International Journal of Control Theory and Applications

ISSN : 0974-5572

Volume 10 • Number 30 • 2017

Review of Genetic Algorithm Based QoS-Aware Recommendation Algorithms

K. Vaitheki[a] and G. Zayaraz[b]

[a]*Asst. Professor, Department of Computer Science, Pondicherry University, Pondicherry, India.*

[b]*Professor, Department Of Computer Science and Engineering, Pondicherry Engineering College, Pondicherry, India *Corresponding Author*

Abstract: The demand of web service application requires improvement in prediction performance of Quality of Service (QoS). The recommendation system improves the prediction performance of missing QoS values. Collaborative Filtering (CF) approach is used for predicting the QOS values of Web service by considering the past usage experience of users that shows improvement in recommendation accuracy. CF only uses the user ratings to provide the recommendation. Hence, CF processes are not able to recommend for the models unavailable user ratings leads to poor accuracy. The status that represents poor accuracy and unavailable user ratings termed asCold-Start problem. This paper presents a review of the Genetic Algorithm (GA) based QoS-aware recommendation algorithms.The genetic approach predicts the best and optimal web service based on their Qos as well as content present in the web service related to the user query. The optimal prediction of QoS values in large-scale system can be obtained and the prediction accuracy improved by genetic approaches.

Keywords: *Collaborative Filtering (CF), Genetic Algorithms (GA), Matrix Factorization (MF), Quality of Service (QoS).*

1. INTRODUCTION

Web services provide the interaction between user, IP provider and relying party. A user connected to the browser access the high quality of web services to share the ideas that makes attractive. The Network of Future (NoF) concept utilizes the cooperative entities under the improvements provided by hardware and software. The NoF enables the user interaction and generation of large amount of data. The mechanism, which compares traffic data with the matching pattern to identify the security threats, is termed as Intrusion Detection Systems (IDS). The centralized control in web services introduced the problem [1-7].

The Service Oriented Architecture (SOA) guarantees the execution of web services within different administrative domains and overcome the centralized problem. The non-functional characteristics of web services are a necessary process for categorization. Quality of Service (QoS)[8]predicts the non-functional characteristics. The properties of QoS divided into two categories. They are user independent and user dependent. The service provider addresses the identical properties for different users such as price, popularity, etc., are termed as user independent QoS properties. The unpredictable internet connections influences the wide variety of properties such as throughput, failure time are termed as user dependent properties.

Several approaches are used for service selection. The straight forward approach monitors the similarity between the users and web service to predict the web service with the best QoS value[9, 10] termed as web service composition. The parametric model with large amount of data contains maximum number of parameters and hence the complexity occurs in the analyzed phase. The Security and QoS Trade-off tool (SQT) is the necessary tool to handle the Content based Parametric Relationship Models (CPRM)[11]based on predefined set of relationships. The missing values of QoS lead to risk in comparison. Research works provides the MatrixFactorization (MF) approaches [12-16]with relational regularization methods. A location based hierarchicalMF successfully predicts the missing QoS values.

Research works based on MF contains the pre-conditions. But, the real time QoS values are not known. Hence, the practical prediction algorithm to predict the missing QoS values is called as CF[17-23].The CF algorithms are categorized into two phases such as neighborhood-based and model-based.The neighborhood based model calculates the similarity between users for recommendation sensitive to sparse data. The user service matrix with low rank approximations trains the predictor model in the model based methods. Similar users in the system are identified to improve the recommendation performance. But, new users to the system are not recognized since the system does not contain any historical information. This is termed as *cold start* problem. The evolutionaryalgorithms applied on the web service composition reduce the cold start problem. The web service architecture is shown in Fig. 1

