A Survey on Web Service Mining Using QoS and Recommendation Based on Multidimensional Approach

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Abstract The process of web service mining intends to discover required services so as to provide the users with the services that are important and desired. While as the system that has been proposed has an important role in the recommendation of services to the users. Multiple techniques have been projected to execute the proposed actions, the collaborative filtering technique is mostly used for the recommended system here, we will describe different approaches which make use of collaborative filtering and also QOS, (a technical notation that is applied to the Web service mining). We will also discuss some methodologies of recommended system which use the multidimensional approach.

Keywords Web service mining · Recommender system · Collaborative filtering · QoS · Data warehouse

1 Introduction

In beginning era of internet, the use of web was just to store information and that too only text and images. The Web has evolved since then to a great extent into host of multimedia information as well as the service-providing applications. The service applications include map-finding, weather-reporting, e-commerce and many more.

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G. De Pietro et al. (eds.), *Intelligent Interactive Multimedia Systems and Services 2016*, Smart Innovation, Systems and Technologies 55,
DOI 10.1007/978-3-319-39345-2_38

There are also real time applications using hardware devices like temperature sensor systems and the traffic monitor cameras. The Businesses and the government organizations realized the fact of integrating the existing Web applications, so as to provide the value-added services which were unavailable in the past. Unfortunately, customized interfaces that are required for accessing applications and deficiency of semantics in data they consume and produce have made unified integration and assimilation of the applications and the fast deployment of the value-added services very much challenging. To address all of these problems, the two qualifying technologies can be seen. The first one is initiative of the Web service that was announced in year 2000 by the IBM, HP, Sun and the Microsoft. The given initiatives included the Web services of IBM, HP's e-speak Sun's Open Network Environment (ONE) and Microsoft's.NET. The joint effort among such big companies and the other institutions resulted in World Wide Web Consortium (W3C) publishing specifications of the Web service [1]. Giving to W3C specification, Web service is Web application the functionalities of which can be accessed programmatically via set of the homogeneous XML interfaces. As a transition of web from Web of data to the web of data as well as services, where the Web services can be seen as first-class objects, an increase in opportunities to combine the potentially interesting as well as gainful Web services from the existing services can be seen. Since collective opportunities in composing the services can exceed anyone's imagination, lot many of such opportunities would be hiding in Web of the available services, which would be unexpected to most of the people. Sometimes we may not have the particular queries needed for searching them, but unrevealing of these opportunities in early stages in would be seen very advantageous in today's competitive business environment. For government organizations, doing so will means that the citizens in advance would receive the useful and the potential services. It is therefore important to actively attempt in discovering the useful services even if goals are not specified at moment, or are difficult to imagine or are unknown. Lot like easy access of surplus data which has provided the fertile ground for research in data mining, we do expect that increase in availability of Web services would also spur the need as well as opportunities giving the new grounds to Web service mining.

There is a strong belief that the Web service mining will be a key in realizing Semantic Web services in full potential by leveraging big investments in the applications which have been operated till now as the non-interoperable silos.

With augmentation the number of web services and the task to discover the desired service is becoming increasingly difficult. Firstly, it is complicated for the user to find the desired service, because the number of services recovered compared to research done can be enormous. On the other hand two concepts semantically different could have an identical representation, which will further lead to feeble precision. Consequently, services can be recovered unrelated with the need for their consumers. That is why we need to establish an efficient and reliable process of web services mining. The proposed system can be defined as a system that can help user to discover useful services according to their customized preferences, past behavior or based on their similar tastes with other users. Therefore, the recommended

system has an important role in their ability to recommend a service to the customer. It provides a ranking of services in predicting what services are the most necessary for users, based on the history, preferences and user constraints. Since many Web services have same functionality, another parameter should be introduced to be defined as a deciding factor. The quality of service (QoS) is the decisive factor appropriate, a set of information such as Accessibility [2], Accuracy, Availability, Cost, Execution time, Latency, Performance, Reliability, Response time, Scalability: Scalability [2], Success ability [3], Throughput [3], Reputation, Self-adaptability [4]. A recommendation can be done from the data warehouse. It is a database object-oriented, integrated, time-variant, contains a collection of non-volatile data that is used mainly in organizational decision making. Generally, the performance indicators here are more related to query throughput and response time. The technology well suited to this is OLAP (On Line Analytical Processing), it is a software technology that enables analysts, managers and executives to gain insight into the data through a coherent and easy access to a wide variety of information that has been processed and stored in data warehouses. A first step towards solving the problems of Web service mining is to study the current methods for the extraction of useful Web services. The main objective of this document is to provide a complete classification of Web services mining approaches using recommendation systems based on multidimensional and QoS techniques. Our classification is based on the following lines: Web service mining approaches by QoS, Recommended system based on the multidimensional and web service mining by recommended systems (collaborative filtering) and QoS.

