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A New Framework for Matching Semantic Web Service Descriptions based On OWL-S Services

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Abstract

Nowadays, semantic web services are published and updated with growing demand for cloud computing. Since a single service is not capable of processing the increase of data and user's demand the improvement is necessary to match and rank semantic web service to achieve the user's goal. In the semantic web service framework, users' request is the input to the system and output is ranking of semantic web service. It has become a limitation to match between requests with the semantic web service description. This paper proposes a new framework for matching and ranking semantic web service based on OWL-S. The proposed new framework can match the keyword in each task and ranking service. This framework is done by using performance ontology-based indexing. The result is obtained and the performance of the services for multiple requests has been measured.

Keywords: Big data, *Cloud Computing, Semantic Web Service, Selection Service.*

1 Introduction

With the growing of large volume and high variety of available web services on cloud computing, single service is published with difference formats (WSDL, XML, and OWL-S) and their common functionalities are to analyze and manage different format of services [1], [2]. In the big data era, a huge number of web

users with the increasing complexity of their requests, is difficult to support the users' requests. Therefore when no single services are able to fulfill complex requirements from users, the composition services can be implemented [3]. Based on the general framework of web service selection [3],[4], a single service and composition services are choosed web services to fulfill the users require. In the service selection process, the choosed services are based on the service descriptions, and also created compose process that allows a single service to combine and complete the service tasks [6]. Therefore, there is a limitation in services selection. Furthermore, there is a similar problem found in the semantic web services framework found and the general framework of web service selection. Then, a specific issue is raised in this regard where services selection from the best set of semantic web services is matched by users' need according to web services, also including the semantic web service that are integrate of both semantic web and web services [7], [8]. The semantic web service is a web service described in web ontology language for services (OWL-S) which is a major technique. It is used in the domain of semantic web services for describing semantic data about web services. The description of web services is composed to three parts: the service profile, the service model, and the service grounding [9], [10].

However, the large volume and high velocity of semantic web services are able to fulfill every task that can offer excepted function for users' require. There is a limitation of selecting the best web services with a list of "Candidate web services", using the similarity functions based on input, output parameter (IOPE) [3], [10] or using non-function service properties. Firstly, matchmaking services match service name and description of semantic web service by matching with requirements [1], [6], [8], [9], [11]–[13]. Secondly quality of services (QoS) consists of many attributes such as availability, response time, reliability and throughput which cause the different of performance in terms of effectiveness [13]–[18].

Recently, especially in the era of big data, the increasing of various services is discovered by matching engine with keywords. A limitation has been found on the preprocessing process where the ambiguous words are cleaned only on keyword queries exclude description of semantic web services in [6], [9], [19]–[21]. It is an important process that involving the request of keywords used for matching with a semantic web service description by the common traditional matching engine. In addition, if a user has not familiar knowledge about semantic web service description, it becomes difficult to find a matching with a user queries consisting of important keywords. Therefore, our research focuses on candidate services that included ranking process. Based on the previous research, [13]–[18] proposed QoS attribute values to ranking semantic web services with analytic hierarchy process (AHP) technique – is one type of multi-criteria decision making (MCDM), used many QoS attributes values for ranking process and there are five attributes that often used to ranking services are shown five attributes: response

time, availability, throughput, reliability and cost or price. However, in our QoS datasets, there are four attributes have been used: response time, availability, throughput and reliability.

In this paper, we propose service selection framework process approach which consists of two main stages. The first stage is preprocessing process with cleaning suffixes words and Porter Stemming algorithm. While, the second stage is the matching process with ontology-based indexing algorithm to enhance with AHP technique for ranking semantic web services candidate based on OWL-S service and QoS attributes.

This paper is organized into the following sections. Section 2 discusses the related work. Section 3 describes on semantic web services on OWL-S and quality of services (QoS). Section 4 describes the proposed framework for matching and ranking. Section 5 describes results and discussions Section 6 is the conclusion and future work.

