Evaluation of QoS Based Web- Service Selection Techniques for Service Composition

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Abstract

In service oriented computing, services are the basic construct that aims to facilitate building of business application in a more flexible and interoperable manner for enterprise collaboration. To satisfy the needs of clients and to adapt to changing needs, service composition is performed to compose the various capabilities of available services. With the proliferation of services offering similar functionalities around the web, the task of service selection for service composition is complicated. It is vital to provide service consumers with facilities for selecting required web services according to their non-functional characteristics or quality of service (QoS). The objective of this paper presents the exploration of various techniques of Quality of Service based Service Selection (QSS) approach in the literature. To evaluate the service selection process, a number of criteria for QSS approach have been identified and presented in this paper.

Keywords: Web Service Selection, Service Composition, Web Semantics, Quality of Service.

1. INTRODUCTION

Service-Oriented Computing (SOC) is an upcoming organizational model that allows assembling independent distributed services into complex ones. Services are autonomous, platform-independent computational entities that can be used in a platform independent and programming language independent way. The application functionality of SOC as services relies on its dynamism. That is, it has the capability to dynamically assemble complex services for developing massively distributed, interoperable, evolvable systems. Services are most often built in a way that is independent of the context in which they are used. This means that the service provider and the consumers are loosely coupled. Key to this concept is the service-oriented architecture (SOA).

The Service Oriented Architecture (SOA) is a type of “software architecture that represents software functionality as services over the network” [1]. Web Services are the predominant implementation platform for SOA and it uses a set of standards, SOAP, UDDI, WSDL, which enable a flexible way for applications to interact with each other over networks. Simple Object Access Protocol (SOAP) is a standard protocol that allows network communication between services. The easiest way to publish a web service is to use a SOAP container. When a software component is published as a web service, any SOAP-enabled client that knows the network address of the web service can send a SOAP request and get a SOAP response. To get the message information, SOAP- enabled clients read a WSDL file that describes the web service. Once the Web Services Description Languages (WSDL) file is read, the client can start sending SOAP messages to the web service. WSDL describes what a web service can actually do, where it resides, and how to invoke it. Universal Description Discovery and Integration (UDDI) is a standard that allows information about businesses and services to be electronically published, queried and stored. Published information is stored into one or more UDDI registries, which can be accessed through SOAP.

All these standards are XML-based (Extensible Markup Language), which allows applications to interact with each other over networks, no matter what languages and platforms they are using. The two features, self-description and language-platform-independence, distinguish web services from other distributed computing technologies, like CORBA (Common Object Request Broker Architecture) and DCOM (Distributed Component Object Model).

Research in web services includes many challenging areas starting from service publication to service mining. The most vital among them is web service composition. Web service composition is needed when a client’s complex request cannot be answered by single service, but by combining or composing various functionalities of available services or more than one services. Composition involves three different issues [2]. The first, called selection of service is concerned with selecting suitable services to composite that satisfy the user requirement. The second, called composition synthesis is concerned with synthesizing a specification of how to coordinate the component services to fulfill the client request. The third issue, called as orchestration is concerned with achieving the coordination among services by executing the specification produced by the composition synthesis.

This paper presents a study of one service selection approach called QoS based service selection for service composition. The paper is organized as follows: Section II describes the overview of service selection approaches. In Section III, the specifications of QoS based service selection and the various techniques of QSS are presented. Section IV analysis the evaluation criteria of QoS based service selection approach and compare the various techniques of QSS. Finally section V concludes with discussion and highlights new challenges need to be addressed.

2. OVERVIEW OF SERVICE SELECTION APPROACHES

The current semantic web services architecture focus on solving the issues of service discovery, service selection and service composition. Service discovery is the process of finding or locating service implementations that meet a specified condition. In the same way, service selection is a process that deals with choosing a service implementation from the located services. From this, it is clearly seen that service discovery is a prerequisite requirement for selection process, but selection is the main problem that needs to be addressed for retrieving Web services successfully. For any service selection approaches the basic requirements include: Customer service requirement, Service offerings by the service provider and aggregating the evaluation results.

2.1 Customer-Service Requirement

The customer service requirement may be simple or complex. Simple requirement may not look for composite services to satisfy the user query. Whereas, complex requirements may have both functional and non-functional aspects which needs to be satisfied. For this kind of complex requirement, the services need to be composite. The composite service is a service formed by a composition of other available services. Google research application is accepted as a web service and integrated with other services, such as Gmail, AdWords, Picasa, Orkut, You Tube and Google Maps service, to provide an integrated environment for service consumers. The other known example for service composition is a tour booking service that can be formed as a web service and integrated with other services such as hotel booking, sight seeing, flight booking or car-rental in order to provide a collaborated environment for user. However, there may exist huge number of (tour booking) services which provide similarly functional characteristics. Service consumers not only expect the service to meet functional aspects but they also require services to meet non-functional aspects properties that is, quality of services (QoS) such as service reliability, security, trust and execution cost, etc. Thus the selection of services based on non functional qualities gain more advantages nowadays.