This document is organized as following. Section 2 presents an overview of Web service concepts and presents a comparative study of Web service mining techniques. Section 3 presents a comparison of various techniques of recommendation system and show the usefulness of the data warehouse. Section 4 presents various Web services mining techniques based on collaborative filtering and QoS. While in Sect. 5 we will give our opinion on approaches studied during our work. Finally, Sect. 6 concludes the paper.

2 Web Service Mining

2.1 Definition

Web services mining is a new research discipline, which allows the discovery of the desired Web services, it has become a hot topic in those years. Web service mining is based on particular criteria given by the user. Search the right service that can meet the needs of users is still a problem. We can categorize the Web services mining into two classes that are syntactic based approach and semantic based approach.

2.2 Web Service Mining by QoS

QoS using rank Web services and select the best Web service from a list of services with similar features; it is used to categorize the Web services. The service that has the value of the highest quality of service is first selected. In this part, we studied the existing work of Web services mining by QoS, we'll take a little analysis on this work. Our study is presented in Table 1.

3 Proposed System

3.1 Definition

The proposed system plays an important role in the extraction of Web services. The proposed system can be classified as shown in Fig. 1 Content-based, Collaborative Filtering, Knowledge-based, Demographic-based Hybrid and Recommendations. In this paper we will focus on Collaborative Filtering.

3.2 Recommender System Using a Multidimensional

In this section, we will mention some approaches of literature that use the multidimensional in recommender system.

In [5] the authors propose a new approach for evaluation of recommender system. This approach is built on multidimensional analysis, allowing the consideration of various important aspects to judge the quality of proposed system in terms of applications in real time. They proposed a multidimensional framework to integrate OLAP technology.

Whereas in [6] the authors proposed a multidimensional approach to recommender system which can provide recommendations based on additional background information and more information about users and the typical elements used in most existing recommendation systems. This system supports multiple dimensions, additional information and hierarchical aggregation of recommendation. This recommender system could simultaneously acquire advantage of basic content-based recommendation, knowledge-based recommendation and collaborative filtering recommendation.

The authors in [7] introduced a generic recommendation system, which is able to provide advice for different types of applications. This system provides capabilities of multidimensionality of two-dimensional recommendation system. This upgrade allows generating more specific recommendations.

The authors present a new extension to the traditional approaches of recommendation systems, to be able to support the capabilities of data warehouse. They

Table 1 Comparative study of Web service mining based on QoS approaches

Refs.	Authors	Used technique	Advantages	The negative points
[27]	Makhlughian et al.	It uses data mining algorithm for classification	Can manipulate changes in dynamic environments	This approach takes time
			Satisfy user requests	Algorithm used in this approach is not optimal
[28]	Sachan, Kumar Dixit, and Kumar	Based on the multi-agent system	Efficiency and validity of this model	Only some QoS parameters are considered
			The agent is used to facilitate access to the registry service	
			The agent made the interaction with the UDDI	The approach based on agents is not secure, it's easy to replace them with malicious users
[29]	Ran	A new model based on UDDI register	The functional and nonfunctional requirements are used for the discovery service	Problem to determine the matching algorithms between desired and provided QoS
			A New role is introduced in this context the certifier (s)	
			They verify claims with Web service providers	
[30]	Yu and Lin	Two approaches were used—Multiple Choice Knapsack Problem (MCKP)—Graphical approach	Performance and effective approaches	Defeat for large problems
				Complexity
[31]	Khutade and Phalnikar	Using the matchmaker algorithm	Two steps: matchmaker and selection of Web services	Matchmaker algorithm used in this approach is unable to take a correct decision
			Simplicity of this approach	
[32]	D'Mello and Ananthanarayana	Use a semantic broker system. Search the Web services based on Quality of Service (QoS) and commercial offers (BO)	Effective	Only some QoS parameters are considered
			The broker also reads requirements from the requester and finds the best (profitable) Web service by matching and ranking the advertised services	

(continued)

Table 1 (continued)

Refs.	Authors	Used technique	Advantages	The negative points
[33]	Alrifa, Risse, Dolog and Nejdl	Based on a heuristic algorithm, which decomposes the optimization problem into smaller subproblems can be solved more efficiently than the original problem	Fast and scalable	Based on a very limited set of architectural requirements
			The optimality of the results	
[34]	Kritikos and Plexousakis	OWL-Q based approach	The functional and nonfunctional requirements are used for the discovery service	This approach takes time
				Only some QoS parameters are considered
[35]	Shi, Jinan, Zhang, Liu and Cui	It used a Clustering and Regression Algorithm	Web service selection which can provide the approximate QoS value for users	The clustering based on user data is not a good solution
			It clusters the users based on location and network condition	Only some QoS parameters are considered

