# Web service selection based on QoS and user profile

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**Abstract:** The web services are from different sources, heterogeneous, and of large volume. The user is in a crucial situation to select the best web services. The web service selection process aims to discovery the desired web services; as it allows to select the best web services to users' query. In particular, various web services have the same functionalities, so we need another factor to select the desired web services, which is the quality of service (QoS). The QoS has an important role in the web service selection process, it aims to classify the web service that have same functionality. This paper focuses on different concepts of the QoS. We present a new approach that is composed by two services; its role is primarily the best web service selection in relation with users' query and profile. In our approach, a better knowledge of user behavior is important because users can participate in research design and construction. The experiment shows that our method can accurately recommend the needed web services in a faster time.

**Keywords:** web service; query; user profile; quality of service; QoS.

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## 1 Introduction

With the increasing number of web services (Vannet and Mukesh, 2011), the web service selection process is becoming a difficult task. First, it is complicated for user to find the web services, because the web services number recovered compared by the research done can be massive. On the other hand two concepts semantically different can have an identical representation, which will further lead to low precision. Consequently, the recovered web services unrelated with consumers' needs, which is why we need to establish an efficient and reliable process of web services selection.

Since, another parameter should be introduced as a deciding factor. This enables consumers find the web services based on QoS (Summary of Quality Model for Web Services, 2001). It allows to select the best web service from a list of web services, which have similar functionality. The QoS includes many information such as performance (In terms of response time, latency, etc.), accessibility, availability, security; this information has an important role of web service selection. Consequently, QoS is used as a key factor to distinguish and classify the web services. The web service that has highest value is first selected.

Therefore, a better knowledge of users' behavior is essential to research an effective web service. User profile (Feddaoui et al., 2018) is an important element in various systems, it stores data that user description such as personal data (name, age, etc.), interests (keywords, expertise areas, etc.) and Preferences (language, colour, etc.). Several works use the QoS in the selection phase (Khutade and Phalnikar, 2012; D'Mello et al., 2008; Alrifai et al., 2009), but these approaches have many disadvantages such that the number of non functional parameters used in the selection phase is insufficient. Some the web services selection approaches (Kyriakos and Plexousakis, 2007; Fauvet et al., 2007) have missed precision in the web service recommendation. And the majority of these approaches do not include the users' profile in the selection process.

In this paper, we introduce a new approach of web service selection, based on QoS and the users' profile. This paper is organised as follows: in Section 2, we present a state of the art on user profile and web services selection based on QoS. In Section 3, we propose our approach of web service selection based on QoS and user profile. Section 4 presents experimental results and analysis of them. Section 5 concludes the paper.

## 2 Related works

In this part, we study the importance role of users' profile and the web service selection approaches based on QoS.

### 2.1 User profile approaches

User profile has an important role of the web service selection, a novel approach (Amoretti et al., 2016) where user profile and context-based data participle to recommendation production. Based on the aforementioned approach, UTravel recommends points of interest (POIs), i.e., locations that match user interests. By means of the UTravel mobile application, the user can see his position on a map, and a set of surrounding locations with cultural or commercial relevance, according to his preferences and to the current context.

A methodological approach in which they identify different behavioral user profile, named 'user-categories', base on behavioral attributes derive by the human factors of gender and expertise level. The result of user categories can be applied in the modeling mechanism of adaptive EUD environments system (Tzafilko et al., 2014). A new approach base on multi agent system for web search results personalisation. The proposed approach (Moawad et al., 2012) introduces a model to build a user profile from initial and basic information and maintain it through implicit user feedback to establish a complete, dynamic and update user profile. In the web search process, the model semantically optimises the user query in two steps: query optimisation using user profile preferences and query optimisation using the Word Net ontology.