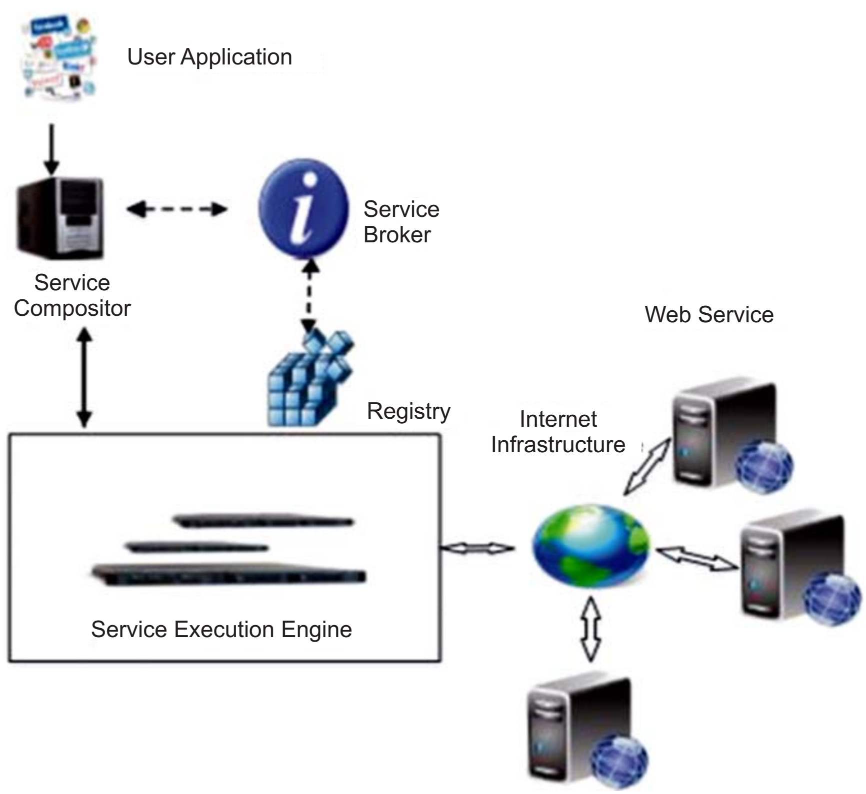

Figure 1: Architecture of web service system

The traditional approaches in web service composition area are not validates with the constraints. Hence, the research works shifted to evolutionary based web service composition algorithms[24, 25] to handle the constraints. An exhaustive search emulates the all compositions to find the optimal one. The increase in web services leads to increase in composition search space. The maximum space is time consuming and resource consuming. Hence, an exhaustive search is not suitable in service composition. Heuristic algorithms are introduced to reduce the time consuming and improve the efficiency. The data scarcity in QoS service composition is analyzed with the help of clustering based model [26-28]. Heuristic algorithm finds the near to optimal solution for the service composition with constraints.Alternatively, evolutionary algorithms[29-35] such as immune algorithms, Ant Colony Optimization (ACO), Particle Swarm Optimization (PSO) and Genetic Algorithms (GA) effectively finds an exact optimal solutions compared to heuristic algorithms.

The paper is organized as follows. Section 2 describes the various QoS web services, QoS web service recommendation system based on collaborative filtering and Genetic Algorithms (GA). Section 3 presents the comparative analysis of the web services, QoS based web services, real world QoS web services, QoS Recommendation systems and GA-based QoS-aware recommendation algorithms along with the advantages and drawbacks. Section 4 providesthe conclusion of this review.

2. QOS BASED WEB SERVICE RECOMMENDATION SYSTEM

Various QoS based web services and their recommendations are described in this section. The recommendation approach categorized into five sub sections as following

1. Web services
2. QoS-aware web service selection
3. QoS recommendation systems based on collaborative filtering.
4. Real world QoS-aware web services.
5. QoS Web Service Recommendation Systems based on Genetic Algorithms (GA).

2.1. Web Services

The numerous web services were available to constitute the distributive framework for machine process able manner. The availability of web services introduces three categories of problems such as plan, discovery and interaction. Initially, plan describes the way of functionality and interaction among the web services. Then, discovery procedure describes the task required to execute the plan. Finally, the interaction process describes the interaction among web services.

2.1.1. Semantic Web Services (SWS)

Web service description with well semantics termed as Semantic Web Services (SWS). The DAML-S [4] specifies the interaction, discovery and invocations in the SWS. SWS describe the content, order of the exchanged messages and the effect of state transitions during exchanging process. DAML S interaction performed in four links.

Link 1: The capabilities are advertised with DAML S/UDDIMatchmaker.

Link 2: Compilation of profile for interaction of ideal web Service with matchmaker.

Link 3: Selection of provider with capabilities that closely Matched

Link 4: Initiate the interaction.

The discovery performance improved for maximum number of web services by SPARQL queries [3]. The promotion of Service Oriented Software Engineering (SOSE) based on QoS-aware web services [7]. The study of the gap between QoS and SWS were presented.

2.1.2. Restful Web Services

International Telecommunication Union (ITU) creates the packet based networks termed as Next Generation Networks (NGN). Simple Object Access Protocol (SOAP) based web services mentioned the standards for interoperation between software applications. The design style termed as Representational State Transfer (REST) [1] is a neutral style for web service architecture model based on three principles as follows:

Addressability: The datasets on resources, which are identified by Uniform Resource Identifier (URI).

Uniform Interface:Interface describes the set of operations on RESTful web services with interoperability and familiarity.

Statelessness: Information needs to fulfill the service request represents statelessness.

The different mapping alternatives between RESTful web services and capabilities interface and the performance is optimized.

1. **iHop Web Services :** The programmatic access to information of RESTful web services required to provide accurate, fast and up-to-date information in iHop web services [2]. The sentences available for each of the gene co- occurrence with the pseudo genes describe the interactions between the web services. The sentences are categorized into two sub sets such as direct and indirect co-occurrence.

   Direct Occurrence: The genes corresponding to obtained sentences co-occurrence with the truly gene set.

   Indirect Occurrence: The genes corresponding to obtained sentences are not identified by gene set.

