et al. [16] utilized the features of QoS, combining fuzzy methods to achieve group consensus. However, most web service selection research has assumed that the decision maker does not understand the process of web service composite structure development. Therefore, there is no difference in the importance of each task [17–20]. Furthermore, the abstract web service composition can be regarded as an enterprise operating process during which users should have differing degrees of importance to each operating process. Consequently, the composite web service should be selected by considering the differing importance of the process in each combination.

There are many studies [11–14,21–27] presenting different frameworks and methods to assist users in selecting the desired web service by considering the opinions of IT staffs but not the preferences of different stakeholders. Web service composition should consider these preferences guardedly because each decision maker may have different preferences when selecting web services. To determine individual preferences during the web service selection process, Lo [28] proposed a method of group decision making with regard to the selection of single web services. Zhang et al. [29] proposed a method of group decision making for web service execution paths. Considering the dynamic changes that web service has experienced [12] and the various QoS domains, it will be more difficult to determine group web service preferences. To consider the needs of the majority during the process of web service composition, the Technique for Order Preference by Similarity to Ideal Solution (TOPSIS) is employed to select the final web service composition because in most cases, multiple users will participate in decision making [28,30,31]. The TOPSIS can aid decision makers in not only ranking alternatives but also generating feasible alternatives to address multiple attributes or multiple criteria [18,32]. However, two challenges need to be solved when employing TOPSIS:

- This method is easily affected by outliers and imprecise or uncertain data, possibly leading disorder among alternatives [33,34]. The final solution is selected from a set of existing alternatives instead of after consideration of the decision makers' opinions. Furthermore, decision maker must set the evaluation for each criterion for every alternative during the group decision process. The evaluation may be imprecise because there are too many alternatives and criteria [35].
- The decision makers must construct the decision matrix. When web service candidates become unavailable or new web services emerge, the alternatives will change, which means that the decision makers must reset the large number of evaluated values.

To solve the abovementioned problems. A selection process named Group Decision Web Service Selection, GDWSS, was proposed, allowing different tasks to have individual domain-related attributes. These attributes can still be aggregated to obtain the domain-related attribute value of the web service composition even if each task has different types of domain-related attributes. Alternative sorting allows for a significant degree of consensus, meaning that the group selection result can match the preferences of the majority of decision makers. With the overall GDWSS process, the final solution has not been selected from the default alternatives, but alternatives are generated by decision makers' preferences and the final solution is chosen from the alternatives. This method has the following features.

- Considers the global optimization of web service composition and the decision maker's preferences simultaneously during the web service composition process.
- Generates alternatives using the decision makers' preferences and choosing the alternative closest to the group's preferences.
- Proposes the WSS-TOPSIS method, adapted from the TOPSIS, which replaces the evaluation of the decision maker with QoS to reduce the workload.

The remainder of this paper is organized as follows. Section 2 includes a brief introduction to decision making methods and a review of the QoS. The method developed is detailed in Section 3. In Section 4, the method used to examine the proposed model is introduced. Finally, the research results and implications are presented and discussed on Section 5.

2. Literature review

The aim of this paper is to present an approach for selecting Web services during the process of building an orchestration/composition, on the basis of some QoS features. The specific proposal is to consider decision maker's preferences, and aims at guaranteeing consistency of the selection considering such preferences.

2.1. The methods of decision making

Group decision-making is more complex than individual decision making due to different opinions. When making multiple-criteria decisions, many factors need to be considered, such as the selection of the lowest-cost, fastest, most reliable web service. But considerations will differ over time. Some multi-criteria decision making methods for web service selection were applied, including Integer Programming (IP), Simple Additive Weighting (SAW) and the TOPSIS.

IP is a branch of linear programming. The most important feature of IP is that the variables are all integers because many of decisions and variables in real cases are inherently integers. Huang et al. [14], Meng et al. [36] and Zeng et al. [12] applied IP to compute the assessed value of web service compositions and select web services by optimizing the assessed value because this method is good for global allocation of tasks to services. This programing has three main elements, namely, decision variables, the objective function and constraints. The primary goal is to transfer the variables of the objective function to find the maximum or minimum values. However, IP problem may takes very long processing time for computers to find the optimal solution with the increase of problem size. For this reason, IP problem is limited