2 Related Work

Based on the web service composition framework and semantic web service framework, The similar process on both of framework is services selection process as shown in Fig 1 and Fig 2. It brings to the problem of selecting the best semantic web services with a list of "**Candidate semantic web services**", using the similarity functions [3], [22], or using non-function service properties. There are many attributes such as availability, response time, reliability and throughput and, therefore, different in terms of effectiveness [9], [13]. Based on our review, the service selection can be categorized into two types: 1. functional services which is specifying on functional properties such namely Input, Output, Precondition and Effect (IOPE) [1], [6], [8], [9], [11]–[13] and 2. non-functional services is text description matching and used the quality of service (QoS) attributes [13]–[18], [23].

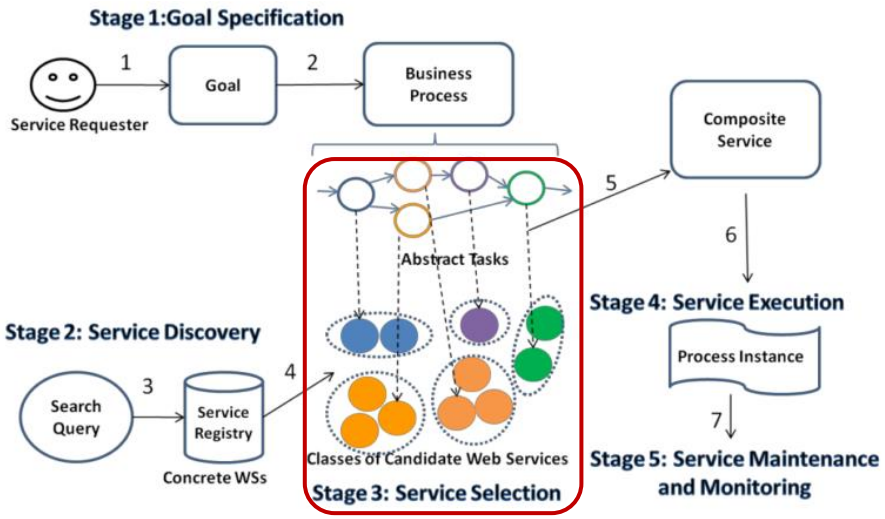

Fig. 1: Web service composition framework [4]

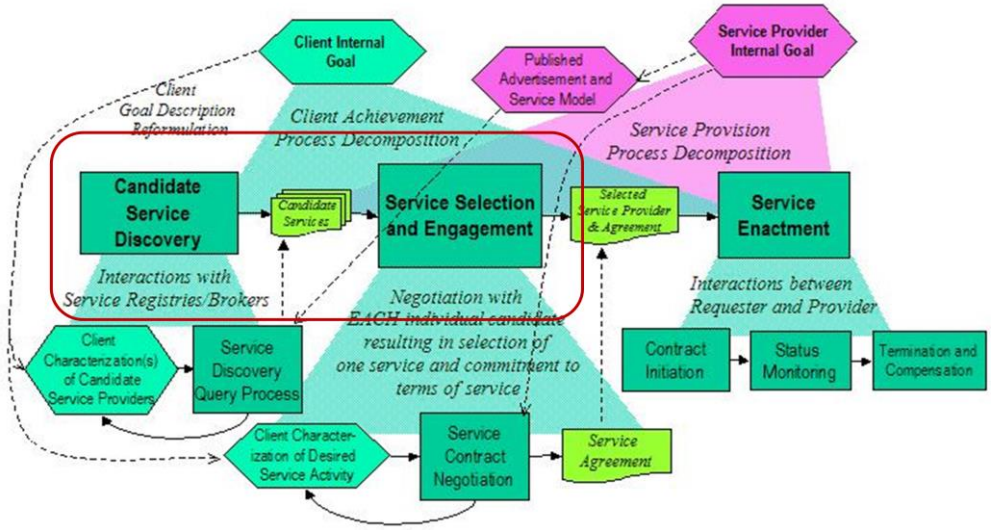

Fig. 2: Semantic web service framework [24]

