QoS Based Optimal Selection of Web Services Using Fuzzy Logic

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***Abstract*—With increase in the number of Web services, the complexity involved in finding appropriate services for the given user's request also increases. So, selection of appropriate services has become an important task while processing the request. Initially, service selection is based on the matchmaking algorithm, but as there are number of identical and overlapping services for a single request, a mechanism needs to be defined to determine which services will participate in selection of the given request. Though ranking methodology considers the need of requestor, it does not consider other constraints like functional and non functional qualities. To meet these kinds of constraints, QoS based web service selection has been chosen. This approach maximizes the user satisfaction by composing the qualities of web service using Fuzzy rule based system. This allows imprecise information and help to model highly complex problems that have multi dimensional data. This method is experimented and the results prove better selection when compared with conventional methods.**

***Index Terms*—Web Services, Composition, Selection, Fuzzy, User Preferences, QoS, Ranking.**

I. Introduction

Web services allow applications to communicate with each other in a platform independent manner. A Web service is a software interface that describes a collection of operations that can be accessed over the network through standardized XML messaging. It uses protocols to describe operation to execute or to exchange data with another Web service. The principal building blocks needed for today's Web Services Interaction are SOAP, UDDI, and WSDL. For interaction, first the services are registered in UDDI repository and made available for invocation. The UDDI repository contains all the necessary information to identify Web Services along with a URL that points to its corresponding WSDL file. The descriptions about the operations are available in the WSDL file. Secondly, service requestor query the UDDI repository and find the Web Services best suited for his need and in the third step, the WSDL file of that service is downloaded. Lastly, use the downloaded WSDL file to generate messages to interact with the Web application Providers.

Web services provided by different vendors have unpredictable characteristics. So, to select the highly relevant web service, QoS for Web services are considered [6, 11]. However, due to the dynamic and unpredictable nature of web services, it is not an easy task to evaluate the desired QoS. Table 1 shows the basic domain independent qualities for the web services that are useful while selecting the web service. To provide users a better service, it is necessary to identify the users' needs, and then identify all the possible QoS metrics for web services and based on that select the available service.

TABLE 1.
BASIC QUALITIES FOR WEB SERVICE. IT SHOWS THE BASIC INDEPENDENT QUALITIES FOR SELECTION OF WEB SERVICES

Qualities	Description	Nature
Reliability	The Stability of the service functionality. It is related to the number of failures and the ordered delivery of messages.	High
Availability	The probability that a service is available.	High
Throughput	The number of requests served in a given time period.	High
Response time	The time taken to process its sequence of activities.	Fast
Latency	The round-trip time between client request and service response.	Low
Execution cost	The amount of money for a single service execution.	Low
Scalability	The capability of increasing the capacity of service provider's system and ability to process requests in a given time interval.	High
Reputation	The average rate of the service reported by clients.	High

The representation of crisp values assumes that every element is either a member or non-member of a given set. The drawbacks of such language are that the membership function of crisp logic fails to distinguish between members of the same set. To succeed using imprecise knowledge, Fuzzy logic is used [14]. Fuzzy logic looks like human reasoning for using approximate information and uncertain information to make decisions. The

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advantage of using such Fuzzy logic [11] is that, it allows with relatively few rules, provides a natural way to model some types of human expertise in a computer program, uses imprecise language and inherently robust. In addition to that, it has the ability to model highly complex business problems involving multiple experts.

II. Related Work

Kyriakos Kritikos, Dimitris Plexousakis [1] describe about the basic web service discovery and deals with the requirements for web service discovery. The process involved are the matchmaking which finds the list of relevant services in the registry and then selection is based on ranking approach. First filter different services according to the user preferences and choose which service can be most probably used through the categorization of Super matches, exact matches, partial matches, service that fail. The technique considers parameters like Availability, Reliability, Security, but not all together.