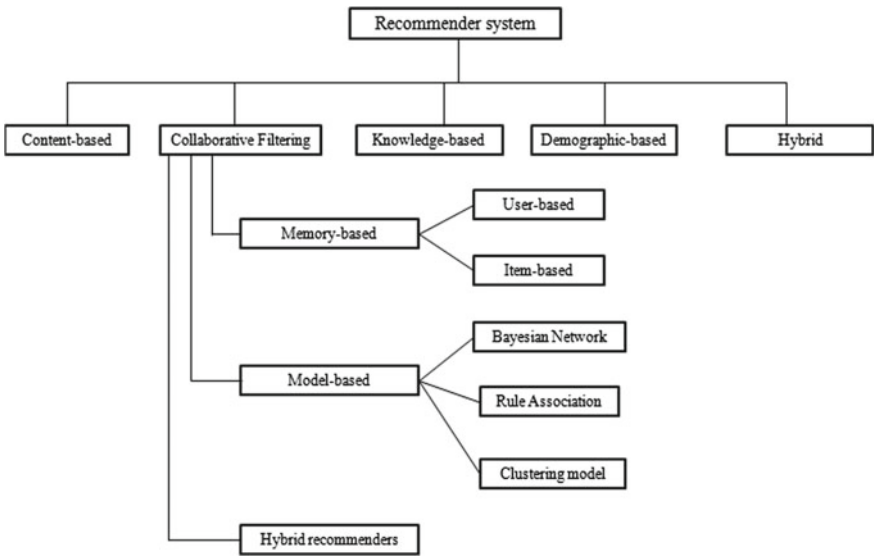

Fig. 1 Classification of recommender system technique

propose a recommendation system that works in multidimensional with the ability to support multiple dimensions. This approach is also supported on the OLAP technology [8].

The author present AWESOME (Adaptive website recommendations), a new data warehouse based on recommendation system capturing and evaluating user feedback on presented recommendations. It allows the use of a large number of prescribers generated automatically by websites recommendations. The recommendations are dynamically determined by a flexible approach based on specific rules [9].

The author present a multidimensional approach to the recommendation in the commerce. This approach has three phases. In the first phase it is possible to represent users, items, context information and the relationship between them in a multidimensional space. The second then determines each user's usage patterns in different contextual situations. While the third phase will create a new space of the recommendation in two dimensions. The final recommendation is made in this space [10].

The authors present an approach to recommender systems which can provide multidimensional recommendations which are based on additional background information besides the information of users and items used in most current recommendation systems. This approach supports multiple dimensions, extensive profiling and aggregation of hierarchical recommendations. This article also presents a method for estimating the multidimensional able to select two dimensions of segments [11].

Here they proposed to use OLAP technology during their exploration as a basis for recommending requests to the user. They proposed a generic framework to recommend queries based on OLAP server. This framework is generic in the sense that the change of its parameters changes how the recommendations are calculated. They showed how to use this framework to recommend simple MDX (Multi-Dimensional Expressions) Query [12].

In this article the authors proposed to apply approach based on collaborative filtering that exploits the ancient explorations of cube for recommending OLAP queries. This approach has been implemented with OLAP technology for recommend MDX queries [13].

The author proposed a generic framework of recommendations MDX queries and four instantiations of the framework. This framework is generic in the sense that it can be instantiated in different ways to change the method of recommendation calculations. This Framework consists of three steps:

- All registered queries pretreatment.
- Candidate recommendations generation.
- Candidate recommendations scheduling.

3.3 *Collaborative Filtering*

We can define collaborative filtering (CF) as a process that selects the desired services in relation to a user request from the preferences of other users. The collaborative filtering is classified into two classes as shown below:

Memory based Collaborative Filtering. In this type of collaborative filtering, a set of items or users is generated based on the relevance of the user or item. This system works on implicit or explicit evaluations. The user-item ratings are stored in the system and allow generating the list of items or user to be recommended. There are two types of memory based Collaborative Filtering: item-based and user-based [14]. The collaborative filtering based on user evaluates the interest of a user for an item using the ratings from other users for this item. On the other hand, item-based predicted rating of an item to a user, based on similar products, enjoyed by the user.

Model-based Collaborative Filtering. The basic idea of this approach is to model the interactions of user-item with the main characteristics of the extraction. This model is then trained by using these data. Several algorithms are used in this approach as Bayesian clustering.

4 Web Service Mining by Collaborative Filtering and QoS

We explored various research approaches to study the Web services mining by collaborative filtering techniques and the quality of service and present their limitations.

The proposed work in [15] provides a method for the selection of Web services based on the hybrid Collaborative Filtering and QoS. In [15] the selection of Web services is based on two phases: (i) the selection of Web services using the Collaborative filtering based on memory and QoS (ii) selection of Web services using the Collaborative filtering based on model and QoS.