2.2 Provider-Service Offerings

The services offered by service provider are concerned about functional and non-functional qualities of services. The functional properties make use of domain ontology. To provide consumer the requested service with non-functional properties makes use of QOS ontology. The problem that arises here is how to map the quality preferences offered by consumer with the quality categorization in QOS ontology. This can be solved by labeling the qualities (eg. performance, security) in QoS ontology with the service Identification.

2.3 Service Selection Process

This involves matching the customer required service with the offered service. The dynamic selection of web services involves getting user requirements, the provider of service need to publish or register their services using service description language, finally the matcher will match the user requirements with the registered service description. The requirements specified by the user or customer may vary from description of service and Quality of service (QoS). To overcome this problem, domain ontology and QoS ontology may be used. The registered service descriptions by the service provider contain the semantic profile and QoS parameters. The provider of the service is also required to specify the location of a WSDL document describing a web service. A query processor may be used to analyze the requirement specified by the user with the domain ontology and QoS ontology. The semantic matcher will match the user request with service description and locate available services matching with requirements. The discovered services are then taken as input to the selection process to select the best service that satisfies the user requirement. In basic form, service selection involves mapping a set of services to a service—this can be thought of as the best service; in a more general form, service selections maps a set of services to a ranking of the services in that set [6]. Multitude of service selection techniques and algorithms are proposed in the literature such as Use of optimization algorithm [3] for service selection, integer linear programming [4], broker-based architecture [5], negotiation model for service selection etc [29] [31]. With the thorough study of service selection process in the literature, the following approaches are identified.

1. Functional based service selection approach
2. Non-Functional based service selection approach
3. User based service selection approach

The Web Service Selection process is broadly classified as Functional based approach, Non-functional based approach and User based approach. Functional based service selection approach represents the Static and Dynamic semantics. Selecting an appropriate service is concerned with retrieving functional descriptions from service repositories and then ensuring that the described and required interfaces match with each other. Static semantics represents the properties of messages and operation semantics. The properties of messages include parameter passed (Data type, language, unit and business role) and message types (Serviceability, provider type, purpose, consumer type). Dynamic semantics represents the properties of behavior and operation logic. With dynamic semantics in the service selection process of Web service, the resultant contains more than one service provider offering similar services.

With the rapidly growing number of available services, customers are presented with a choice of functionally similar services. This choice allows customer to select services that match other criteria, often referred to as non-functional attributes. Two fundamental questions arise because of this: How can these extra attributes be described and how can one select the most appropriate service. These questions should address both the selection of isolated services as well as the selection of services within the context of other services. The non-functional based service selection represents the QoS and Context in semantic web service selection. The properties of QoS may be (security, reliability, response time, call cost etc.), the properties of Context may include context of customer (location, intention, consumer's name, application, e-mail, termination of hardware and software) and context of service (provider's details, service descriptions etc,). User based approach represents the selection of best service among numerous discovered services based on customers' feedback, trust and reputation.

Approach I. Functional Based Service Selection

Today, the advancement in Web services requires growth in the areas of service interoperation, discovery, selection, composition, choreography, orchestration and mining. A possible solution to all these problems can be provided by converting Web services to Semantic Web [23]. Semantic Web services (SWS) can provide a solution to the integration problem like composition. In general, the semantics to be added to a Web service may be called as functional semantics. In Web services, functional semantic is taken into consideration thereby avoiding unsatisfied results which are not of customer interest. Functional property is the functional semantics of a service that describes what a service actually does.

Web Service Selection is related to the process of evaluating and ranking the discovered web services to identify the ones that fulfill a set of functional and non-functional properties requested by the service customer. Most of the existing techniques rely on syntactic descriptions of service interfaces to find web services with disregard to semantic service parameters. This generates major problems in the service selection mechanism. To solve these problems, Web service descriptions are enhanced with annotations of ontological concepts, semantic matching and by considering non-functional properties.

Approach II. Non - Functional Based Service Selection

In a Web environment, multiple WSs may provide similar functionalities with different Non-functional property values (e.g., different prices). Such Web services will typically be grouped together in a single community. To differentiate the members of a community during service selection, their non-functional properties need to be considered. These properties are characterized as quality of service (QoS) and context based services. Both are highly important and are to be taken into account during the WS selection.

The W3C working group (2003) defined various QoS attributes for web services (WS) in their 25th November 2003 publication. This include: performance, reliability, scalability, capacity, robustness, exception handling, accuracy, integrity, accessibility, availability, interoperability, security, network-related QoS requirements etc. Although regular QoS attributes are listed, it remains some issues on selection of web services according to the user desired. First, there exists some web services provided with similar functional requirements which, might lead to the problem of differentiating the services with QoS. Second, the perception on QoS of web services distinct between the customer and provider. There also exist a number of other issues which need to be considered on QoS based service selection process.