There are various approaches available for matching and ranking based on web service composition framework and semantic web services framework. [4], [23], [25] have shown a majority problem at selection service process. From our further review, we recognize that matching based on OWL-S for semantic web services have been used earlier [6], [9], [19], [21], [26]. Most of the researchers proposed the natural language processing (NLP) technique that focused on the connections between computers and natural languages. Moreover, they also focused on users'require keywords but not discussing the comparison of user's request dataset matching between on owl-s models (service profile and service model [6]. Based on our review, a summary of comparative studies on matching semantic web service is presented in Table1.

Table 1: Comparative studies on matching semantic web service

Author	**Adala.A al.** [19]	**Cuzzocrea. A al.** [6]	**Sangers, J Al.** [21]	**Lakshmi, M al.** [9]	**Shan Liang al.** [20]
Consideron	Keywords request by users	Keywords request by users and compared on owl-s	Keywords request by users	Keywords request by users	Keywords request by users
Technique	NLP techniques to matching	A graph-based method for matching	NLP techniques to matching	NLP techniques to matching	Latent Semantic Indexing and a logic based reasoning
Preprocessing (cleaning)	Ambiguous words	Ambiguous words	Ambiguous words	Ambiguous words	Ambiguous words
Language	OWL-S	OWL-S	WSMO	OWL-S	OWL-S

Author	Adala.A al. [19]	Cuzzocrea. A al. [6]	Sangers, J Al. [21]	Lakshmi, M al. [9]	Shan Liang al. [20]
Format	(Service Profile)	(Service Profile and Service Model)		(Service Profile)	(Service Profile)
Owl-S Model	Service Profile	Service Profile	Service Profile compares with service model	Service Profile	Service Profile
Accuracy/ Processing time	Medium	Medium	High	-	-

From the previous studies, AHP method was used with quality of services to search for the high ranked services that are selected web services by QoS values. For instances, [14], [15], [18] used AHP method with five QoS attribute values to solve selecting services on the huge web services which all the function to fulfill users' require. Further, [16] proposed four attributes of QoS values with hybrid method between AHP and VIKOR methods. But [17] proposed to use all attributes of QoS values when applying AHP method with a new framework. A summary ofcomparative studies on ranking semantic web service with QoS is shown in Table2.

Table 2: Comparative studies on ranking semantic web service with QoS.

Author	R. Dinesh and group [14]	Wanchun D. and group [15]	Mojtaba K. and group [16]	Saurabh K. and group [17]	Kumar N. and group [18]
Consider on QoS Attributes	5 attributes used: 1) throughput 2) availability 3) cost 4) response time 5) reliability	5 attributes used: 1) duration 2) reputation 3) successful 4) execution 5) cost	4 attributes used: 1) response time 2) security 3) cost 4) reliability	All attributes	5 attributes used: 1) throughput 2) availability 3) consistency 4) response time 5) cost
Technique	AHP	AHP	VIKOR and AHP	Using SMI framework and AHP method	AHP
Language Format	To proposed a web service selection model using AHP with QoS attribute values.	Improving AHP to satisfied priorities and preferences for selection web service with numeric weights.	To proposed a hybrid to support selection service with the weights of criteria.	Proposing new framework that compared and ranked the cloud service based on users' requirements with QoS attribute values.	Proposing new framework for cloud service selection model used analytic hierarchy with multi criteria QoS and compared the result with the previous research.

Author	R. Dinesh and group [14]	Wanchun D. and group [15]	Mojtaba K. and group [16]	Saurabh K. and group [17]	Kumar N. and group [18]
Future Work	-	Implement this method with real life and benchmark applications.	-	Improve ranking algorithm with fuzzy sets and plan to implement a new framework on Amazon EC2 and Microsoft Azure.	Apply this model with another MCDM model and implement it on the real world data set.

3 Overview Semantic web services and QoS

In this section, we describe the concepts, definitions and focus on semantic web services that are described in OWL-S. Besides, the essential of OWL-S will be described briefly.