Tao Yu, Yue Zhang, Kwei-jay Lin [3] selects the service with maximum utility function with QoS constraints. The algorithms used are combination model and graph based model. Multi dimensional multi choice 0-1 knapsack problem is used by combination model. The representation of services in combination model is in the form of DAG. Inputs for each service are weight, cost, knapsack with capacity. The process is to select one service from each level to be placed in the knapsack within the capacity yet has the highest total profit. This graph based approach is a multiconstraint optimal path problem. Inputs are service with cost. It select the path for service by applying shortest path algorithm like ford, Floyd and the minimum cost gives the highest ranking service. The problems with these models are Context is not taken into account and Dependences among QoS factors are ignored. Moreover they are simplified models with high complexity.

Eyhab al-Masri et al [2] proposed to solve problems in keyword based search techniques, WSRF (Web Service Relevance Function) which is used for for measuring the relevancy ranking of a Web Service. Keyword based search technique is problematic since it only consider about the user preferences. The service which matches the user preference may fail because of the unsatisfiable network properties, so, to avoid quality based selection emerges. In order to provide quality driven ranking, the model uses a crawler engine. The model enables users to search and manage criteria based on their interest. Highest ranked service is considered the most relevant as per the user's interest.

Shao-chong Li et al [4] Selected the service based on multi QoS attributes by focusing on degree of consumer satisfaction and hypothezing consumer preference historical information. To achieve these a heuristic based approach is followed, where the utility function concentrate on maximum user satisfaction. The dynamic composition of QoS based web service selection is done using Fuzzy constraint satisfaction problem. The optimal service selection is done by comparing the distance for the smooth interpolation between variable centroids between each of service vector with the optimal vector from which minimum distance vector is selected. But, it is hard to eliminate the noise in the web while focusing on selection of relevant web service.

Ping wang et al [5]Mohamed and Almulla, Kawthar Almatori et al [6] ranked the web service by considering the non functional requirements using Fuzzy technique. This approach represents imprecise QoS constraints and preferences. Web service dynamic composition is done using Fuzzy constraint satisfaction problem which uses depth first search to find the solution. The main issue with this technique is that calculating the factors like user or system oriented, tendency of the system etc.

Mahdi Bakhshi et al [15] evaluates service composition using user preference by applying Fuzzy logic technique. Here selection of service is by composition of user preferences and quality properties. The preferences are given as inference rule block inside the Fuzzy engine. The process is to obtain the weights for rank parameter from the user preferences and qualities. Modeling user preference is based on weights given by user and service providers. These weights are fuzzified and applied to Fuzzy rule based model. The resultant set is then ranked. The advantage is it makes use of only fuzzy values than crisp values.

In [8], Chengying Mao et al adopted a complexity measurement technique based on Petri Nets for web service composition. Based on business process representation, two metric sets are provided through analyzing the compositions execution logics and dependency relations in workflow. The first one is count based metric set and the second one is execution path based metric set. Then an extension based on cognitive informatics is discussed.

III. Problem Description

Ranking of services, during the process of selecting services has become challenging. There are various selection techniques, like using user preference based service selection and service qualities aware selection which plays an important role in all service related tasks, since the property values get updated dynamically based on the service provider network. It is simple to imagine a scenario in which multiple services which provides the same functionality for fulfilling a user request. In this case the ability of the user to differentiate between the services depends upon their non-functional qualities. The problems that occur in the quality driven service selection are volatile nature of the quality factors, quality statistics is not taken care while selection, multiple QoS factors has to be considered for selection and subject of the search process is not used. To improve the quality driven selection, there is a need for other approaches like multi attribute optimization, constraint satisfaction problem, Genetic approach, Fuzzy techniques. In our approach we concentrated on solving the multiple QoS factors while selection, by composing the QoS factors of that service using Fuzzy technique.