Approach III. User Based Service Selection

A User based methodology is a mechanism using consumers' feedbacks to identify good services from bad ones. It has advantages in solving the selection problem for Web services. The service consumer would like to choose a service that is trusted or a service with a high reputation. Trust and reputation play an important role in a service selection process of user based service selection. With this approach, web service selection may be customized according to users' different constrains and preferences. Most approaches proposed in the literature about personalized selection concentrate on how to rank web services according to users' preferences on various QoS metrics. A trust based methodology [7] for service selection is proposed. QoS-based semantic web service selection solution with the application of a trust and reputation management method is presented. This work is based on Virtual Internet Service Provider.

This paper focuses on one of the non – functional property known as QoS based Service Selection approach, its specification [20], techniques and criteria for evaluating techniques of QSS approach.

3. QoS BASED SERVICE SELECTION

A QoS property can be static or dynamic [24]. A static QoS property value is defined at the time it is described whereas the dynamic QoS property value requires measuring and updating its value periodically. The QoS value from the service consumer's perspective can be positive, negative, close, or exact. For example, consumers expect to buy a service with low price and expect to retrieve the service in a low response time. Whereas performance, integrity etc., have positive trend in which the consumer expects the positives values are better.

3.1 Specification of Service Selection Approaches

The specification or description for non functional based service selection approaches concentrates on many factors. These factors are separately identified and presented by analyzing various techniques of non functional based service selection approach. Table 1 depicts the QSS Specification and Description.

Spec. No.	***Specification.***	***Descriptions***
S(1)	QoS Modeling	Specify the modeling language used. Such as WSML and its variants WSML – Core, WSML – Flight, WSML – Rule, WSML – DL and WSML – Full
S (2)	QoS Categorization	Describe the Ontology of QoS categorization with its identification value.
S (3)	User Preferences	Describe the varying preferences for the non-functional criteria specified by the service consumer
S (4)	QoS Evaluation	Specify the evaluation criteria used to evaluate the non – functional properties.
S (5)	Aggregating the evaluation of	This deals with aggregating individual scores to gain a final score for the service.

	QoS	
S (6)	QoS Properties	List the number of non –functional properties considered.
S (7)	Level of Automation	States the level of automation mechanisms. A – Fully automated, SA – Semi automated, NA – Not applicable.
S (8)	Coordination Distribution	Describes how individual web service can interact in order to accomplish an application task. C – Centralized, CO – Coordination, GCO – Global coordination.
S(9)	Agent Involvement	State whether agent participation is involved in the process of service selection mechanism.
S (10)	Ranking Algorithm	A service rank is a quantitative metric that shows the "importance" of a service within the process of service selection mechanism to rank the services.

TABLE 1: QSS Specification and Description

(a) QoS Modeling

Service requestors need to distinguish services based on their non-functional criteria to make the most appropriate choice amongst a number of services with equal or similar functionality. Therefore, a QoS modeling is needed. That can be used in service descriptions as well as service requests. Due to the adaptability of non-functional properties (the new ones might be required at any time) it is unlikely that a complete standard set can be identified. The criteria differ depending on the domain. For example the E-Learning domain service should consider the accuracy, reputation, and cost. In contrast E-Publishing service should consider the security, price, quality properties. Therefore it is desirable that the model for delivering non-functional properties is designed in a simple way.

WSMO with its associated language, the WSML (Web Service Modeling Language) provides a formal syntax and semantics to describe the QoS characteristics of services. The Web Service Modeling Ontology (WSMO) defines four main elements as the main concepts of semantic Web service. This includes Ontologies, Web Services, Goals and Mediators [25]. Ontology's are formal explicit specifications of a shared conceptualization [21]. They define a common agreed terminology by providing concepts and relationships between the concepts. Goals are descriptions of web services that satisfy the user desires when confer with a service in terms of functional specification, behavior and quality of service. Web Services are description about services. The description consist of functional, non-functional and the behavioral aspects of web services. Mediators address the heterogeneity issues between different WSMO elements. The Web Service Modeling Language is a formal language for describing ontologies, goals, web services and mediators. It is based on logical formalisms of WSMO namely description logics, first – order logic, and logic programming [22]. These formalisms are the basic point to describe the variants of WSML. The variants includes, WSML – Core, WSML – Flight, WSML – Rule, WSML – DL and WSML – Full.

