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Selecting Suitable Semantic Web Service Composition, Using Promethee Method and Non-Functional Parameters

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Abstract. So far many methods are introduced to compose Web services. In order to automate Web service composition, concepts from semantic Web technology are used. By using this technology, we can compose Web services in order to response users' request automatically or semi-automatically. By the growth of Web services amount, the possible composition of Web services which can satisfy users' requests will increase. In this paper a new classification of Web service non-functional parameters is introduced and a new approach is proposed to select more suitable semantic Web service composition among all alternatives. The PROMETHEE method selects the best composition based on non-functional parameters and user's preferences. PROMETHEE is a method for multi criteria decision making method which can be used in our approach with good performance.

Keywords: Semantic Web Services, Web Service Composition, Non-functional Parameters, PROMETHEE

1. Introduction

Nowadays Web is one of the most important Medias in all over the world. Web services are important parts of Web. Web services are special type of Web applications. They are self-descriptive modular applications. Web services can be located, published and invoked through the Web. Web services can do many operations from simple request to complex business processes [1]. When a service is implemented other applications and services can discover and invoke it. In order to response some of user's requests Web services should be composed. By the growth of Web service amount the manual composition will be a time consuming task. The semantic Web technology and ontology based techniques are frequently used to compose Web services automatically. Semantic Web Service (SWS) is combination of Web service technology and semantic Web technology [2]. Semantic Web service is used in order to make Web services understandable for machines and can automate Web service operations like invocation, execution, composition and monitoring. Some of approaches are being used for describing Web services semantically are OWL-S, WSMO, WSDL-S and SWSF [3]. To compose semantic Web services automatically, Web services should be described in one of these approaches. In the next step a composition method is needed, some of composition methods are described in related works section. In many cases there are different compositions which can satisfy user's requests. Selecting most suitable composition is an important step in semantic Web service composition. In this paper PROMETHEE (Preference Ranking Organization METHod for Enrichment Evaluation) method which is a multi criteria decision making method is used to select the best composition among all the possible compositions. Web services non-functional parameters are used as decision making criteria in this paper. However, many other parameters and constraints can be used in this approach for selecting the most suitable Web service composition.

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Now the paper structure is introduced. In section 2 related works are mentioned. In the next section PROMETHEE method and its applications are introduced. Non-functional parameters and a hierarchy which is developed for non-functional parameters in Web service composition are proposed in section 4. Composition algorithm and proposed approach are coming in section 5. A conceptual sample is introduced in the next section. Finally conclusions and future works are introduced.

2. Related Works

So far many researchers have been done in the field of Web service composition, using semantic Web technology. In this section some these works are briefly reviewed. Also some performance optimization approaches are mentioned in this section.

In one classification Web service composition is divided in two categories: static and dynamic. Semantic Web service composition falls into dynamic category. Kumar and Mirsha [4] introduced a suitable classification for Web service composition approaches. Based on this classification an expert system will select best composition approach. Arpinar et al [5] proposed a framework for Web service composition based on ontology. In their approach Web services are being composed base on their interface similarity and also they are being ranked to select best composition. Best composition is selected by users' help. Many researchers used AI planning to compose semantic Web services [6]. Also Petri nets are used for modeling Web services and their communication analysis [7, 8]. In other research SWORD tools is developed which is a rule based system for composing semantic Web services [9]. Rao [10] reviewed most of automatic semantic Web service composition approaches in his survey. In most of proposed approaches in semantic Web service composition area, finding a composition which can satisfy requests is main goal. Selecting suitable composition among these compositions is an important problem some works have been in this scope. Liu et al [11] used Web service composition system feedbacks to find a suitable composition. In a paper Wang et al developed a soft computing framework to optimize Web service composition quality. They used genetic algorithm and neuro-fuzzy for optimization [12]. In other research genetic algorithm and greedy algorithm are used to improve selection [13].

3. PROMETHEE Method

PROMETHEE is a multi-criteria decision making method which was introduced by Brans in 1982 [14]. The first version of PROMETHEE is called PROMETHEE I and other versions have added some complement options to their later versions. PROMETHEE method has some advantages to other decision making methods. For example, PROMETHEE has less comparison between criteria than AHP (Analytical Hierarchy Process) method [15]. Also PROMETHEE does not have 0-9 point limitation. DECISION LAB [16] software can be used for decision making with PROMETHEE.