IV. Method for Web Service Selection

Initially, the end user gives request to Fuzzy service discovery module to find the list of services that are available in the registry. The registry will return the collection of service descriptions to Fuzzy service selection module. The returned service may be available or not available to the public user which depends on service provider. If the services are not available, because of user preference matching the service may be in highest rank and the end user gets disappointed on seeing the service down. So user move to, next highest matching of services which is time consuming and result in more cost. So to overcome these constraints Fuzzy service selection, this makes use of non-functional parameters like response time, throughput, availability, rating and reliability into account for service selection. These parameters are manipulated in QoS manipulator and the resultant value is passed to fuzzy engine for finding the degree using min-max fuzzy rule based approach. The inference from the fuzzy engine is that higher the degree then higher is the process available to the user, then the ranking process is done and result is sent to the end user. Fig. 1. shows the architecture of the Proposed System. It shows the total flow starting from the *client request* to ranking of services through selecting services from *UDDI Registry*, evaluating the QoS using *QoS Manipulator* and ranking the list of similar services with the help of *Fuzzy Engine.*

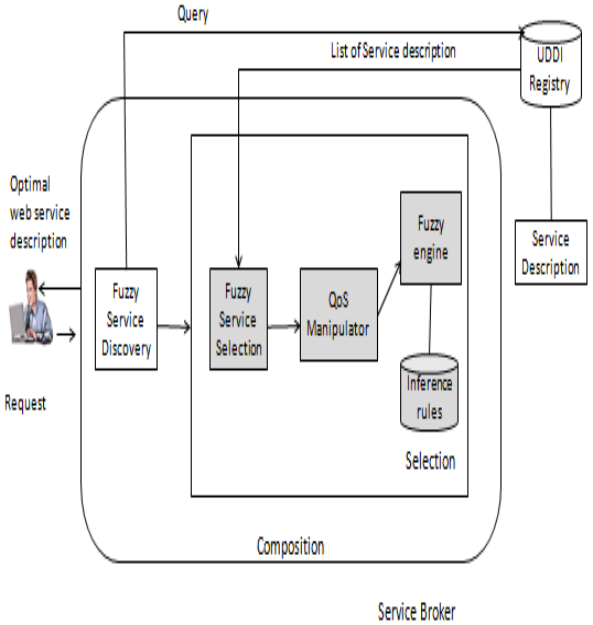


Fig. 1. Architecture of the proposed system.

A. Fuzzy Logic

Fuzzy logic [14] handles the expression of vague concepts. An approach to uncertainty that combines real values and logic operations Fuzzy logic is based on the ideas of fuzzy set theory and fuzzy set membership often found in natural language. The idea of fuzzy logic is to switch gradually from low to high end. To express imprecision quantitatively, a set membership function maps elements to real values between zero and one.

B. Fuzzy Membership Function

The first step is to take the crisp inputs and determine the degree using membership functions. One of the key issues in fuzzy sets is how to determine fuzzy membership functions. A membership function gives the measures for degree of similarity with an element to the fuzzy set. Membership functions can either be chosen by the user arbitrarily or be designed using machine learning methods like artificial neural networks, genetic algorithms. The different membership functions available are triangular, trapezoidal, piecewise-linear, Gaussian, bell-shaped, etc. The membership functions used in our method are triangular and trapezoidal membership function since these methods are simple and it takes the user values, then map directly to the fuzzy set.

Triangular Membership Function.

$$\text{Traingle}(x;a,b,c)= \max\left(\min\left(\frac{x-a}{b-a}, \frac{c-x}{c-b}\right), 0\right). \quad (1)$$

The three parameters {a, b, c} (with a < b < c) determine the x coordinates of the three corners of Triangular Membership Function as stated in equation 1.

Trapezoidal Membership Function.

$$\text{Trapezoid}(x;a,b,c,d)= \max\left(\min\left(\frac{x-a}{b-a}, 1, \frac{d-x}{d-c}\right), 0\right) \quad (2)$$

The four parameters {a,b,c,d} (with a < b <= c < d) determine the x coordinates of the four corners of trapezoidal Membership Function as stated in equation 2.

C. Fuzzy Engine

It works in two steps: The creation of dependency matrix, with the help of services and their QoS parameters and based on the inference rule block that is available in the repository to find the exact optimal service by calculating the dominance degree.