3.1 Semantic web services Based on OWL-S

Semantic Web services are the services that have been enhanced by XML web services and the semantic web. The goal of semantic web services (Nacer et al. , 2014) is to create a semantic web of services whose interfaces, properties, and effects are described in a non-ambiguous and utilizable way by software agents [7]. In this case, OWL-S is an upper ontology of service concepts that used XML-based ontology description language to describe the semantic of services based and identify service composition semantics.

OWL-S is a XML-based ontology description language to specify service composition semantics, including inputs, outputs, preconditions and effects (collectively called IOPE). By using OWL-S for the description of Web services, the ability of computer systems to find eligible services autonomously can be increased.

The semantic web services describe semantic data regarding to web service and service description are grouped into three major classes: service profile, service model and service grounding [9], [27] as shown in Fig 3. The service profile describes a general description of a web service that specifies the semantics of the service signature and what the service does in terms of its capabilities and shared to facilitate service discovery [6], [28]. The service model is used to compose services and describe how clients can interact with the service by defining the requester-provider interaction protocol [29], [30]. The grounding model describes specific how to access the service and provides by detailing of the mapping between semantic inputs, outputs, message formats, and operations [29], [30].

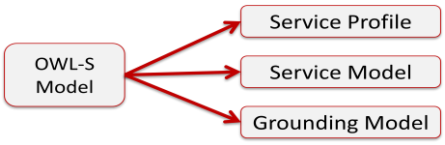

Fig. 3: Semantic web service framework [9], [27]

In our research, we focus on the service profile that involves the process of matching users' require with text description. The service profile is described on the textual description and functional description of the service- input and output of a service [9], [20], [27]. As a snippet of an OWL-S file is shown in Fig4.

```
<profile:Profile rdf:ID="EBookOrderProfile">
  <service:presentedBy rdf:resource="#EBookOrder1Service" />
  <profile:serviceName xml:lang="en">EBookOrder</profile:serviceName>
  <profile:textDescription xml:lang="en">An e-book order web service, where an
  ebook request is given by title and the required book is placed into the users
  shopping cart. The service also checks availability of the book in the stock
  and verifies user's account.</profile:textDescription>
  <profile:hasInput rdf:resource="#EBookRequest" />
  <profile:hasInput rdf:resource="#UserAccount" />
  <profile:hasOutput rdf:resource="#EBook" />
</profile:Profile>
```

Fig. 4: Snippet of an OWL-S service

3.2 Quality of Service (QoS)

The research of Quality of Service has been an active research area for several domains. The term "quality of service" has been used for expressing non-functional requirements for different areas such as network research community. The QoS is "the totality of features and characteristics of a product or service that bear on its ability to satisfy stated or implied needs" [31] [32] [33]. There are 11 of QoS attributes: response time, availability, throughput, success ability, reliability, compliance, best practices, latency, documentation, service name, and address.

4 Proposed Framework

The overall architecture of the proposed overall of matching and ranking owl-s service framework is shown in Fig.5 and more details about the framework are described in Fig.6. The matching semantic web service is a common problem in web services that used requirement to find the best services from service providers. In our framework, after the result is obtained from matching process, we transfer service to rank the semantic web service with multi criteria decision making by Analytic Hierarchy Process (AHP) method to work on multi criterion with the construction.