2. **Single Sign On (SSO) Schemes :** The web traffic in browser concentrated in the field study of Single Sign On based systems [6]. The semantic information is recovered by an algorithm and potential opportunities are explored. The serious logic flaws are identified through SSO schemes. The steps for SSO scheme described as follows:

Steps:

1. Automated black box test on HTTP messages (Browser
2. Related Messages) carried out.
3. Identification of authentication token in HTTP field.
4. Understand the adversary capability to forge the
5. authenticated token.
6. Improved guidance in prediction of logic flaws.

2.2. QOS BASED WEB SERVICES

The research work concentrates the prediction of Quality of Services (QoS) values. QoS values are important in the design of Service Oriented Architecture (SOA). Various processes are involved in prediction of QoS values. They are discussed as follows:

2.2.1. Matrix Factorization

The effective tool for prediction of missing QoS values is Matrix Factorization (MF) [12-16]. The MF model maps the users and items to a space termed as joint latent factor of low dimensionality d. The user and item interactions are captured in factor space. There are two Location Based Regularization (LBR) models created based on MF process. The unified models are created by combination of LBR models. The trustworthiness problem is considered in the implementation of MF by using random walk generation algorithm. The relationship between the users in the social network identified. The approximation of matrix by product of low rank matrices revealed the relationship between the users, latent factors and service policies. The contributions to QoS-aware WS through MF process as follows:

1. Neighborhood identification for user and service side by using similarity calculation techniques.
2. Capture of relationship between neighborhoods by using regularization terms (LBR)
3. Improvement in prediction performance by combining regularization model with MF.

1. **Mobile context model :** The efficiency of Web Services depends upon the quality of user feedback. The user feedback influenced by loading speed and quality of video. The influence level of QoS by explicit user feedback in Living Lab experiment [9]. The process split up into three stages as follows:
   a) The test users in the network are asked to watch and evaluate the videos.
   b) The testing users are arranged in various groups and brief analysis about the experiment described.
   c) Rating of video and extracting answers for queries from the tested users.

2.2.2. Mixed programming

The performance of QoS web services are challenging with the addition of constraints. Hence, the QoS oriented web services framework alternated in order to optimize the performance. Mixed programming techniques select five QoS measurements by using service selection algorithm as follows:

1. **Availability:** The probability of service describes the availability of QoS web services. The large availability value assigned for frequently accessed services and the smaller availability value is assigned for less frequent accessed services. The availability for access time T_{access} and execution time T_{exec} described as follows:

$$\text{Avail}(S) = \sum T_{access\ i} / T_{exec} \quad (1)$$

2. **Execution time :** The delay between the request sent and the results for respective requests is termed as execution time. The execution time comprises the operations performed for a given service

$$T_{exec} = \frac{1}{n}\sum_{i=1}^{n} T_{exec_i}(op, s) \quad (2)$$

2.3. Reliability

The evaluation of successful execution rate describes the reliability of the system. The network connection between the service providers and requestors are also evaluated using reliability.

2.4. Trustiness

The differences between new QoS performance to existing QoS performance describes the trustiness of the system.Trustiness depends upon the experience of the end user. The trustiness Trusty_i for the number of users accessed in time interval (t_1, t_2) is expressed as

$$\text{Trusty} = \frac{\sum \text{Trusty}_i}{n(t_2 - t_1)} \quad (3)$$

2.4.1. Cost

The fee for the user to be paidfor invoking the service describes the cost in QoS. The function of invoking interface describes the cost function.

2.4.2. Heterogeneous data centers

The efficiency of QoS in the small scale system is more compared to large-scale system. Hence, online and scalable data center[10]enhances the efficiency of the large-scale web service systems. The scalable data center schedulesaccounts for the heterogeneity and interference. The performance metrics on the basis of type of application are described as follows:

1. **Single Threaded Workloads:** The committed Instructions per Second (IPS) is the initial performance metric in single threaded loads. The time required running applications for profiling and increased overheads are also considered.
2. **Multi-threaded workloads:** The IPS is ambiguous in presence of synchronization schemes. Active and wait states are identified and addressed in multi-threaded workloads.

2.4.3. Security and QoS Trade off (SQT) Model

The complex dependencies are not specified in traditional works. The Security and QoS Tradeoff (SQT) [11] model is presented to describe the complex dependencies in Content based Parametric Relationship Models (CPRM). SQT model describes the rules for recommendation as follows:

1. Instantiated parameters are hidden
2. Prediction of parameters that satisfies the necessary objectives.
3. Priority assigned after the definition of objective.
4. Identification of unsatisfied objectives

2.5. QOS Recommendation Systems

Service computing requires effective personalized QoS recommendation system with the CF techniques. Various CF techniques [17-23]are employed for QoS recommendation system.