Creation of Dependency Matrix: The obtained membership values are listed in the matrix form with the services at one end and the list of QoS parameters at the other end.

$$\begin{array}{c} \\ S_1 \\ S_2 \\ \cdots \\ \cdots \\ S_m \end{array} \begin{array}{c} \begin{array}{ccccc} q_1 & q_2 & \cdots & \cdots & q_n \end{array} \\ \begin{bmatrix} a_{11} & a_{12} & \cdots & \cdots & a_{1n} \\ a_{21} & a_{22} & \cdots & \cdots & a_{2n} \\ \cdots & \cdots & \cdots & \cdots & \cdots \\ \cdots & \cdots & \cdots & \cdots & \cdots \\ a_{m1} & a_{m2} & \cdots & \cdots & a_{mn} \end{bmatrix} \end{array} \quad (3)$$

Where S_1 to S_m are the available services. q_1 to q_n are the QoS attributes and a_{ij} is the Fuzzy linguistic variable that are represented in equation 3. Now the dependency matrix is sent to fuzzy rule block for mapping the values.

Fuzzy Mapping Rules: The second step is to take the fuzzified inputs and apply them to the fuzzy rule block.

The general from of fuzzy rule block is "IF X THEN Y", where X and Y are collections of propositions which contain linguistic variables. Fuzzy rule-based systems execute faster than conventional rule-based systems as it is easy to understand, read, add, modify services, presents natural knowledge in uniform representation and also separates knowledge from processing which reduces the time complexity.

The main Fuzzy operators used are Fuzzy union and Fuzzy intersection. The fuzzy union is the union of two fuzzy sets which find the maximum of each element from two sets. Therefore for the two fuzzy sets A and R with membership functions μA(x) and μR(x) the union of these functions is represented as in equation 4.

$$\mu AUR\ (x)=\max(\mu A(x), \mu R(x)). \quad (4)$$

The fuzzy intersection is the intersection of two fuzzy sets which just finds the MIN of each element from the two sets. Therefore for the two fuzzy sets A and R with membership functions μA(x) and μR(x) the intersection is represented as in equation 5.

$$\mu A\cap R\ (x)=\min(\mu A(x), \mu R(x)). \quad (5)$$

Where μA(x) is the QoS availability value of service X and μR(x) is the QoS reliability value of service X. The Fuzzified membership values of QoS parameters of each service is sent to MIN-MAX rule block to finds its corresponding weight.

D. Defuzzification

The last step in the fuzzy inference process is defuzzification. Fuzziness helps us to evaluate the rules, but the final output of a fuzzy system has to be a crisp number. The Fuzzy rule base system results in not a crisp number and the direct translation to crisp number is also complex which leads to the necessity of defuzzification. The input for the defuzzification process is the aggregate output of fuzzy set from the Inference rules and the output is a single crisp number. There are several techniques for defuzzification. In this project center of gravity (CoG) method is used and it is expressed as in equation 6.

$$x = \frac{\sum_{i=1}^{n} m^i w_i}{\sum_{i=1}^{n} m^i} \quad (6)$$

where m^i is the membership value for each rule, w_i is the weight associated with each rule and x is the defuzzified result. This method is used as it is faster, easier and gives accurate result.

E. Algorithm for Selecting Web Services Using Fuzzy Logic

Input: Query for searching of relevant services.

Output: List of services in highly ordered form.

Get the query from the user.

Retrieve the results for the search of similar services from the registry.

Extract the non functional requirements of the service with respect to QoS values

Manipulate the QoS parameters

Pass the QoS values to Fuzzy engine algorithm.

Rank the services obtained from the Fuzzy engine.

Return the list of ranked services to the user.

Fuzzy Engine Algorithm.

Input: list of web services with QoS attributes.

Output: weights for each Web Service.

Compute Fuzzy values for QoS parameter.

Construct the Fuzzy judgement matrix A= (aij)m*n

Where m= list of QoS attributes, n=Web services and aij = Fuzzy values

Find the Fuzzy values using triangular or trapezoidal membership method.

Calculate the QoS Weights using the inference rules in Fuzzy engine by taking Fuzzy judgement matrix as input.

Defuzzify the values for each Web service using center of Gravity method.

Return the final crisp defuzzified value to the main method.