(b) QoS Categorization

QoS properties are designed in hierarchical way. This involves grouping properties by domains such as environment, performance or safety. Speed quality and response time on performance aspects while security, privacy and authentication are safety aspects. If such hierarchical structure exists then users should be able to express preferences at a higher level, while service provides will express their offerings in a fine way. Using WSML [26], the simplest way of modeling is done by assigning a simple value to non functional properties of WSMO elements. The data value assigned to non functional properties is used as an identifier during service publication. To specify QoS characteristics in particular it can be modeled separately with the use of building and defining QoS Ontology. Figure 1 depicts the QoS ontology with the assumed identifier value. W3C defines various QoS attributes such as performance, reliability, scalability, capacity, and so on. Here the figure 1 covers ontology of characteristics such as interoperability, capacity, integrity, environment, performance, reliability, security, business and availability. When a new service is published, the value of QoS characteristics in service description is matched with the value assigned in QoS ontology. By this way, the newly published services are aligned. Upon receiving the request from the customer, the system extract the services require and QoS characteristics specified and match with the QoS ontology to locate it.

1. QoS Characteristics
    - 1.1 Interoperability
    - 1.2 Capacity
    - 1.3 Integrity
    - 1.4 Scalability
    - 1.5 Accuracy
    - 1.6 Accessibility
    - 1.7 Environment
        - 1.7.1 Temporal
        - 1.7.2 Location
    - 1.8 Performance
        - 1.8.1 Latency
        - 1.8.2 Response Time
        - 1.8.3 Throughput
        - 1.8.4 Error Rate
    - 1.9 Reliability
        - 1.9.1 Recover
            - 1.9.1.1 Failure
            - 1.9.1.2 Disaster
        - 1.9.2 Consistency
        - 1.9.3 MTBF (Mean Time Between Failures)
    - 1.10 Security
        - 1.10.1 Encryption
            - 1.10.1.1 Data
            - 1.10.1.2 Messages
        - 1.10.2 Authentication
        - 1.10.3 Authorization
        - 1.10.4 Auditability
        - 1.10.5 Accountability
        - 1.10.6 Non – Repudiation
        - 1.10.7 Traceability
    - 1.11 Business
        - 1.11.1 Cost
        - 1.11.2 Reputation
        - 1.11.3 Monitoring
    - 1.12 Availability
        - 1.12.1 MTTR (Mean Time To Recovery)
        - 1.12.2 Load Balancing

1.12.3 Up Time
1.13 Network related
1.13.1 Bandwidth
1.14 Stability
1.14.1 Method Stability
1.14.2 Interface Stability

FIGURE 1: QoS Categorization

(c) User Preferences
Depending on the situation service requestors may have varying preferences for the non-functional criteria. In the same way, different requestors will have different preferences. A good mechanism should not only allow expressing values for each property, but preferably also represent the relations among the preferences. For example, a customer may consider the security property as more important than privacy when requesting a financial service. Hence, the selection approach needs to provide for mechanisms for users to specify their preferences, that is which of the non-functional properties they feel more strongly about and also relations between these properties.

(d) QoS Evaluation
It is difficult to predict how many non-functional properties will be available, and the type of these properties for a customer requested service. For example, the evaluation function to compute the speed criteria will be different from the function to calculate the location criteria. It is not easy to define a Universal evaluation function for all kinds of non-functional properties. Hence, the evaluation function for one property adapt to varying numbers of criteria, but should also automatically identify the measurement methods to be used to evaluate each criteria.

(e) Aggregating the Evaluation of QoS
After evaluation the next step is to aggregate individual scores to gain a final score for the service. In this step a suitable aggregation method needs to be selected. Global optimization or local optimization may be used [27]. Using arithmetic or geometric means to aggregate QoS properties results in complex situations.

(f) Level of Automation
Level of automation states the automation mechanisms like manual process of selection mechanism, or semi-automatic service selection mechanism or fully automated service selection mechanism involved in web service selection and composition. Most research contributions handling the service selection for service composition focus on automatic process without human intervention. For example human intervention may involve selecting QoS parameters used for selection, and changing preferences etc. Semi – automatic process involves little human intervention, the major task such as corrections and composing are done by the system [28]. Fully automated service selection approach may also use agents in the web service selection process [32].

(f.1) Agent Involvement
State whether agent participation is involved in the process of service selection mechanism. A software agent is a piece of software that acts for service consumer or provider in semantic web service to make the process of service selection automatic. Agents work cooperatively to evaluate either service providers or service consumers.

(g) Coordination – Service Composition
This describes how individual web service can interact in order to accomplish composite service selection process. The WS-Coordination defines how the coordination among the services need to take place, how the data items are to be exchanged in order to complete successful composition as part of business process defined in a Business Process Execution Language (BPEL) [30]. The composition algorithms may be centraily cooperated or globally cooperated.