2.5.1. CF

The prediction of missing QoS values is an important requirement in recommendation systems by CF. The prediction performance is an important process to describe the non-functional characteristics of web services. The similarity computation between the web services is an important process in CF. The similarity measurement for two (*i*, *j*) web service users (U) isdescribed as:

$$\text{sim}(i, j) = \frac{2 \times |U_i \cap U_j|}{|U_i| + |U_j|} \tag{4}$$

The algorithm for QoS recommendation system based on collaborative filtering is described as:

1. Scenario that includes the functionalities *i.e.* invoking of Services.
2. Lower and upper bound of QoS attributes, binding of functionalities, requested functionalities, and recommendation required functionalities are given as the input to the algorithm.
3. The execution plan and score are the outputs of thesystem.
4. The scenario functionality factor is built by setting the information in functionality factor.
5. The matching scenario executions for each of the functionality requires recommendation.
6. The scores for the services in bounds are computed.
7. The normalized scores for CF process are computed.

The adaptation process was refined by using the collaborative approaches that efficiently predict the missing values.

2.6. Real World QOS Web Services

The research work on QoS web services is shifted into real world web services. The performance of real world web services on large-scale evaluations are described in detail as follows.

2.6.1. Distributed QoS

The lack of real world web services to describe the QoS driven mechanism is improved with the use of distributed model [25]. Two large-scale distributed web service evaluations are performed as follows:

1. The hand experiences of real world web services provided and invocations for distributive users estimated.
2. The web service datasets suitable in large-scale evaluation are released.

2.6.2. Decision support techniques

The complex dependencies and heterogeneities are not considered in large-scale QoS evaluation scheme in real world. The problems addressed based on decision support techniques[24] are automatic service identification and representation and interfaces for cloud service selection. The processes in decision support techniques are as follows:

1. Based on the categorization of manual collected /submitted information, the directories are manually maintained.
2. The listings are automatically created.
3. Indexes are generated by combination of entries directories and listings.

2.6.3. Clustering

The data scarcity problem in collaborative filtering are effectively reduced by the clustering models [26-28]. User Based Clustering (UBC) and Web Service Based Clustering (WSBC) models introduced to improve the efficiency.

1. **User Based Clustering (UBC) :** The landmarks based on the distance matrix (latency) are clustered in which the smaller distance represents the high similarity. Then, the landmarks are clustered in N_C clusters by using the Hierarchial clustering algorithm. The algorithm is implemented in several steps:

   Step 1: Calculate proximity matrix for landmarks

   Step 2: Assign landmark to each cluster

   Step 3: Merge two clusters according to minimum distance between the clusters

   Step 4: Update the distance matrix

   Step 5: Consider the specific cluster and members as outputs for distance matrix

2. **Web Service based Clustering (WSBC):**

In this process, the number of landmarks N_L are clustered based on QoS matrix Q_L. The Pearson Correlation Coefficient (PCC) between the two users are described as

$$S_{ij} = \frac{\sum_{m=1}^{W}(q_{im}-\bar{q}_i)(q_{jm}-\bar{q}_i)}{[\sum_{m=1}^{W}(q_{im}-\bar{q}_i)^2 \sum_{m=1}^{W}(q_{im}-\bar{q}_i)^2]^{1/2}} \quad (5)$$

The value of PCC in the range from -1 to 1. The most similarity represents 1 and the most dissimilarity represents -1. The composition problem considered as an optimization problem on the basis of results of clustering.

2.7. QoS Web Service Recommendation Systems based onGenetic Algorithms (GA)

The inter service dependencies and the conflicts in QoS recommendation system are considered as an optimization problem. Several bio-inspired algorithms [35] such as Genetic Algorithms (GA), Particle Swarm Optimization (PSO) and Ant Colony Optimization (ACO) are used for QoS recommendation system.

2.7.1. Genetic Algorithm

The scalable choice and the suitable constraints are evaluated based on GA [29, 30,34]. The GA based QoS service recommendation systems contains the following steps:

Step 1: The initial population that represents the tasks are created.

Step 2: The generation of new offspring is performed by the sequential processes such as mutation, selection and crossover.

Step 3: The fitness value for recommendation system computed for each individual in population.

Step 4: Repeat the generation of off springs and computation of fitness function until the algorithm converges.

The computation time increases since the number of constraints increases. But, the time was not affected by the composite web services leads to effective web service recommendation.

2.7.2. Partial Selection

The search space in service composition is more. Hence, the QoS oriented web services are systematically evaluated to reduce the search space. The partial selection process [31] in QoS recommendation system effectively reduces the search space. The candidates in service set and the QoS values are compared to predict the optimal compositions. The monotonous conditions such as additive, multiplicative, minimum, maximum and union and intersection are demonstrated.

2.7.3. Top-K Query

The large number of candidates cannot be handled by single threaded systems. Hence, suitable method such that top-K query [32, 33] process implemented for large-scale QoS web service compositions systems. The contributions of top-K query approach to QoS web service recommendation system are as follows:

1. Parallel method addresses the top-*k* query inspired by Map reduce method
2. The top-K composition problem division reduces the time for communication and guarantees the validity of results.
3. The efficiency and accuracy are improved.