V. Selection Of Similar Web Service

The quality of services for any service changes dynamically. Many registries are available to invoke the real time web services. Most providers use UDDI based registry and some use membrane based registry. Some of the real time web service providers are webservicex.net, service repository, cloudberia, visual webservice.com, predic8, xmethods.net, strikeiron etc. The visual web service provides the various web services using WSDL. Service repository uses membrane registry which is non-UDDI registry, it list all the available QoS properties. Predic8 is used to capture and manipulate the SOAP messages. XMethods.net lists the various web service using UDDI and WSDL. From these real time web service providers [2] has collected the corresponding QoS parameters and its WSDL files.

A. Available Holiday Services

From the collected services, to rank the reliable and available service, first the collected parameters are parsed and corresponding QoS values are listed. Fig 2 shows the list of available services for the given query 'Holiday'.

Fig. 2. Available Holiday services. This shows the list of (*Holiday*) services with their (*availability*), (*reliability*) rate and the (*wsdl*) links.

List of web services before ranking

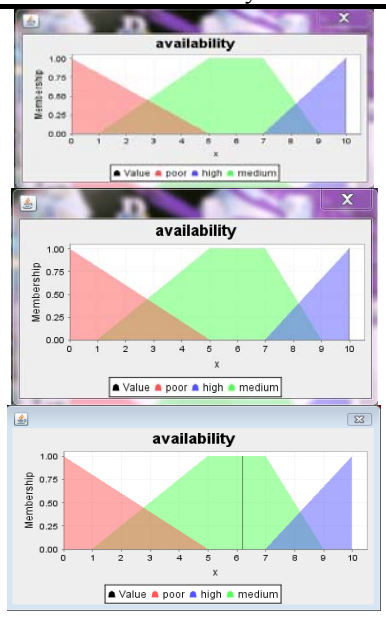
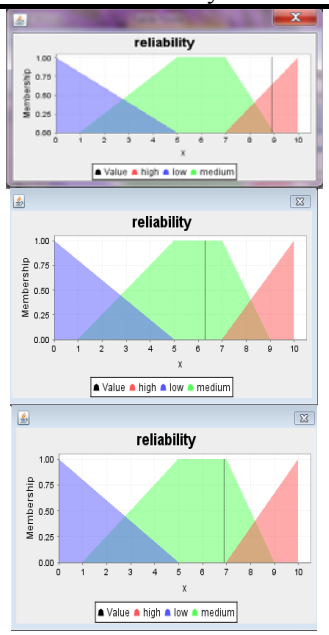
services	availability	relaibility	wsdl
HolidayService	100.0	65.0	http://www.holidaywebservice.com/Holidays/HolidayService.asmx?wsdl
GBSCTHolidayService	100.0	62.9	http://www.holidaywebservice.com/Holidays/GBSCT/GBSCTHolidayService.asmx?wsdl
GBNIRHolidayService	100.0	89.2	http://www.holidaywebservice.com/Holidays/GBNIR/GBNIRHolidayService.asmx?wsdl
USHolidayService	62.0	69.1	http://www.holidaywebservice.com/Holidays/US/USHolidayService.asmx?wsdl
GBEAWHolidayService	98.0	63.7	http://www.holidaywebservice.com/Holidays/GBEAW/GBEAWHolidayService.asmx?wsdl
GBSCTHolidayDates	100.0	42.3	http://www.holidaywebservice.com/Holidays/GBSCT/Dates/GBSCTHolidayDates.asmx?wsdl
GBNIRHolidayDates	77.0	81.1	http://www.holidaywebservice.com/Holidays/GBNIR/Dates/GBNIRHolidayDates.asmx?wsdl
GBEAWHolidayDates	43.0	17.6	http://www.holidaywebservice.com/Holidays/GBEAW/Dates/GBEAWHolidayDates.asmx?wsdl
USHolidayDates	83.0	13.0	http://www.holidaywebservice.com/Holidays/US/Dates/USHolidayDates.asmx?wsdl

Fig. 2. Available holiday services.