(h) Ranking Algorithm
A service rank is a quantitative metric that shows the importance of a service within the process of service selection mechanism. It is known that semantic based service discovery concerns on the matchmaking process between customer's requirement and service profile or description. Its semantic matchmaking process plays a role as a ranking mechanism in service selection process. However ranking based on semantic similarity does not suit for efficient service selection. Because, from customers perspective, it is always not true that a web service with high semantic similarity is suitable than a web service with lower similarity. The other difficulty with semantic similarity is that the users find it hard to distinct which service is better suitable between a pool of similar services [17]. To achieve better ranking performance many ranking algorithms have been proposed in the literature. One such approach is to integrate more information besides semantic information. The information may range from time, place, location [18], customer and providers situation [19] etc. The limitation with this approach is that the system becomes more complicated when new constraints are added. To overcome this, the authors [33] have proposed a method a social collaborative filtering method for ranking. This method makes use of learning other user's previous experiences. This method is used most successfully in all kinds of recommendation systems but the limitations with this method are information distortion and independence of service selection.

3.2 QSS Service Selection Techniques
The various techniques of QoS based service selection identified from the literature are discussed in this section. Figure 2 portraits the various QSS techniques identified.

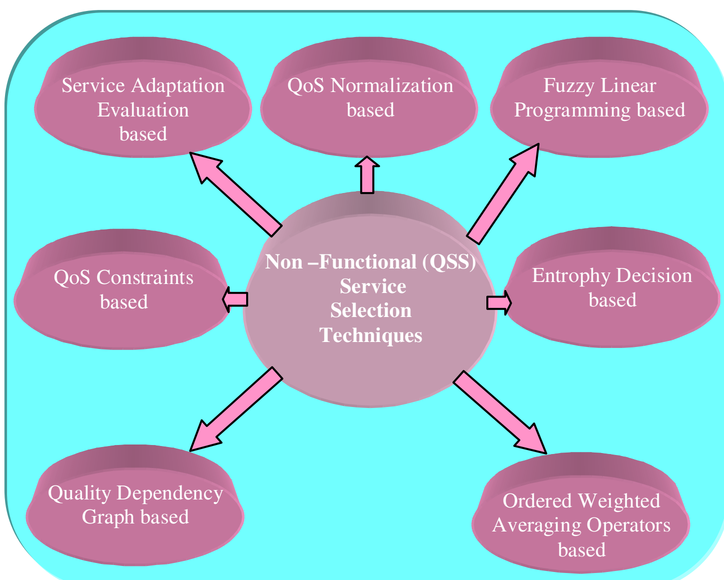

FIGURE 2: QSS Service Selection Techniques

3.2.1 Service Adaptation Evaluation Based QSS Technique
Baopeng et al [8] proposed a QoS model and used hierarchy policy approach to capture goals of users, applications, environment and resources to form rational service composition and adaptation action. The authors have proposed a Service adaptation evaluation (SAE) algorithm to handle service adaptation problem and service composition decision problem in pervasive computing environment. The system model consists of property primitives for policy hierarchy such as Control Construct, InterpretedAs, BelongTo, ExistIn, and Commit. The proposed multidimensional QoS model is focused not only on the traditional QoS properties but also Requirements of functional QoS parameters and Environmental QoS. The QoS model is

designed with four layers namely Resource layer, Environment layer, Application layer and User layer. Each layer describes its own QoS properties. The use of policies at different layers triggers the service adaptation and provides better service composition performance. A policy driven service selection algorithm is proposed by the authors to make selection mechanism semantic-aware and QoS-aware. It is said semantic-aware because, the algorithm performs well even if the composite service semantic logic changes to form new semantic logic. QoS-aware represents the input, output QoS parameter consistency, and end-to-end QoS properties such as delay etc. A policy description language defined in this technique consists of three symbols namely primitive symbols, action symbols and function symbols.

3.2.2 QoS Normalization Based QSS Technique
In order to enable quality-driven web service selection, Yutu Liu et al [9] proposed a dynamic and secure framework to evaluate the QoS of a number of web services. The three key aspects that are developed in this technique include Extensible QoS model, Preference-oriented service ranking, fair and open QoS computation. The QoS model in this technique is designed to evaluate the QoS of web services without changing the computational model. In service ranking, this technique concentrates on representing QoS from the service requestor's preference perspective. The QoS computation aspects ensure that the information is collected in a fair manner. For QoS based service selection modeling, three quality parameter or properties is measured for generic quality services namely execution price, duration and reputation. It considers transaction, compensation rate, penalty rate for business related quality criteria. In order to rank the web services, this technique prefer normalization. The purposes of normalization are: one to allow for a uniform measurement of service qualities independent of units. Two, to provide a uniform index to represent service qualities for each provider. Three, to allow setting a threshold regarding the qualities. The number of normalizations performed depends on how the quality criteria are grouped. The authors have proposed a prototype model to implement the QoS registry with hypothetical phone service. They have analyzed collecting service quality information, collecting quality information from active execution monitoring and collecting quality information from user feedback. In their proposed framework, the authors have defined deterministic and non-deterministic criterion to indicate the value of QoS quality and when a service is invoked. The non-deterministic indicate for QoS quality that is uncertain when web service is invoked. The advantage of this technique is, it lessens the overhead of QoS registry, and it dose not need expensive middleware to select the service provider.