3. DISCUSSION

Various techniques for QoS web service recommendation system are depicted. The results of the survey are shown in Table 1. The web services and the high-quality search space require the prediction process. From the review, it is evident that the GA can result better recommendation system than the existing algorithms such as CF and clustering approaches. The missing QoS value prediction on large-scale systems are effectively done in CF approaches.Moreover, the result evidently proves that the GA can improve the prediction accuracy with low computation time.

Table 1
Information About Different QoS Web Service Recommendation Approaches

Techniques	*Author & Reference*	*Year*	*Performance*	*Advantages*	*Limitations*
			Web Services (WS)		
Semantic Web Services	Sycaraet al.[4]	2003	They propose the prototypical example to describe the semantic web services such as DAML-S. It also describes the DAML S process model.	There is no performance penalty during the normal operation of web services. Ensures effective management using DAML S process model.	The DAML S process model dependent on the existence of ontologies leads to the complexity in management of interactions
	Zhou et al. [7]	2006	The steps toward the semantic quality of web services and examined the studies related to architecture and classification.	Effective web service management	Requires more search space for discovery
	Garcíaet al. [3]	2012	The scalability problem handled by the addition of preprocessing stage according to SPARQL services. The service repositories do not refer functional and non-functional aspect was discarded.	Reduced search space for discovery mechanism Improved performance.	Penalty of precision is introduced in discovery mechanism
RESTful Web Services	Belqasmiet al.[1]	2011	A survey of RESTful web services presented. An evaluation of suitability of RESTful web services for service provisioning in Next Generation Network (NGN).	Significant potential improvement in RESTful web services. Open issues for discovery/development mechanisms solved.	Resource definition and provisioning of adequate middle ware open issues are to be solved.
	Verborghet al.[5]	2013	The semantics of web services expressed by pre and post conditions in N3 rules and integrated the standards and conventions.	Minimum complexity Full semantic expressiveness	Compatibility and exchangeability needs to be improved in multi domain web services.
iHop Web Services	Fernándezet al.[2]	2012	Improvements in iHop web services and the scenario applied in iHop web services described	Fast, accurate and up-to-date summary of information.	The family of iHop web services to be expanded for large-scale genome studies.
Single Sign On (SSO) schemes	Wang et al.[6]	2012	The field study of popular web SSO schemes reported. The actual web traffic focused to recover the semantic information and identify the potential for opportunities.	Provided the collaborative effort for SSO community	Investigations are required to improve the security

Techniques	*Author & Reference*	*Year*	*Performance*	*Advantages*	*Limitations*
			QoS based Web Services		
Matrix Facto-rization	Lo et al.[14]	2012	The geographical information incorporated according to local connectivity between the users to identify the neighborhood. Two unified Location Based Regularization (LBR) models were built.	Significant improvement in prediction accuracy for real world QoS data set.	LBR model considered user feature vectors. Hence, some QoS values are missed.
	Lo et al. [15]	2012	Different similarity measurements between user and service side were carried out by using Extended Matrix Factorization (EMF) model to identify the neighborhood.	Effective improvement in missing QoS value prediction.	Missing prediction require more relational regularization terms
	He et al.[13]	2014	The global context and local information considered for hierarchical matrix factorization. The QoS values from matrix factorization clustered by K-means algorithm	Significant improvement in QoS prediction. Higher accuracy.	Location information was not considered. Missing prediction leads to problem in large size data.
	Deng et al.[12]	2014	The degree of test between the users was assessed by using the matrix factorization. The recommendation results were obtained by extended random walk algorithms.	Improvement in accuracy, speed and quality.	The trust relationship between the users varies with time.
	Zhang et al.[16]	2014	The prediction of missing QoS values formalized as generalized Non-negative Tensor Factorization (NTF) to deal the user service model.	Better prediction accuracy.	Monitoring of more real world QoS web service was required.
Mobile Network	De Pessemieret al.[9]	2012	Feedback model proposed and handled the QoS parameters of mobile network in Living Lab experiment. Collaborative systems and content based recommenders models were introduced.	Effective elimination of influences of QoS parameters on explicit user feedback done.	The activity location and expectation of end user was not considered.