A new method based on co-training algorithm (Rebaï et al., 2013) to detect and to remove irrelevant elements. This method automatically adapts the content for any profile and allows us to obtain the most generic classifier to each one. A multi-dimensional user data model and its application in web search (Anil et al., 2013). Online and offline activities of the user are tracked for creating the user model. The main phases are identification of relevant documents and the representation of relevance and similarity of the documents. The concepts keywords, topics, URLs and clusters are used in the implementation.

### 2.2 Web services selection approaches

In this part, we discuss the related works for web services selection. A new approach for selection the best web service was presented in Makhlughian et al. (2012). This could deal with changing conditions in dynamic environments. We notice that this algorithm is not optimal and it takes time to select the web service. While an approach (Ran, 2003) gives confidence to web service consumer opinions on quality of web service. This approach takes semantic modeling of QoS parameter. Functional and non-functional requirements are taken into account for web service selection in presented work. The disadvantage of this approach is the complexity to determine the matching algorithm between desired and provided QoS.

A new approach (Yu and Lin, 2007) which are: combinatorial approach and graphical approach. The first approach allows to modelise the problem as a multiple choice knapsack problem (MCKP), while the second approach allows to modelise the problem as a constraint in graph theory, or they take the shortest route. We notice a complexity of completing preferred and given QoS by providers. While two steps are defined for web services discovery (Khutade and Phalnikar, 2012) presented these are: twinning and selection. The First step allows for meeting QoS requirements in WSDL documents, and the result is from of the web service list. The second step allows to organise the output list according to the web service quality. But the problem with this

approach is that the matchmaker algorithm is unable to take a correct decision based on QoS.

A new approach allows to discovery the semantic web service (D'Mello et al., 2008). This approach classifies the similar web services using a ranking algorithm. The default of this approach is that authors use some QoS parameters; this number is insufficient to select the optimal web service. The presented algorithm (Alrifai et al., 2009) decomposes the optimisation problem into sub problems. This decomposition solves more efficiently than the original problem. It is characterised by the scalability and the selection web service is characterised by its optimality. We note that this approach is based on a very limited set of architectural requirements which gives a poor selection.

A semantically analysing for user needs (Kyriakos and Plexousakis, 2007). This information enriches syntactic base WS-QoS. In another, use of 'roadmap' that leads to semantic web services discovery. In this approach only some QoS parameters are considered.

A new approach (Fauvet et al., 2007) to provide a framework for substituting one web service for another and selected from those best suited to non-functional needs. The proposed model is formalised through abstract types, it allows for providers to register they web services and for customers to select one or more. This approach is slow since the rules definition by the providers is not automatic. The web services discovery based on agent (Berdjouh and Kazar, 2009), applies inferences to match the user's query with the web services offered. The matching algorithm is based on comparing outputs and inputs of query with outputs and inputs of web service and presents different levels of matching. We note the performance lack of the matching algorithm since it lacks other search parameters and this approach is not secure.

A new approach (Guo et al., 2011) that composed by four level for semantic web service, based on QoS ontology. The QoS ontology is constructed and the QoS description with the QoS concept in OWL-S model is extended. The number of the QoS parameter used is insufficient to make decision.

The web service selection approach (Zhang, 2014) adopts a swarm optimisation algorithm. However, there are some limitations in this scheme; for example, there are no clear cut guidelines on what would be the best choice to some parameters of particle swarm optimisation.

The various concepts of QoS associated with web services (Sachan et al., 2014), helps users to web service selection according to their requirement and reduces the human effort. The further process of ontology adding with semantic web services is also illustrated here. The disadvantage of this approach is the number of the QoS parameter used is insufficient and the approach based on agent is not secure.

The proposed approach for web service selection based on multi-agents (Murugesan et al., 2014), allows users to discovery and selection web services. This novel approach based on multi agent system, effectively supports web services discovery with QoS registration, verification, certification, and feedback. We note that approach based on agent is not secure; it's easy to replace an agent with a virus.

A new model for web service selection (Keskesl et al., 2010), based on a mixed context and QoS ontology. The authors particularly show how this approach can be made to support an e-commerce framework and how it can add dynamics to B2B interactions by automating selection among heterogeneous services. We note that this approach based on ontology lacks precision in the web services selection.