3.2.3 Fuzzy Linear Programming Based QSS Technique
Ping et al [10] proposed a QoS-aware service selection model based on fuzzy linear programming (FLP) technologies, to identify their dissimilarity on service alternatives and assist service consumers in selecting most suitable services with needs and preferences of customers. The proposed model has key aspects such as vague reference, weighting of QoS attributes, and service ranking. In the process of selecting web services, the vague preference of QoS by service consumer is handled by the proposed model. Weighting of QoS attributes is designed to explore the optimal solution. Service ranking deals with ranking on web services. A fuzzy group consensus aware service selection algorithm is proposed based on LINMAP (Linear Programming techniques for Multidimensional Analysis of Preferences) model to find the optimal QoS weighting attribute for web services. For the proposed service selection algorithm, the authors have represented arithmetic operations on fuzzy numbers. This includes representation for Triangular Fuzzy number, Fuzzy arithmetic operations for addition, subtraction, multiplication and division. The normalized Euclidean distance between two triangular fuzzy numbers, and the weighted square distance from positive ideal solution. Further, the authors have addressed the consistence and inconsistence measurement of service customers by aggregating difference between fuzzy performance rating and FIPS. The square distance defined is used for accessing QoS attributes weights.

3.2.4 QoS Constraints Based QSS Technique
Tao yu et al [11] proposed the service selection problem in two models the combinatorial model and the graph model. A QoS service broker acts as an external, independent broker entity that

can help users construct composite services. To conduct service selection for the general flow structure the combinatorial model is used. The combinatorial model reflects the service selection problem as multidimensional multichoice 0-1 knapsack problem. The graph model sees the selection problem as a multiconstraint optimal path problem. To provide end – to – end QoS constraint for distributed services, the authors have proposed a broker based architecture. This architecture includes, service discovery, planning, selection and adaptation as its main function. The service selection algorithm proposed in this technique is designed with different composition structure. An efficient algorithm designed for quality driven web service composition ensures that the services selected satisfies the QoS requirements of users. Four different algorithms have been proposed by the authors and the algorithms does the task of service selection, algorithm for designing QoS constraints, heuristic algorithm to find the near optimal solutions, and algorithm to handle composition structures namely sequential, parallel, conditional, and loops. The QoS service broker called QBroker help customers to select the best service for the process of composite service before invocation. The authors have proposed different stages of process for service composition namely: Process plan, Function graph, and Service candidate graph. This technique supports constructs for composition model such as Sequential, AND split, XOR split, Loop, AND join, and XOR join. The QoS service selection problem as MMKP is designed in such a way that it ensures to select one service candidate from each service class to build composite service that meets the QoS constraints. To find optimal solution, BBLP (branch and bound) algorithm is used with MMKP. WS_HEU algorithm is used in this technique to find feasible solution in polynomial time. It has three main important steps namely: To find an initial feasible solution, Improve the solution by feasible upgrades, and to improve the solution by infeasible upgrades.

3.2.5 Entrophy Decision Model Based QSS Technique

A fuzzy entropy decision model, called Linguistic Entropy Method is proposed [12] to assign linguistic weights of QoS attributes and prioritizes the ranking order of service alternatives. To overcome the issue of measuring the QoS criteria in web service selection process, the authors have evaluated fuzzy weights of QoS attributes and rank the web services. The proposed technique is composed of enhanced version of Linguistic Entropy Method (LEM) and Fuzzy Synthetic Evaluation Method (FSEM). The Shannon entropy method uses probability function estimate uncertainty of object based on information theory. The weights for linguistic terms are evaluated with the use of triangular fuzzy number. The ratings to linguistic terms is provided by decision maker and designed by triangular fuzzy number. The algorithm Linguistic Entropy Method has accomplished a set of procedures to assign weights to QoS attributes in the web service selection process. First step is to organize the evaluation framework. That is, the QoS attributes are classified and taxonomy of QoS attributes is prepared. The next procedure is weighting the QoS attributes. This is performed by the decision maker. The third procedure is to select QoS attributes using fuzzy entropy weights assigned. Next procedure is to evaluate the score for each QoS attributes. The next procedure deals with constructing the fuzzy decision matrix by applying fuzzy weighting rules. Final procedure is about ranking the attributes and the services are selected.

