ABSTRACT

After a period of research and development, Web services have become one of the typical technologies for sharing data and software and the Web service number available on the Web is continually increasing. This increase has been enhanced by cloud computing which is an emerging field for new computing paradigm for providing different services on request. As statistics shown in the website seekda.com, there are around twenty eight thousand Web services existing on the Web, offered more than 7,700 different providers. Hence there is a requirement for efficient methods for making effective recommendation on services, which is a serious issue in many practical applications such as service discovery and composition.

Web service recommendation process is of finding the usefulness of services automatically and recommending services to end users. Web service recommendation can also be viewed as the process of service selection process which is generally considered a process consisting of two steps such as functional requirements-based matching, and finally filtering and ranking-based on non-functional i.e. Quality of Service (QoS) requirements. Investigators are trying to improve the performance of the service selection systems using different approaches and algorithms where collaborative filtering is one of them.

Nowadays, Web service discovery using Universal Description, Discovery and Integration (UDDI) registries are not utilized for publishing Web services, as the public UDDI registries by companies namely, IBM, Microsoft, and SAP has been shut down. Recently, number of Web service discovery approaches has been proposed and several Web services publication websites have emerged such as WebServiceList, XMethods, and ProgrammableWeb. These approaches and websites use keyword-based search techniques which are not sufficient to fully describe the functionalities of Web services. On the contrary, semantics-based methods attain better retrieval efficiency than the syntactic methods. But, service providers need to work more to describe services by using semantic meta-data as the semantic approaches are describing the publicly available services using machine understandable languages.

Obviously, scalability is a very important concern in the discovery process. Discoverers usually get frustrated because of results consisting of a huge number of services which often increase with the space of published services. There is a lack of search space reduction techniques, which allow discoverers to promptly obtain proper Web Services, in spite of the huge
number of alternatives. Hence, the scalability of discovery systems has to be improved, without ignoring their effectiveness of retrieval.

When there are a number of similar services, QoS is considered for selecting the appropriate service from equivalent service set. Occasionally the service user may have no invocation record for services and hence the estimation for such services’ QoS helps from other similar users or invocation records by the user on other Web services.

Also, it is necessary to create an efficient technique to measure the ranking relation order between the retrieved services based on user’s requirements on different QoS attributes. The manner of ranking Web services is a central part of a Web service selection system, as it helps users to select their preferred service easily. But most of the existing approaches for ranking ignore the role of user’s requirements which is an important factor in the ranking process. Also most of the researchers have considered only few quality factors and not considering user’s QoS requirements while ranking services.

The focus of this research work is to advance the current modern way recommending Web services. There are two main service recommendation techniques such as collaborative filtering and content-based recommendation. Collaborative filtering is a method that has been widely used for recommending Web services to a given user by considering other similar users’ ratings on the Web services. For instance, if user likes Web services $S_a$ and $S_b$ and if $S_a$ and $S_b$ liked by many users, also like service $S_c$, then the service $S_c$ would perhaps be recommended to that user.

User feedback, such as ratings, to reflect users’ opinions or experiences on performance or quality are used in the collaborative filtering systems, which is a major factor considered in a recommender system. The explicit user feedback systems, such as reputation-based or community feedback-based systems, usually involve human efforts to provide feedback or ratings.

However, all users are not willing to provide feedback or ratings after each usage, and furthermore, the user ratings might not be exact or reliable. Also feedbacks provided by the users are often unable to completely reflect users’ true views or experiences.

Although this technique is effective, one big problem is that Web services without having a considerable set of user interactions (e.g., newly deployed Web services) cannot be recommended, which is also known as the cold start problem.
On the other hand, content-based methods make recommendation on Web services based on the similarities of the descriptive information of Web services (e.g., service functionalities). Newly-deployed Web services can be recommended by this technique. Hence recommender systems necessitate significant data as customer’s ratings and product features and hence recommendations generated are not of high quality.

So to overcome the above mentioned limitations of the existing approaches for web service recommendation, this research work proposes various approaches to improve the quality of the recommended Web services. In a nutshell, the contributions of this research work are:

- Proposes a new idea for match-making for finding Web services which are semantically similar for a user query. To perform the match on the content Web service description document semantically, the support-based semantic kernel is constructed using an innovative concept of clustering and merging on the large quantity of text documents covering diverse areas of domain of knowledge.

- Proposes an innovative approach for QoS prediction by combining Pearson similarity and Slope One methods. In this work, the Pearson similarity is adopted among services as the weight of their deviation. Also, weight adjustment and statistical process control-based smoothing approaches are also employed to reduce prediction error.

- Proposes an enhanced vector-based ranking method by considering user's requirements. The vector-based model is chosen because of its simplicity and high efficiency. All Web services are evaluated in terms of their similarity degrees to the optimal or the best available values of each quality attribute, and penalize the services that fail to meet the user's requirements.

- Finally, a practical architecture model which uses a hybrid method which combines the collaborative filtering and content-based approaches for service recommendation is proposed which uses implicit user feedback information which are extracted from usage logs. Also in this approach, a new ranking mechanism is introduced based on collaborative filtering method by using the invocation and query histories for inferring the users’ preferences, and for calculating user similarity. The proposed model is implemented and the experiment result shows better accuracy with respect to recommendation quality.