The presented approach (Wang et al., 2006) specifys QoS ontology and it use the onology modeling to annotate the web service descriptions with QoS parameter. The authors continue by recognising the quality attributes and their respective measurements with a QoS selection model. The disadvantage of this approach is that user does not give his preferred QoS for web service selections ie do not consider the user behavior in this approach.

A new classification of web services mining approaches based on QoS presented in Feddaoui et al. (2016). The authors present an overview of web service concepts and a comparative study of web service mining techniques, this paper present disadvantage of each approach. We all take a little analysis on approaches presented in Table 1 the advantage and disadvantage of these works.

The web services selection approaches presented in Table 1 have several disadvantages such as only some QoS parameters are considered and feeble precision to select the desired web service. Also, we notice that the majority of the approaches do not consider the users' profile in QoS parameter choice. There's no language describing both functional and non-functional functionalities, except the presented work (Ran, 2003). In our proposed solution, we propose a new approach for web service selection. Our approach based on QoS and user profile, it uses all QoS parameter.

**Table 1** Comparative study of web service selection approaches based on QoS

| *Ref* | *Advantage* | *Disadvantage* |
|---|---|---|
| Makhlughian et al. (2012) | Can manipulate changes in dynamic environments | This approach takes time and used algorithm in this approach is not optimal |
| Ran (2003) | The certifier verify claims with web service providers | The problem is to determine the matching algorithm |
| Yu and Lin (2007) | The performance and the effective of approach | Defeat and complexity for large problems |
| Khutade and Phalnikar (2012) | The simplicity of this approach | The matching algorithm is unable to take a correct decision |
| D'Mello et al. (2008) | The effective of this approach | Only some QoS parameters are considered |
| Alrifai et al. (2009) | The results optimality | This approach is based on a very limited set of architectural requirements |
| Kyriakos and Plexousakis (2007) | The functional and non-functional requirements are used | Only some QoS parameters are considered |

**Table 1** Comparative study of web service selection approaches based on QoS (continued)

| *Ref* | *Advantage* | *Disadvantage* |
|---|---|---|
| Fauvet et al. (2007) | The dynamicity of this approach | The rules definition by the providers is not automatic |
| Berdjouh and Kazar (2009) | The performance of the matching algorithm | The approach based on agent is not secure |
| Guo et al. (2011) | The optimality of the matching algorithm | Only some QoS parameters are considered |
| Zhang (2014) | The optimality and the rapidity of this algorithm | The difficulty to choose the optimisation parameters of the swarm algorithm |
| Sachan et al. (2014) | The efficient of the web service selection | Only some QoS parameters are considered |
| Murugesan et al. (2014) | The optimality of this approach | The approach based on agent is not secure |
| Keskesl et al. (2010) | The consistency and the effectiveness of this approach | This approach is not precise |
| Wang et al. (2006) | The precision and the simplicity of this algorithm | This approach does not take into account the users' opinion |

## 3 Web service selection approach based on QoS and user profile

Our architecture of web service selection based on QoS and user profile is shown in Figure 1, involves two services. The selection-service allows to select the domain and the QoS request by users. And the calculate-service calculates the QoS for each web service. Our approach composes by two phases namely:

1 The user profile construction phase: For each user we construct a profile describing his personal data, preferences and interests.