Techniques	*Author & Reference*	*Year*	*Performance*	*Advantages*	*Limitations*
Mixed Prog-ramming	Liu et al.[8]	2013	Implementation of optimal mapping between abstract web services and application process carried out. The service based application at run time was refined by QoS negotiation mechanism.	Improvement in user's QoS satisfaction on availability, execution time, reliability, trustiness and cost.	Accountability and security not considered. Extension required for cloud based systems.
Hetero-geneous Data centers		2014	Online and scalable datacenter scheduler (Paragon) introduced for heterogeneity and interference. Similarity based on heterogeneity was discovered.	Significant gain improvement. Fast and huge space was handled.	Parameter dependencies are complex.
Security & QoS Tradeoff (SQT)	Nieto et al.[11]	2014	QoS parametric relationship at different abstract levels identified using Context-based Parametric Relationship Models (CPRM). Recommendation system on CPRM was proposed.	Effective assessment in security.	Great uncertainty occurs in composition mechanism.
			QoS Recommendation systems		
Colla-borative Filtering (CF)	Zhenget al.[23]	2011	A Collaborative filtering approach for predicting QoS values for web services. User collaborative mechanism for past QoS web information collection is proposed and based on collected data collaborative filtering proposed to predict the QoS web service values.	Better prediction accuracy	QoS values of web services varied from time to time.
	Yu et al.[22]	2012	The novel method integrated matrix factorization approach with decision tree to bootstrap service recommendation. The missing interaction estimated by MF partitioning scheme.	Fast and adaptive with new user information.	Cold start problem occur.
	Li et al.[19]	2013	An improved CF recommendation algorithm presented in e-commerce for ceramic products. The factors affecting the quality of recommendation system explored.	Effective and improved quality of recommendation	Less amount of capture the relationship between the web services and providers

Techniques	*Author & Reference*	*Year*	*Performance*	*Advantages*	*Limitations*
	Cao et al.[17]	2013	The relationship between the services and providers was addressed. Then, two CF models SD-HCF and IF-UCF were presented.	Better recommendation quality in SD-HCF.	Trustworthiness of perceived QoS vector was poor.
	Yao et al.[21]	2013	The combination of collaborative filtering and content based recommendation system (Hybrid) considered both rating and content data.	Better recommendation performance	Model to be refined to evaluate the capability of new users.
	Chen et al.[18]	2013	A novel Collaborative filtering algorithm presented for large-scale web service recommendation systems.	Prediction accuracy is improved. Reduction of time complexity.	The architecture's scalability unsatisfied.
	Margariset al.[20]	2015	The framework for adaptive execution on WS-BPEL scenarios. The algorithm for adaptation is meta search algorithms, which includes the QoS aspects and collaborative aspects presented.	Satisfied architecture's scalability	Statistical information for scenario execution schemes was not known.
			Real World QoS Web Services		
Distributed QoS	Zhenget al.[25]	2010	The large-scale evaluations on real world web services conducted. The response time and throughput for distributed users estimated.	Reusable data sets released for better response time and throughput.	Model was not suitable for some QoS parameters.
Decision support technique	Zhang et al.[24]	2012	An intelligent decision support model investigated on cloud based infrastructure services.	The decision support and tools for automated map was the required output.	Poor prediction accuracy
Clustering	Zhu et al.[28]	2012	A novel landmark based QoS prediction framework and two clustering based algorithms such as UBC and WSBC presented to enhance the prediction accuracy.	Confident prediction for web service recommendation	The contextual and semantic information was not considered

Techniques	*Author & Refrences*	*Year*	*Performance*	*Advantages*	*Limitations*
			QoS recommendation system based on Genetic Algorithm (GA)		
Genetic Algorithms	Canfora et al. [30]	2005	QoS-aware composition problem modelled as optimization problem. The proposed work adopt the Genetic Algorithm (GA) to handle the optimization problem.	More scalable and suitability to handle the QoS attributes.	Proposed approach suitable for small scale service oriented system.
	Ai et al. [29]	2008	QoS web service composition problem handled with interservice dependencies and conflicts.	More effectiveness and scalability	High time complexity
	Liu et al. [34]	2012	The application of Genetic algorithm to find the best fitting service composition. The score and sorting of service composition values according to service requests.	Improved discovery for composite services. Reduced time	Prediction performance needs to be improved.
Bio-inspired algorithms	Wang et al. [35]	2012	The research work in web service composition based on bio-inspired algorithms such as Ant Colony Optimization (ACO), evolutionary algorithms and Genetic Algorithms and Particle Swarm Optimization (PSO) reviewed.	Availability of various algorithms improve the recommendation performance.	Problems in premature convergence. Low efficiency in Ant Colony Optimization (ACO).
Partial Selection	Chen et al. [31]	2013	The problem from Pareto – optimal angle required to reduce the search space was studied. Dominant relationship between candidates and workflows were defined.	Reduced search space. Improvement in efficiency. Suitable for large-scale web service composition system	More number of convergence iterations
Top K Query	Deng et al. [32]	2014	Top-K service solutions presented for large-scale QoS based service composition. The composition implemented by the combination of back track search and Depth First Search (DFS) algorithms.	Reduction of search space. Large-scale repositories are accurate and efficient.	Less number of QoS parameters were handled.
	Jiang et al. [33]	2014	The progressive and increment Key Path Based Loop (KPL) algorithm presented based on top-*k* query approach.	Good scalability, accuracy and efficiency	The proposed algorithm needs to be expanded for multiple QoS measurements.