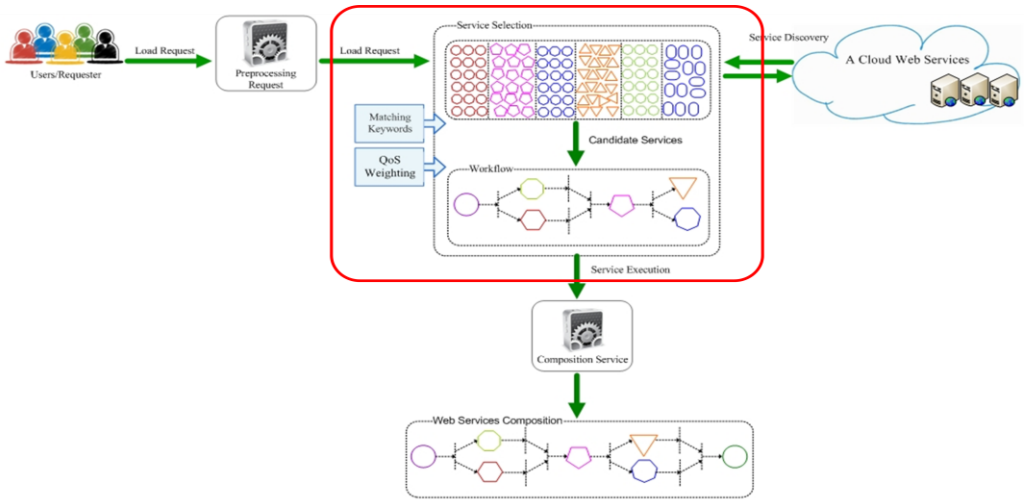

Fig. 5: Matching and ranking OWL-S service Framework

4.1 Ontology-based indexing method

The matching service is consists of two main parts: preprocessing semantic web services and users' requirement, the match between semantic web service and user requirement. At present, there are two main matching processes: one is based on common matching keywords; the other is based on semantic match [6], [9], [28], [34]. Based on our framework, we used Ontology-based indexing method, is a number represents how much a keyword participates in representing a web service. This weight is calculated formula [34]

$$\boldsymbol{w(kws)} = \frac{\sum_{j=1}^{N} \boldsymbol{w(j,kws)}}{\boldsymbol{m}} \qquad (1)$$

Where *n* represents the number of occurrences of term *kws* in the group of keywords of a web service and *m* represents the total number of keywords of the same web service. The details of these steps are explained in the operational framework presented in Fig. 6.

4.2 Multi-Criteria Decision Making (MCDM): The Analytic Hierarchy Process

The analytic hierarchy process (AHP) [35] is a structured technique for organizing and analyzing complex decisions, based on mathematics and psychology. In the AHP final step deals with the structure of an M × N matrix (where M is the number of alternatives and *N* is the number of criteria). This matrix used the relative importance for the alternatives in terms of each criterion with construction. The vector $(ahp_{j1}, ahp_{j2}, ahp_{j3}, \dots, ahp_{jN})$ for each j is the main

eigenvector of an $N \times N$ reciprocal matrix that is determined with pair-wise comparisons of the impact of the M alternatives on the jth criterion [27].

According to AHP the best alternative (in the maximization case) is indicated by the following relationship:

$$A^*_{AHP} = \max_i \sum_{j=1}^{N} q_{ij}\, w_j\,,\ for\ \ i = 1,2,2,\ldots.M. \qquad (2)$$