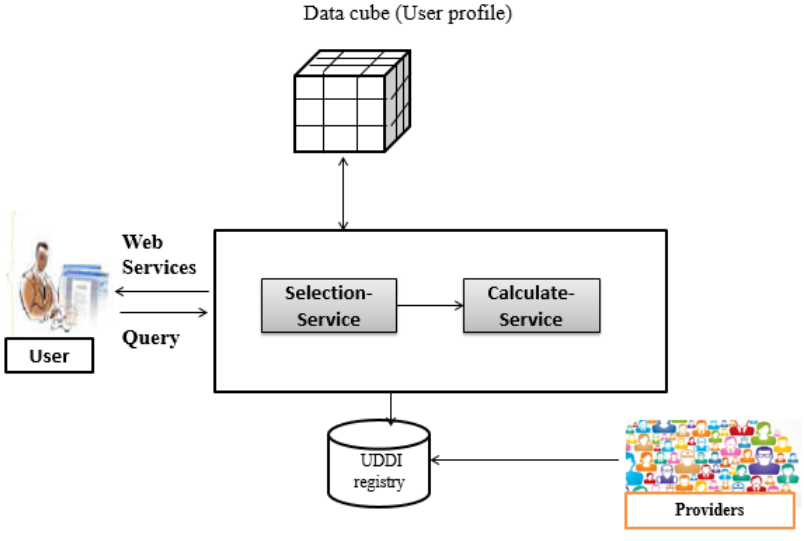
2 The web services selection phase: This phase is composed by two steps namely:

   a The web services selection step: For each user query our approach select the requested web service for a specific query given by a user who already has a profile, this task is done by the selection-service.

b The ranking step: For each web service, calculate-service calculates the QoS parameters and selects the best web service.

When a new user sends a request to search the best web service, our approach provides a list of recommendations generated from the multidimensional database. The selection-service allows to select the web services according of the querie domain. It allows to selects the web services already published in the UDDI registry. According of users' choice the calculate-service calculates the QoS parameter for each web services in list sent by the selection-service and chooses the best web service.

**Figure 1** General architecture of our approach (see online version for colours)




### 3.1 Phase 1: user profile

For each user, we construct a profile to describe the personal data, the keywords used, their preferences, and the web services selected for each query.

#### 3.1.1 User profile construction

User profile (Feddaoui et al., 2018) defines by contextual elements directly user related, such as their interests, search preferences, etc. In our representation, we distinguish mainly three dimensions, briefly describe in the following.

1 Personal data: Personal data is the static part of user profile. They include user identity (name, social security number), demographics (age, gender, address, marital status, and children number), personal and professional contacts and other information such as the number of credit card or health insurance card.

2 Interest centre: The user can formulate through the introduction of a set of keywords to describe user's interests. On the basis of those keywords, the system

will recommend information that best meet their expectations. The focus expresses the area of expertise of the user or scope of exploration. It can be defined by a set of logical expressions (queries).

3 Security: Security is a fundamental dimension of profile. It can affect the data to be questioned or modified. Tow types of security depend on the relevant objects are distinguished:

- User profile security: Make through to access in profile information permissions. Users profile, which may be the information system or other individual users are assign access rights or rights of access packets in order to query data from this profile.
- Results security: Concerns content objects deliver to user. It expresses in indicating the level of security of the or through expressions into an existing formalism.

### *3.1.2 User profile acquisition*

The data collection process from a user involves relevant information collection to construct of user profile. The collection carries directly from the user feedback. Two types of acquisitions distinguish: explicit and implicit.

1 Explicit acquisition is a simple approach to user information obtaining. Indeed, the user asks to fill out forms to personal or demographic information collection such as address, profession and interests.

2 Implicit acquisition involves implicit user data collection. The collection process ensures by observing the user behavior and controls user's activities.

So, we adopt the both technique. Our system includes two types of users. The first is a newly entered visitor that does not have a profile. Technically, this is cold start problem. It is common in almost all recommender systems, and most existing approaches have this problem. The system relies on the demand similarity to web service (Sachan et al., 2014) provided to user. The second is a loyal user, who registers and has user's special profile. In this article, we interest in the second user. This type of user has already filled in a form. Therefore, this form contains three elements such as personal data: (name, age, address, gender), interest centre and profession. These elements need to identify and get an idea about the user's preferences. Thus, a user ends up having user's own profile.

## *3.2 Phase 2: web service selection*

This phase consists of two steps: the web services selection based on the query and calculate the QoS values for each web service.