Techniques	*Author & Refrences*	*Year*	*Performance*	*Advantages*	*Limitations*
			UBC and WSBC presented to enhance the prediction accuracy.		
	Wu et al.[26]	2014	WSDL documents and tags were utilized for clustering the web services. Hybrid web service tag recommendation strategy proposed to handle the limitation of clustering.	More accurate web service discovery. Social network information utilization to facilitate the service mining.	Inappropriate selection decisions
	Yu et al.[27]	2014	The Relational Clustering Model (RCM) presented to address the data scarcity issues in clustering techniques.	Ability to handle the cold start problem	RCM based clustering suffered by frequent and common changes.

4. CONCLUSION

The QoS service recommendation would use the Genetic Algorithms (GA) to predict the QoS values in large-scale web services. Then, best and optimal web service based on their QoS is achieved. The fitness function that describes similarity, user ranking and QoS-awareness is computed. The best fitness service value for recommendation is computed by the GA process. The computation time increases for the maximum number of constraints. But, the increase in the computation time does not affectthe composite web services. Hence, the GA-based recommendation system yields the better prediction accuracy compared to traditional algorithms.

In this paper, an overview of various QoS oriented Web Service (WS) recommendation systems based on clustering, matrix factorization and collaborative filtering are described. From the survey, it is found that Genetic algorithms are the very powerful prediction techniques to for improving the recommendation performance. The results from GA based missing QoS prediction are more improved quality. The efficient prediction of dominant relationship between requests of provider and requestor increases the prediction and recommendation accuracy compared to state of art clustering and collaborative algorithms for large-scale system.

REFERENCES

[1] F. Belqasmi, R. Glitho, and C. Fu, "RESTful web services for service provisioning in next-generation networks: a survey," *Communications Magazine, IEEE,* vol. 49, pp. 66-73, 2011.

[2] J. M. Fernández, R. Hoffmann, and A. Valencia, "iHOP web services family," in *Bioinformatics for personalized medicine*, ed: Springer, 2012, pp. 102-107.

[3] J. M. García, D. Ruiz, and A. Ruiz-Cortés, "Improving semantic web services discovery using SPARQL-based repository filtering," *Web Semantics: Science, Services and Agents on the World Wide Web,* vol. 17, pp. 12-24, 2012.

[4] K. Sycara, M. Paolucci, A. Ankolekar, and N. Srinivasan, "Automated discovery, interaction and composition of semantic web services," *Web Semantics: Science, Services and Agents on the World Wide Web,* vol. 1, pp. 27-46, 2003.

[5] R. Verborgh, T. Steiner, D. Van Deursen, J. De Roo, R. Van de Walle, and J. G. Vallés, "Capturing the functionality of Web services with functional descriptions," *Multimedia tools and applications,* vol. 64, pp. 365-387, 2013.

[6] R. Wang, S. Chen, and X. Wang, "Signing me onto your accounts through facebook and google: A traffic-guided security study of commercially deployed single-sign-on web services," in *IEEE Symposium on Security and Privacy (SP), 2012*, 2012, pp. 365-379.

[7] J. Zhou and E. Niemela, “Toward semantic QoS-aware web services: Issues, related studies and experience,” in *International Conference on Web Intelligence, 2006. WI 2006. IEEE/WIC/ACM* 2006, pp. 553-557.

[8] C. Liu and D. Liu, “Qos-oriented web service framework by mixed programming techniques,” *Journal of Computers*, vol. 8, pp. 1763-1770, 2013.

[9] T. De Pessemier, K. De Moor, I. Ketykó, W. Joseph, L. De Marez, and L. Martens, “Investigating the influence of QoS on personal evaluation behaviour in a mobile context,” *Multimedia tools and applications*, vol. 57, pp. 335-358, 2012.

[10] C. Delimitrou and C. Kozyrakis, “Quality-of-Service-Aware Scheduling in Heterogeneous Data centers with Paragon,” *Micro, IEEE*, vol. 34, pp. 17-30, 2014.

[11] A. Nieto and J. Lopez, “Security and QoS tradeoff recommendation system (SQT-RS) for dynamic assessing CPRM-based systems,” in *Proceedings of the 10th ACM symposium on QoS and security for wireless and mobile networks*, 2014, pp. 25-32.

[12] S. Deng, L. Huang, and G. Xu, “Social network-based service recommendation with trust enhancement,” *Expert Systems with Applications*, vol. 41, pp. 8075-8084, 2014.

[13] P. He, J. Zhu, J. Xu, and M. R. Lyu, “A Hierarchical Matrix Factorization Approach for Location-Based Web Service QoS Prediction,” in *8th International Symposium on Service Oriented System Engineering (SOSE), 2014, IEEE* 2014, pp. 290-295.

[14] W. Lo, J. Yin, S. Deng, Y. Li, and Z. Wu, “Collaborative web service qos prediction with location-based regularization,” in *19th International Conference on Web Services (ICWS), 2012 IEEE* 2012, pp. 464-471.