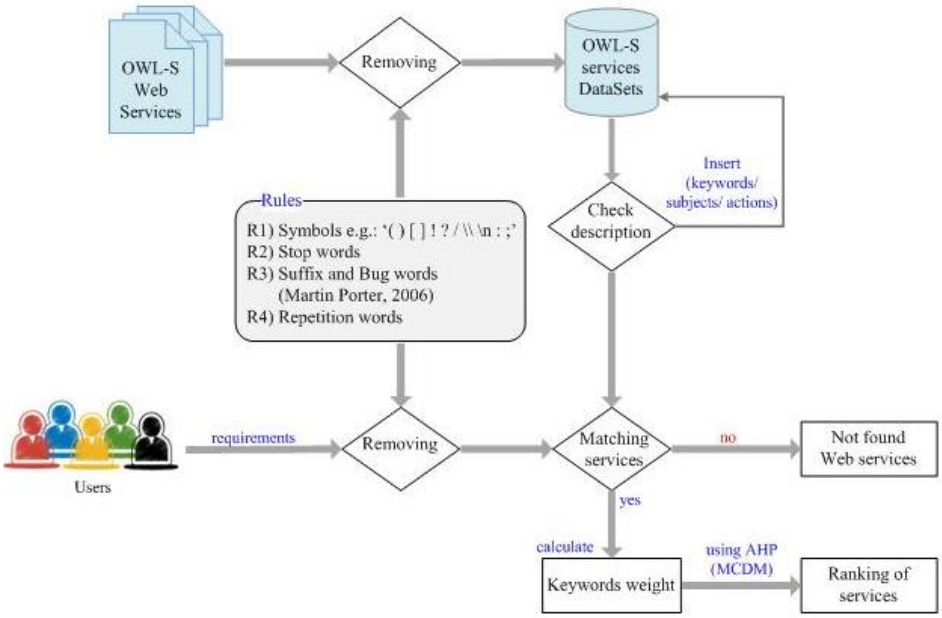

Fig. 6: Matching and ranking OWL-S service Framework

From Fig.6, the proposed method in our research for semantic service is to match the parameter of service with all input from users when there are more than two parameters is the semantic web service matching. In this paper, we use the user's input requirement parameters set as start point, ordinal search of matching semantic web service in the dataset, then add user' input parameter in preprocessing (Data cleansing) to remove symbols, stop words, suffix and bug word and repetition words. At the same time, systems also add semantic web service to the system and the same process is repeated to (Data cleansing) remove **words** that categorized as R1, R2, R3 and R4 for preprocessing. Then, the matching service's output parameter set is added and the systemcontinues in the search service that can be matched with user's requirements. The matched service will be decided by the service parameter's semantic similarity with ontology-based indexing of web service . In the final step, the ranking of semantic web service is based on the important of criteria which are four QoS attribute values - response time, availability, throughput and reliability.

5 Results

In our research, the performance of our framework is evaluated using the OWLS-TC V4.0 OWL-S services retrieval test collection dataset which containing 1,083 indexed owl-s services from OWLS-TC is available at semwebcentral.org. And QoS Dataset V.2 represents 2,507 indexed web services that exist from previous researcher is Al-Masri E. and group [36]. Furthermore, the preprocessing used removing data from Martin porter (1980, 2006) and stop words, suffix and bug words and repetition words.

Based on our framework, the result of this process will be a ranked list of Web services that match the users search criteria. This context-based match- making mechanism provides flexibility by only searching for exact word matches. The computation time is 27.453 minutes with 1,083 indexed owl-s service dataset. Furthermore, our framework is compared with the existing framework [15] with the number of indexed owl-s service from our dataset is 35. The result as shown in Table 3.

Table 3: Comparison the performance proposed and existing framework

	Processing time (Second)
Our Framework	0.8939
Wanchun D. al. [15]	0.9530

The experimental results, when the number of semantic web service set is 35, our proposed framework's computation time is about 0.8939 second and Wanchun D. al. [15] framework's computation time is 0.9530 second. Then, our proposed framework performs better in terms of computation time.

6 Conclusion and Future Work

In this paper, we propose service selection approach on matching with ontology-based indexing algorithm to enhance with AHP and ranking semantic web services candidate based on OWL-S service. The keywords are matchwith the users' requirement with service profile on semantic web services descriptions and ranking to define a priority for selection each of the service candidates. From our experimental results, the proposed framework providing lessprocessing time compare to existing framework which is based on 35 indexed owl-s service dataset. Our computation time is 0.8939 second and the existing framework is 0.9530 second. However, limitation has been identified in the proposed framework where the streaming process that invloving keyword cleansing (extraction, streaming and stop words removal) taking longer time for removing and matching in the preprocessing process. Also, the computation time for matching between user requests with owl-s is also time-consuming.

In future work, the processing time on preprocessing process will be shorten and the accuracy of matching keywords will be focused. Moreover, we will apply clustering algorithm in the classification of dataset on Hadoop or Spark. It is expected to increase the efectiveness on the huge of semantic web services dataset.

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