### *3.2.1 Step 1: web service selection based on users' query and profile*

The web service providers' publish web services in UDDI registry by adding the domain and the QoS parameters to each web service. In our approach, we use the presented

UDDI registry (Ran, 2003), the author extends UDDI registry, so it supports this information, he added to UDDI registry, a quality-information entity that describes QoS of the service offered.

**Table 2** Example of web service ranking based on QoS

| *Id_WS* | *QoS value* |
|---|---|
| *WS_4* | *0.69* |
| *WS_5* | *0.66* |
| *WS_6* | *0.65* |
| WS_10 | 0.63 |
| WS_25 | 0.61 |
| WS_16 | 0.58 |
| WS_13 | 0.55 |

The selection-service role is to receive the querie. It access the UDDI registry for web services selection that can satisfy this query. If it does not find the web service that can satisfy the specific query, it sends the search query for the web service providers. Table 2 presents the algorithm that takes as input the querie and the web service domain. It allows to select the web services which have the same domain as the query Q.

**Algorithm 1** Selection-service algorithm

**Input** Query.
**Output** List L.

```
Begin
List = Ø
Domainquery = getDomain(Q)
for Each WebService ∈ UDDI do
   Domainservice = getDomain(WebService)
   if Domainquerie == Domainservice then
      List ⋃ WebService
   end if
end for
if Liste ≠ Ø then
   send Liste to Calculate-Service
else if Made a call for web service providers then
end if
End
```

### *3.2.2 Step 2: calculate the QoS parameters*

The QoS is used to rank the web services and select the best web service from a list of web services with similar features. It is used to categorise the web services. The web service that gets highest quality value is first selected. Our approach uses the QoS parameters given by the user, ie the user gives the preferred QoS for web services selection. In this work, various QoS parameters that we use for web services selection are:

- Accessibility: Represents the degree of the serving ability a web service query.
- Accuracy: Represents the error rate produced by the service for a specified period.

$$Q_{accuracy} = \sum_{n=1}^{\infty}(Ei), \tag{1}$$

where

$n$: time unit

$Ei$: execution error.

- Availability: Is measured between the time taken by a user to have service access and that of requesting service.

$$Q_{availability} = Time_{begin} - Time_{end}, \tag{2}$$

where

$Time_{begin}$: represents the time used for service access

$Time_{end}$: represents time taken for service requesting.

- Cost: Measuring from service rate charge of service providers in same group.
- Execution time: Represents the required time of user request execution.
- Latency: Represents a subtraction of response time from request time of web service invocation.

$$Q_{latency} = Time_{reponse} - Time_{request}, \tag{3}$$

where

$Time_{response}$: reponse time for web service

$Time_{request}$: request time for web service invocation.

- Performance: It is measured in terms of throughput and latency. Lower latency and higher throughput represents a good performance of web service.

$$Q_{Peformance} = \sum Q_{latency} * Q_{throughput} \tag{4}$$

- Reliability: Is measured by ratio between request time of web service and all of time request in specific time.

$$Q_{reliability} = \frac{Ns}{N}, \tag{5}$$

where

$Ns$: number of requests successfully responded

$N$: total requests.

- Response time: Represents required time to user request responding.

$$Q_{reponsetime} = \frac{Tsr}{Ttr}, \tag{6}$$

where

$Tsr$: service time

$Ttr$: transmission time.

- Scalability: Is an important quality aspect of web service, it refers to ability serve service requesters' request despite of the variations in requests volume.

$$Q_{scalability} = Max(Ns), \tag{7}$$

where

$Ns$: the number of the simultaneous transactions on web service

- Successability: It represents provider yields successful results over service requesters' request messages.

$$Q_{Successability} = \frac{SA}{NR}, \tag{8}$$

where

$SA$: the number of the successful acknowledgements received

$NR$: to the total number of requests sent.