3.2.6 Quality Dependency Graph Based QSS Technique

Chao Lv et al [13] proposed a technique for service selection mechanism to utilize “serve, be served” relationship and to evaluate the quality of services in business environment to select the enterprise to collaborate with. Quality Dependency Graph (QDG) method is used to model the relationship among enterprises. An Analytic Hierarchy Process (AHP) model is used to calculate the evaluation result of each candidate organization. The authors have presented Quality Dependency graph based on the characteristics of enterprise collaboration technique namely Dependency and Diversity. This QDC is used to evaluate the candidate enterprises in the service selection process. And an AHP model is used to weights the QoS attributes. The authors have proposed two algorithms to do the service selection task. First algorithm to create QDC from business specification. The second algorithm is used to get the service guideline for business role.

3.2.7 Ordered Weighted Averaging Operator Based QSS Technique

Hong Qing et al [14] proposed a novel non functional property-based service selection method by modifying the Logic Scoring Preference (LSP) method with Ordered Weighted Averaging (OWA) Operators to automate the service selection process. The authors have focused on two main issues of service selection process. They are Service automation and Dynamic aggregation function. Service automation deals with the automated ranking of QoS attributes. In order to make the selection process automatic, the ranking problem is transformed into OWA problem to automatically calculate the LSP orness degree. To evaluate the aggregation function, a method is used which combines LSP metrics with OWA operators. An algorithm is proposed to show the modified LSP method. Two new operators called Conjunction and Disjunction is introduced by the authors in the new LSP algorithm to represent relation between criteria such as replaceability, simultaneity etc. This LSP algorithm evaluates quantitative features for the different entities. The four main steps or procedure of this algorithm includes, specifying the evaluation variables, defining the elementary criteria, analyzing the degree decision and analyzing the preference. To overcome the change of criteria and preferences in the dynamic environment of service selection, a type based evaluation matrix is proposed and defined three types of criteria. They are Numerical type, Boolean type and Set overlap type. The advantage of this technique is that, this addresses both the issues of service selection process by assigning a proper quantitative aggregation metrics. And provided an automatic mechanism to facilitate the dynamic metric invocation and aggregation.

3.2.8 Summary of QSS Based Service Selection Process

QoS based service selection plays an important role in the process of service composition. Table 2 shows the comparative study of QSS techniques with the specification discussed. QoS aware service selection for compositing the services overcomes the problem faced in functional based service selection in which they provide only similar functional semantic properties, which might lead to the problem of differentiating available services. The techniques discussed above have advanced the process of QoS-aware service selection. However, the issues that need to address includes:

- Representation of QoS characteristics and QoS modeling.
- Assigning the QoS weightings.
- The fuzzy view on the QoS parameters between service consumers and service providers.
- The universal metric for evaluating the QoS parameters.

T	***QSST (1)***	***QSST (2)***	***QSST (3)***	***QSST (4)***	***QSST (5)***	***QSST (6)***	***QSST (7)***
S (1)	Yes. Multidimensional QoS model	Yes. Extensible QoS model	Yes. QoS model based on LINMAP	Yes	Not applicable	Yes	No
S (2)	Average	Yes	Yes	Yes	Yes	Yes	Not applicable
S (3)							

	Yes	Yes	Yes	No	Not applicable	No	Not applicable
S (4)	No	Yes	Yes	Yes	Yes	Not applicable	Yes
S (5)	No	Yes	Yes	Yes	Yes	Not applicable	Not applicable
S (6)	Availability of resources	Execution price, duration, reputation	Not given specifically	Not given specifically	Runtime, Transaction, Cost, Security, Network	Not applicable	Yes
S (7)	Semi - automated	Automated	Automated	Automated	Automated	Semi automated	Semi automated
S (8)	Centralized	Centralized	Centralized	Centralized	Peer - Peer	Not applicable	Peer - peer
S (9)	No	No	No	No	No	No	No
S (10	Yes. Policy driven ranking algorithm	Yes. Using normalization matrix	Yes. Consensual ranking	BBLP algorithm and WS_HEU algorithm	No	Yes(QDG, AHP)	Yes(Logic scoring preferences)

TABLE 2: Comparison of QSS Techniques.

4. ANALYSIS OF QSS APPROACH

The techniques of QSS approach have their advantages and disadvantages when compared with each other. There are many issues related to QSS approach that need to be addressed. Researchers all over the world are currently working on various aspects of QSS issues such as achieving consensus achievement, QoS modeling, etc. The analysis of QSS approach evaluates each technique based on evaluation criteria to identify which technique suits well for certain kind of application development. This section describes the various possible evaluation criteria for QSS approach.

To say whether a technique is good or bad for certain application development, they need to be evaluated based on some parameters. This process is like testing a program or software. The general parameters that are to be addressed for Non - functional based service selection approach include, Accuracy of the technique, Performance of the technique, Service availability, Complexity of Time, Complexity of cost, Scalability, Supportability, Failure rate, Threats to validity, Selection rate, Effectiveness, Information Retrieval metrics like precision and recall, Efficiency, F – measure, Mean average precision, Geometric mean average precision, Interpolated precision, Interpolated recall. The following are the evaluation metrics used for information retrieval system [15] [16]. The same set of metrics can be applied for evaluating QSS techniques.