4. Non-Functional Parameters

In this section we will introduce Web service composition non-functional parameters in a hierarchy. These parameters will be used as criteria for decision making in PROMETHEE method to select suitable composition. This hierarchy has six levels. These parameters are gathered from researches in the domain of Web services non-functional parameters, performance and QoS [17-20]. In the first level we have the hierarchy root which is called selecting best composition based on non-functional parameters. In the second level, three basic parameters quality of service, provider and costs are introduced. In the third level each of the three above parameters are divided into their sub-parameters. QoS divided into performance, reliability, availability, accessibility, integrity, regularity, scalability and resources. Provider includes profile, policy and number of service. Profile has some information about provider and number of services means how many service this provider has developed. Costs divided into three main views. Rental costs which includes information about renting services costs, buy costs that has information about purchasing prices and invocation costs.

Most of parameters in the level 3 will break into some sub-parameters. Figure 1 shows the whole hierarchy and parameters which will be used in our approach.

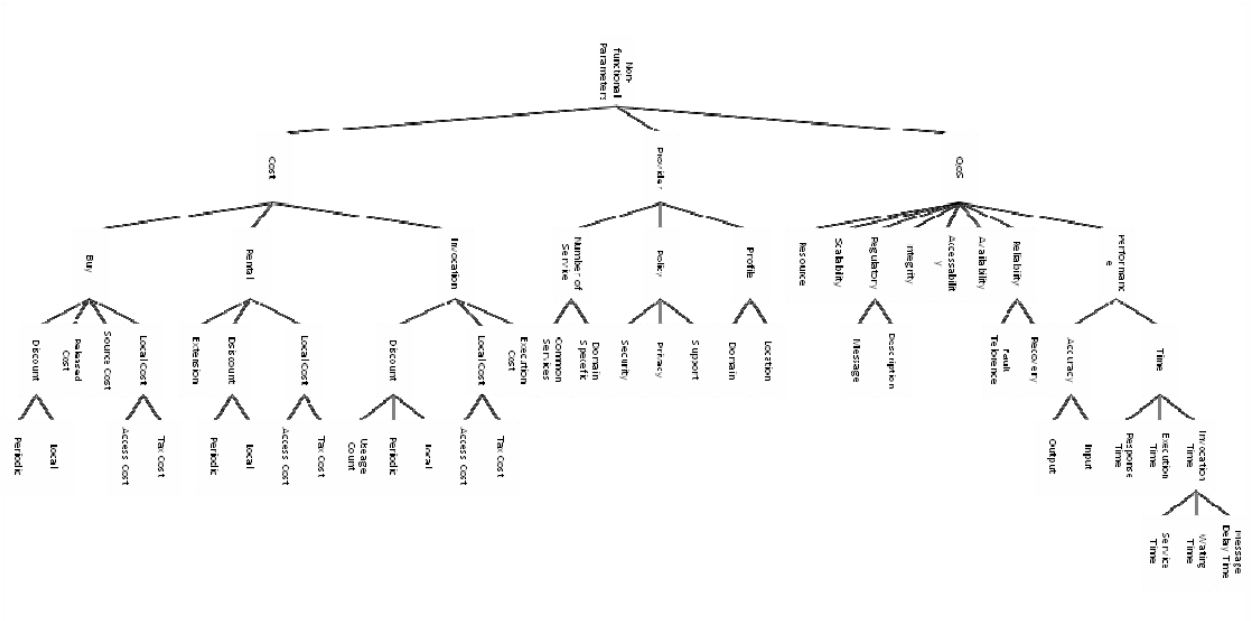

Fig 1: Non-Functional Parameters Hierarchy

5. Proposed Approach

So far various algorithms are developed for composing semantic Web services. Some of them are reviewed in related works section. In these methods composition operations are done in three general steps.

- Creating Web services and input/output sets;
- Creating dependency graph via created sets based on semantic similarity;
- Parsing dependency graph, using forward, backward or bidirectional approaches [18].