- Throughput: Refers to the maximum number of the transactions completed by a web service which can process for a time unit.

$$Q_{throughput} = \frac{\sum_{n=1}^{\infty}(Ti)}{time}, \tag{9}$$

where

$Ti$: the maximum number of the completed transactions

$Time$: time unit.

- Reputation: Feedback, is given by users on a web service.

$$Q_{reputation} = \frac{Cpositive - Cnegative}{Ti}, \tag{10}$$

where

$Cpositive$: positive comment number

$Cnegative$: negative comment number

$Ti$: the maximum number of the completed transactions for unit time.

- Self adaptability: Is the power to dynamically change the behavior of a system in response to the internal and the external events (Summary of Quality Model for Web Services, 2001).

The calculte-service receives the web services list by selection-service, it classifies QoS the web services based on specific QoS given by user and selects the best web service; for example, if a user wants a more efficient web service $Q_{Peformance}$, we select the web service that is most efficient Table 3 presents an algorithm that takes in inputs the list of web services L and the QoS parameter used to select web services.

**Algorithm 2** Ranking-service algorithm

**Input** List L.
**Output** Web service Ws.

```
Begin
Ws = L[0]
QoSOpt = ClassifiesQoS(Ws)
for Each WebService ∈ L do
   QoS = ClassifiesQoS(WebService)
   if QoS optimum then
      QoSOpt = QoS Ws = WebService
   end if
end for
Return Ws
End
```

The following file presents the WSDL file contains the information about the web service example 'travel agency'.

## 4 Implementation

We implement our approach with development environment Java Eclipse, we use as application server Tomcat 6.0 and MySQL Workbench 5.2 CE (Inan and Juita, 2011) to construct the users profile, with data warehouse snowflake schema, as shown in Figure 2.

According to our method (Our approcha of web service selection based on QoS and user profile is shown in Figure 1, involves two phases. The first phase allows to extract the desired web service using the users' query and proile. The second phase allows to use paramter QoS for web service ranking), the main functions of this approach is composed by two parts:

1 the desired web services extraction using the users' query and proile

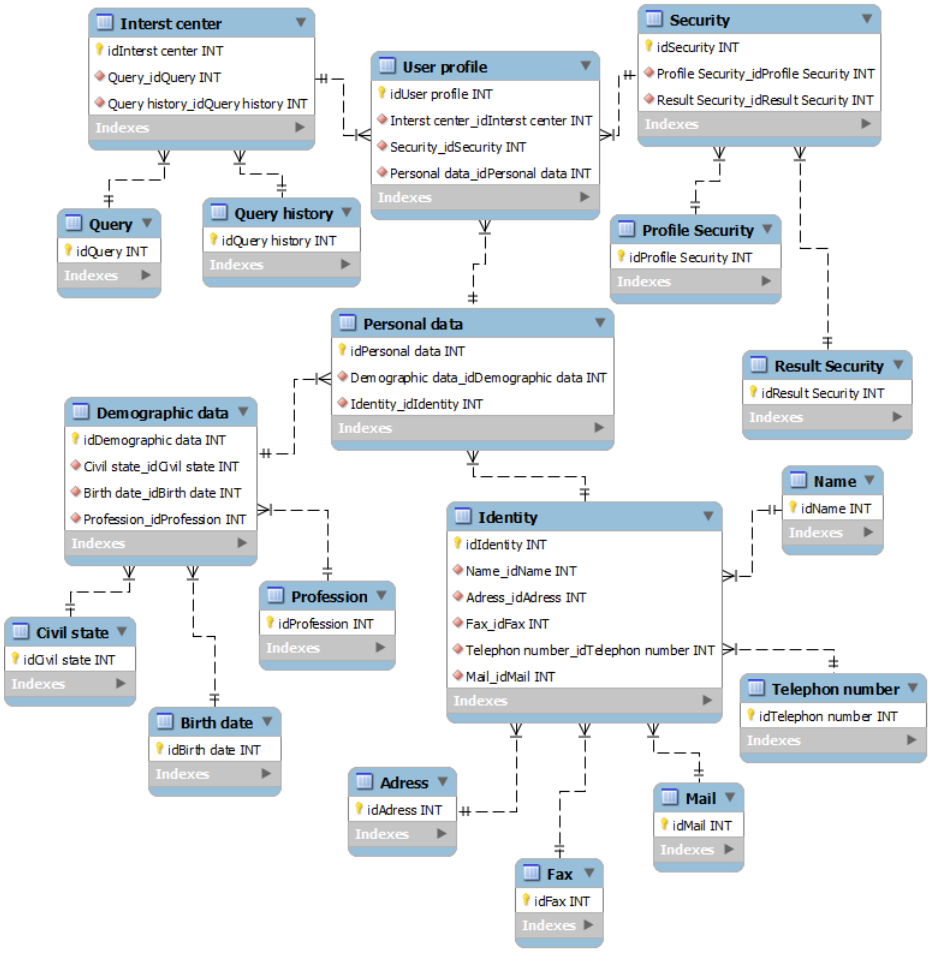
2 QoS ranking phase.