[15] W. Lo, J. Yin, S. Deng, Y. Li, and Z. Wu, “An extended matrix factorization approach for qos prediction in service selection,” in *Ninth International Conference on Services Computing (SCC), 2012 IEEE* 2012, pp. 162-169.

[16] W. Zhang, H. Sun, X. Liu, and X. Guo, “Temporal qos-aware web service recommendation via non-negative tensor factorization,” in *Proceedings of the 23rd international conference on World wide web*, 2014, pp. 585-596.

[17] J. Cao, Z. Wu, Y. Wang, and Y. Zhuang, “Hybrid Collaborative Filtering algorithm for bidirectional Web service recommendation,” *Knowledge and information systems*, vol. 36, pp. 607-627, 2013.

[18] X. Chen, Z. Zheng, X. Liu, Z. Huang, and H. Sun, “Personalized qos-aware web service recommendation and visualization,” *IEEE Transactions on Services Computing*, vol. 6, pp. 35-47, 2013.

[19] H. Li, Y. Zhang, and G. Cheng, “Ceramic Products Recommendation Based Improved Collaborative Filtering,” in *The International Conference on Artificial Intelligence and Software Engineering (ICAISE 2013)*, 2013.

[20] D. Margaris, C. Vassilakis, and P. Georgiadis, “An integrated framework for adapting WS-BPEL scenario execution using QoS and collaborative filtering techniques,” *Science of Computer Programming*, vol. 98, pp. 707-734, 2015.

[21] L. Yao, Q. Z. Sheng, A. Segev, and J. Yu, “Recommending web services via combining collaborative filtering with content-based features,” in *20th International Conference on Web Services (ICWS), 2013 IEEE* 2013, pp. 42-49.

[22] Q. Yu, “Decision tree learning from incomplete qos to bootstrap service recommendation,” in *19th International Conference on Web Services (ICWS), 2012 IEEE*, 2012, pp. 194-201.

[23] Z. Zheng, H. Ma, M. R. Lyu, and I. King, “Qos-aware web service recommendation by collaborative filtering,” *IEEE Transactions on Services Computing*, vol. 4, pp. 140-152, 2011.

[24] M. Zhang, R. Ranjan, A. Haller, D. Georgakopoulos, and P. Strazdins, “Investigating decision support techniques for automating cloud service selection,” in *4th International Conference on Cloud Computing Technology and Science (CloudCom), 2012 IEEE* 2012, pp. 759-764.

[25] Z. Zheng, Y. Zhang, and M. R. Lyu, “Distributed qos evaluation for real-world web services,” in *IEEE International Conference on Web Services (ICWS), 2010* 2010, pp. 83-90.

[26] J. Wu, L. Chen, Z. Zheng, M. R. Lyu, and Z. Wu, “Clustering web services to facilitate service discovery,” *Knowledge and information systems*, vol. 38, pp. 207-229, 2014.

[27] Q. Yu, “QoS-aware service selection via collaborative QoS evaluation,” *World Wide Web*, vol. 17, pp. 33-57, 2014.

[28] J. Zhu, Y. Kang, Z. Zheng, and M. R. Lyu, "A clustering-based QoS prediction approach for Web service recommendation," in *15th IEEE International Symposium on Object/Component/Service-Oriented Real-Time Distributed Computing Workshops (ISORCW), 2012* 2012, pp. 93-98.

[29] L. Ai and M. Tang, "A penalty-based genetic algorithm for QoS-aware web service composition with inter-service dependencies and conflicts," in *International Conference on Computational Intelligence for Modelling Control & Automation, 2008* 2008, pp. 738-743.

[30] G. Canfora, M. Di Penta, R. Esposito, and M. L. Villani, "An approach for QoS-aware service composition based on genetic algorithms," in *Proceedings of the 7th annual conference on Genetic and evolutionary computation*, 2005, pp. 1069-1075.

[31] Y. Chen, J. Huang, C. Lin, and J. Hu, "A Partial Selection Methodology for Efficient QoS-Aware Service Composition."

[32] S. Deng, L. Huang, W. Tan, and Z. Wu, "Top-Automatic Service Composition: A Parallel Method for Large-Scale Service Sets," *IEEE Transactions on Automation Science and Engineering*, vol. 11, pp. 891-905, 2014.

[33] W. Jiang, S. Hu, and Z. Liu, "Top K Query for QoS-Aware Automatic Service Composition," *IEEE Transactions on Services Computing*, vol. 7, pp. 681-695, 2014.

[34] S.-C. Liu and S.-S. Weng, "Applying Genetic Algorithm to Select Web services Based on Workflow Quality of Service," *Journal of Electronic Commerce Research*, vol. 13, p. 157, 2012.

[35] L. Wang, J. Shen, and J. Yong, "A survey on bio-inspired algorithms for web service composition," in *16th International Conference on Computer Supported Cooperative Work in Design (CSCWD), 2012 IEEE* 2012, pp. 569-574.