In many of these approaches after applying these three steps, more than one composition is found. Each of these compositions is called candidate composition and the best composition is called main composition. Selecting main composition can be done automatically or semi-automatically. An important category for selecting main composition is depended on non-functional parameters which can be found in figure 1.

In our proposed approach we used PROMETHEE method for choosing best composition among all possible compositions. In the next section we will review conceptual sample to make our work understandable to the readers.

These parameters preferences for each user are different from others. Also one user can have various priorities in different situations. In our proposed approach we have the following algorithm:

- Retrieving user's profile information;
- Assigning weight to the criteria which are mentioned in user's profile;
- Assigning weight to the criteria which are not mentioned in user's profile based on knowledge-base repository;
- Applying PROMETHEE steps;
- Ranking Compositions,

6. Conceptual sample

Assumption 1: assume that from a Web service data set we have created compositions like figure 2.

Fig 2: Composition 1 = [WS0, WS1, WS4], Composition 2 = [WS0, WS2, WS4], Composition 3 = [WS0, WS3, WS4]

Assumption 2: we have chosen two non-functional parameters cost and performance in our sample.

Assumption 3: the following tables include cost and performance values for each of Web services composition.

TABLE 1: COST, PERFORMANCE FOR COMPOSITIONS

	Cost ($)	Performance
Composition1	5+40+5=50	(70+90+80)/3=80
Composition2	5+5+5=15	(70+30+80)/3=60
Composition3	5+10+5=20	(70+60+80)/3=70

PROMETHEE Steps:

Step 1: create criteria set

We choose two non functional parameters from whole non functional that illustrated id table xx

$$C = \{cost, preformance\} \quad (1)$$

Step 2: add weight parameter in table

We specify which criterion must be maximized/ minimized for optimization.

TABLE 2: EVALUATION TABLE WITH WEIGHT AND MIN/MAX

S	cost	Performance*
Min/Max	Minimized	Maximized
Weight	0.75	0.25
Co1	50$	Good
Co2	15$	Bad
Co3	20$	Normal
*Good, Normal, Bad = 80,70,60		

Step 3: calculate deviation between alternatives

If criterion Min/Max is minimized the deviation sign must be change

Step 4: Choose preference function. Brans proposed six type of preference function in [21].we use *usual* function for comparison.

Step 5: create aggregated preference

$$\pi(alt\ a, alt\ b) = \sum_{j=1}^{k} p_j(alt\ a, alt\ b) w_j \quad (2)$$

TABLE 3: AGGREGATE PREFERENCE

	Co1	Co2	Co3
Co1	π(Co1,Co1)=0	π (Co1,Co2)=0.25	π (Co1,Co3)=0.25
Co2	π (Co2,Co1)=0.75	π (Co2,Co2)=0	π (Co2,Co3)=0.75
Co3	π (Co3,Co1)=0.75	π (Co3,Co2)=0.25	π (Co3,Co3)=0

Step 6: calculating φ^+ and φ^-

$$\varphi^+(alt\ a) = \frac{1}{n-1}\sum_{x \in A} \pi(a, x) \quad (3) \qquad \varphi^-(alt\ a) = \frac{1}{n-1}\sum_{x \in A} \pi(x, a) \quad (4)$$

TABLE 4. LEAVING AND ENTERING FLOWS

	PROMETHEE I		PROMETHEE II
	φ^+	φ^-	$\varphi = \varphi^+ - \varphi^-$
Co1	0.25	0.75	-0.50
Co2	0.75	0.25	0.50
Co3	0.50	0.50	0

Step 7: sort alternatives (1- Co1, 2- Co2, 3- Co3).

7. Conclusions

In this paper a new method is introduced for composing semantic Web services. These compositions are created by applying graph based algorithm and approaches to the semantic Web services. Selecting suitable composition can be done by applying various criteria and constraints. In this paper a hierarchy of semantic Web service non-functional parameters is proposed. Finally these parameters are used for decision making to select suitable Web service composition among all alternative compositions. The PROMETHEE method is used for decision making process. This method had high performance in multi criteria decision making.

As future works we can mention to improve proposed hierarchy. Also other criteria and constraints and variables can be used for decision making. Another approach which can be defined as future project in this domain is using other decision making approaches based on proposed structure.

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