In this example, we provide 180 web services in experimental design. Figure 3 shows the results of a restaurant search. The selection-service finds services 4, 5 and 6, based on querie ie according to the domain of each web service. While, of each restaurant calculate-service classifies the web services based on QoS. It sends the restaurant 4,

as shown in Table 2. According to the parameters of QoS computed, in this example the user did not choose a particular QoS that is why he selects the restaurant 4 according of all QoS parameters. In our approach, the QoS information is stored by developing the tModel in a UDDI registry. Before a provider publishes a web service, a corresponding tModel will be created to store the QoS information of the web services. calculate-service calculates the QoS parameters with the formula (11).

$$Q_{Accessibility} + Q_{Accuracy} + Q_{Availability} + Q_{Cost} + Q_{Executiontime} + Q_{Latency} + Q_{Peformance} + Q_{Reliability} + Q_{Responsetime} + Q_{scalability} + Q_{Successability} + Q_{Throughput} + Q_{Reputation} + Q_{Selfadaptability}/14. \quad (11)$$

**Figure 2** User profile data warehouse snowflake schema (see online version for colours)




Formula (11) allows us to choose the web service that has the best QoS using all the QoS described in Subsection 3.2, and in case the user does not give his favourite QoS

to make the selection. So we use the all parameters available in the WSDL file of the web service.

Each QoS parameter is given by the web service provider by adding it to the specific WSDL file for each web service. Calculate-service select the web service using the all QoS parameters described in the WSDL file. The WSDL file contains the QoS value or the parameters needed to calculate through the calculate-service.

**Figure 3** Example result of a restaurant search (see online version for colours)

```
************************ Selection-Service ************************
Connexion etablie…
Service 4, Service 5 and Service 6

************************ Calculate-Service************************
Best service: Calculate QoS
[id, nom, domain, Accessibility, Cost, Execution time, Successability,  Reputation, Throughput, Scalability,
Availability, Accuracy, Self adaptability]
[4, restaurant4, restaurant, 0.5, 0.1, 0.1, 0.2, 0.1, 0.1, 300, 0.1, 0.1, 0.1, non]
[5, restaurant5, restaurant, 0.6, 0.9, 0.8, 0.8, 0.9, 0.7, 200, 0.7, 0.5, 0.1, non]
[6, restaurant6, restaurant, 0.5, 0.2, 0.5, 0.2, 0.4, 0.6, 250, 0.4, 0.6, 0.8, non]
```

**Figure 4** Example result of the restaurant search based on $Q_{Cost}$ (see online version for colours)

```
************************ Selection-Service ************************
Connexion etablie…
Web Service 6 and Web Service 22

************************ Calculate-Service************************
Best service: Calculate QoS
[id, nom, domain, Cost]
[6, restaurant6, restaurant, 0.25]
[22, restaurant22, restaurant, 0.28]
```