Notations	Relevant	Non relevant
Retrieved	true positives (tp)	false positives (fp)
Not retrieved	false negatives (fn)	true negatives (tn)

TABLE 3: Notations for True Positive and True Negatives

Precision (P): It is the fraction of retrieved documents that are relevant to the user’s need.

$$P = \frac{number\ of\ relevant\ items\ retrived}{total\ number\ of\ reterived\ items} = \frac{tp}{tp + fp}$$

Where tp and fp are specified in Table 3.

Recall (R): It is the fraction of relevant documents that are retrieved to the user’s need.

$$R = \frac{number\ of\ relevant\ items\ retrived}{total\ number\ of\ relevant\ items} = \frac{tp}{tp + fn}$$

Where tp and fn are specified in Table 3.

Accuracy (A): It specifies the fraction of classifications that are correct.

$$A = \frac{tp + tn}{tp + fp + fn + tn}$$

Where tp, fp, tn and fn are specified in Table 3.

F-measure: A measure that trades off precision versus recall is the F-measure. It is the harmonic mean of precision and recall.

$$F - measure = 2 * \frac{precision * recall}{precision + recall}$$

A new evaluation criteria is applied to [8] evaluate the adaptation of service selection assessment. Considering the user and environment requirements the criteria is proposed. [9] Conducted a series of experiment to investigate the relationship between QoS value and business criteria, study of effectiveness of price and the sensitivity factors in QoS computation. In [10], the approach not only deals with the decision maker's imprecise perceptions under incomplete information, but also objectively determines the importance weights of QoS criteria. The computational time is evaluated for this. The performances of algorithms for sequential and general flow structure are evaluated in [11]. This study includes two parts: the comparison of optimal and heuristic algorithms where runtime, approximation ratio, memory usage as metrics are used and the comparison of combinatorial and graph models where the provisioning success rate as a metric is used. The performance rating of each service alternative and the score of each alternative service is evaluated in [12]. The evaluation parameters for evaluating the QSS techniques are depicted in Table 4.

Spec. No.	***Specification.***	***Descriptions***
E(1)	**Accuracy**	Accurate gives many results in many senses. In service selection, accuracy defined as how relevant services are acquired that satisfy the user requirement
E (2)	**Service availability**	Service availability defines the existence of services in the registry.
E (3)	**Computational Time**	Time to retrieve the related or best relevant services that satisfy the customer need.
E (4)	**Computational Cost**	The total amount of cost required to get or select the services from the register which is been already registered by the service provider.
E (5)	**Scalability**	The possibility to register or select more services in the future.
E (6)	**Information Retrieval metric**	The kind of metrics used to measure the retrieved services.
E (7)q	**Supportability**	Support to modify or replace the services in the registry by the service provider.
E (8)	**Security**	States the security measure defined in the technique proposed.
E(9)	**Usability**	States how usable and efficient the retrieved services are.

TABLE 4: QSS Evaluation Metrics for Web Service Selection.

5. DISCUSSION AND CONCLUSION

With the increasing availability of Web services as a solution to enterprise application integration, the QoS parameters offered by Web services are becoming the chief priority for service providers and their service consumers. This paper have outlined the approach of non – functional (QoS) Web service selection based on requirements and specification identified from the thorough study from the literature. This paper reviewed a number of techniques in the context of the QoS based approach and have presented a summary of QoS parameters involved in the techniques identified and also the evaluation metrics that can be applied to obtain and test how the techniques perform against the specification criteria.

Due to the agile and dynamic nature of the web, providing the suitable QoS for enterprise business application is really a challenging task. In addition to this, modelling the QoS parameters also relies on the consensus between service consumer and service provider. To achieve the consensus among the service holders, their fuzzy view on QoS parameters have to be modelled and weighted in universal manner. This may cause service providers and consumers to better understand about QoS characteristics. The measurement process for each QoS parameters is very complex since it should consider what and how to measure, who does the measuring and where the measurements are taken. This raises the issue of conflicts on QoS characteristics metrics between service consumer and provider.

It can be concluded that most approaches contribute specific aspects to the overall picture of service selection, which requires methods for expressing user requirements, expressing service offerings and also the actual service selection method. Approaches tend to concentrate on specific of these areas and employ a variety of techniques to do that. It is more appropriate to make some suggestions for future developments in the area of selection approaches.

Important aspects that need addressing are powerful mechanisms to capture user requirements that are both user friendly and also expressive enough to capture large numbers of preferences and the logical relations between preferences. One aspect that falls into this area is the measuring of weights. Also, in the process of capturing the needs of users, their preference of data, research has to show interest and capability to automatically capture this, to reduce the burden on the user part, and to react to changes in circumstances automatically.

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