While the authors in [16] provide a mechanism for Web service discovery for two phases based on the collaborative filtering and QoS. The first phase is used to filter the services with QoS values is incorrect. While the second phase is used to recommend services to users based on their non-functional requirements, which describe by the QoS provided by the consumer.

In [17], the authors propose a new recommendation algorithm of Web services, this approach does not require additional Web services invocations. It is based on the predicted values of QoS, Web services recommendations by QoS can be produced to help users select the optimal service. To improve the accuracy of prediction, they propose in this article a system of recommendation geolocation Web service that uses the quality of Web services and user locations for wished service prediction.

In [18], the authors propose a framework for the efficient discovery of Web services that provides customers with service quality information and reduces the

probability of failure by analyzing the statistics of previous service recommendations. This proposed framework allows the selection of Web services based on QoS properties implicitly collected by an agent-based distributed system.

In [19], the authors propose a new Web service recommendation system based on collaborative filtering, which can help users find specific services using QoS. The recommendation system uses location information and service quality values for users and recommends a personalized service for users based on the results of the grouping. Different to other studies, this approach uses the characteristic of QoS and achieves a considerable improvement in the recommendation accuracy.

In [20], the authors present in this article a new collaborative filtering system with QoS to recommend large-scale Web services. The proposed scheme automates the Web service selection process using the quality of service, it facilitates the selection of Web services. Most existing service selection approaches ignore the great diversity in the service environment and assume that individual users receive identical QoS of the same service provider. This can lead to inappropriate selection decisions.

In [21], the authors propose a Web service mining based on collaborative filtering and QoS, which classifies Web services to the recommendations. In particular, the similarity between two Web services is measured by the correlation coefficient. In this approach, we noticed that the authors also improve NDCG measure (Normalized Discounted Cumulative Gain) to assess the accuracy of the recommendations returned with the order of ranking.

In [22], the authors present a recommendation of Web services based on QoS. It will help users choose the correct optimal solution. This approach is based on collaborative filtering of Web services, the recommendation works by collecting the QoS records of users and the correspondence with users that share the same information or the same likes.

The work presented in [23] is a Web service recommendation system that allows discovering and proactively managing Web services. The authors focus on the underlying search and classification algorithms of services for active recommendations. The basic idea in this approch is to involve the user in their recommendation of Web services system. Users are encouraged to share their observation for Web services quality with others in the recommendation system. This can be effectively used by users for a better selection of Web services. The experimental part in this article demonstrates the effectiveness of this technique.

In [24], the authors propose a method for predicting the quality of personalized service. It not only considers the impact of the network but also the Web server environment, in particular the needs of individual users. It analyzes the behavior of previous users. When there is no information on the target motif, the system uses collaborative filtering to recover data on other motifs. Experimental results show that the proposed method makes it possible to significantly improve the accuracy of the QoS prediction.

In [25], the authors propose algorithms for semantic building of recommendation Web services using collaborative filtering. This work enables the use of semantic markup for Web services to increase the accuracy of the recommendations based on collaborative filtering algorithms when user-item matrix is sparse.

In [26], the authors proposed a system based on collaborative filtering of Web services to help users to find certain services with optimal performance QoS. The basic idea of this system is to predict the quality of Web services and recommend the best values for active users on the basis of historical records Web services quality. This proposed method uses NLP protocols to obtain enriched recommendation focusing on user feedback. The system successfully merges the ranking of Web services and user feedback to provide a hybrid solution for an appropriate recommendation.

5 Discussions

The first part of our research focuses on Web service mining by QoS. Here, the approaches we have studied, used the QoS information as classification means, they allow us to get that optimal services. These approaches are used to discover services wanted but they present several problems such as:

- Only some QoS parameters are considered.
- Lack semantic modeling of QoS parameter.
- Security problem especially for approaches that are based on the agents.
- Defeat for large problems.

While the second part of our research is on the recommendations systems that have a significant impact on the discovery of Web services. The recommendation from data warehouse plays an important role in the Web service mining, since the multidimensional allows us to make a reliable and accurate recommendation especially using OLAP technology.

The final part of our research is on the Web service mining by collaborative filtering and QoS, in this part we have shown the utility of QoS in the selection of Web services, according to the QoS parameters we can classify Web services and choose the best service from a list of services that have the same functionality. Current approaches to Web services mining present several weaknesses among which:

- Don’t take into account the behavior of the user.
- Are not adaptable to change.
- Lack of precision in selection of the desired service.
- With the increasing number of services, the Web service mining system crashes every time.

6 Conclusion

This paper presents a classification of Web service mining approaches. Our classification is based on the proposed system technique and the QoS. So we talk about the recommendations is done from the data warehouse. The purpose of Web services mining is to select the best Web service for a particular task. The QoS has an important role in the discovery of Web services. We conducted an analysis of these approaches and highlighted some of their merits and shortcomings.

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