**Figure 5** Compute time for web service selection with queries number (see online version for colours)

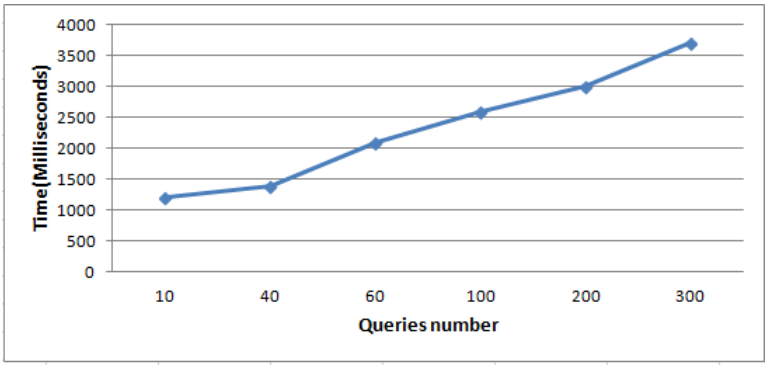
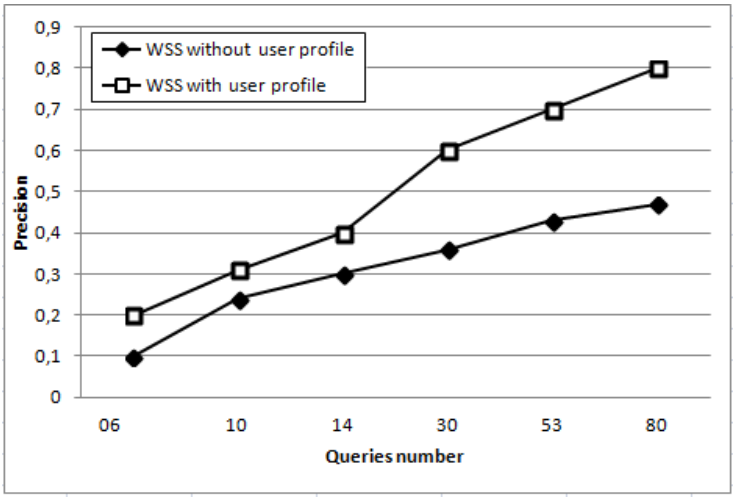


**Figure 6** Comparison of the performance between WSS with user profile and WSS without user profile




While Figure 4 shows for the restaurant search with the $Q = Cost$ given by the user. Calculate-service selects the best web service based on $Q_{Cost}$, we find the values 0.25 and 0.28 respectively for WS_6 and WS_22. It sends restaurant 6.

Figure 5 shows the compute time of web service selection approach based on QoS slowly increases with request number. For request number that does not exceed 100, a compute time by applying our approach is less than 1,200 ms. In addition, request number of exceeds 100, our approach has spends 3,000 ms for the web service selection.

In addition, we compare our approach for web service selection based on QoS and user profile (WSS with user profile) with the web service selection based on QoS approach (WSS without user profile) using the precision as a means of ranking. As a result, the experimental simulation result shown in Figure 6 indicates that the performance of our method can achieve an accuracy rate of 80%, and its performance is significantly.

## 5 Conclusions and future works

The web service selection has an important role to find the desired web services. In this research, we propose a new approach for web service selection. Our model selects the most appropriate web service between the web services that have the similar characteristics, according to the QoS parameters. User is involved in the web service selection, as it choices the QoS for the optimal web services selection.

Our new approach for web services selection is based on two steps:

1 the web services selection based on the query domain and the user profile

2 the web services filtering based on QoS.

Our approach allows user's to choose his selection parameter and also, we integrate all QoS parameters. Our approach shows its effectiveness in web services selection, precision, users' satisfaction and the web service selection in time decrease.

We note during the realisation of our research that we find a problem if the user does not have a profil. Also, the QoS parameter is insufficient of web services filtering. In our future work we will integrate this approach with a new collaborative filtering algorithm.

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