B. Fuzzy Representation for Holiday Services

Table 2 shows the fuzzy chart representation for some Holiday services where chart shows the Fuzzy availability point, Fuzzy reliability point and the weight in the assumed Fuzzy model. Table has the list of similar holiday services with their fuzzy representation (*availability*) and (*reliability*) value which are obtained using the Inference rules in Fuzzy Engine. The resultant calculated degree obtained during the defuzzification is represented in (*Weight*)

TABLE 2.
FUZZY REPRESENTATION FOR VARIOUS HOLIDAY SERVICES.

Availability	Reliability	Weight
		

List of web services after conventional Rule based ranking

rank	services	availability	relaibility	Degree	WSDL
10	GBEAWHolidayDates	43.0	17.6	30.3	http://www.holidaywebservice.com/Holidays/GBEAW/Dates/GBEAWHolidayDates.asmx?wsdl
20	USHolidayDates	83.0	13.0	48.0	http://www.holidaywebservice.com/Holidays/US/Dates/USHolidayDates.asmx?wsdl
30	USHolidayService	62.0	69.1	65.55	http://www.holidaywebservice.com/Holidays/US/USHolidayService.asmx?wsdl
40	GBSCTHolidayDates	100.0	42.3	71.15	http://www.holidaywebservice.com/Holidays/GBSCT/Dates/GBSCTHolidayDates.asmx?wsdl
50	GBNIRHolidayDates	77.0	81.1	79.05	http://www.holidaywebservice.com/Holidays/GBNIR/Dates/GBNIRHolidayDates.asmx?wsdl
60	GBEAWHolidayService	98.0	63.7	80.85	http://www.holidaywebservice.com/Holidays/GBEAW/GBEAWHolidayService.asmx?wsdl
70	GBSCTHolidayService	100.0	62.9	81.45	http://www.holidaywebservice.com/Holidays/GBSCT/GBSCTHolidayService.asmx?wsdl
80	HolidayService	100.0	65.0	82.5	http://www.holidaywebservice.com/Holidays/HolidayService.asmx?wsdl
90	GBNIRHolidayService	100.0	89.2	94.6	http://www.holidaywebservice.com/Holidays/GBNIR/GBNIRHolidayService.asmx?wsdl

Fig. 3. Ranking of holiday services using fuzzy rules.

List of web services after Fuzzy Rule base ranking

rank	services	availability	relaibility	Degree	WSDL
10	GBEAWHolidayDates	43.0	17.6	28.124693176239695	http://www.holidaywebservice.com/Holidays/GBEAW/Dates/GBEAWHolidayDates.asmx?wsdl
20	USHolidayDates	83.0	13.0	40.40528558488516	http://www.holidaywebservice.com/Holidays/US/Dates/USHolidayDates.asmx?wsdl
30	USHolidayService	62.0	69.1	50.00000000000002	http://www.holidaywebservice.com/Holidays/US/USHolidayService.asmx?wsdl
40	GBNIRHolidayDates	77.0	81.1	60.972672089063565	http://www.holidaywebservice.com/Holidays/GBNIR/Dates/GBNIRHolidayDates.asmx?wsdl
50	GBSCTHolidayDates	100.0	42.3	73.52629429932497	http://www.holidaywebservice.com/Holidays/GBSCT/Dates/GBSCTHolidayDates.asmx?wsdl
60	GBEAWHolidayService	98.0	63.7	79.99999999999999	http://www.holidaywebservice.com/Holidays/GBEAW/GBEAWHolidayService.asmx?wsdl
70	HolidayService	100.0	65.0	80.00000000000004	http://www.holidaywebservice.com/Holidays/HolidayService.asmx?wsdl
80	GBSCTHolidayService	100.0	62.9	80.00000000000004	http://www.holidaywebservice.com/Holidays/GBSCT/GBSCTHolidayService.asmx?wsdl
90	GBNIRHolidayService	100.0	89.2	80.00000000000007	http://www.holidaywebservice.com/Holidays/GBNIR/GBNIRHolidayService.asmx?wsdl

Fig. 4. Ranking of holiday services using conventional method.

C. Fuzzy Rule based ranking of Holiday Service

Obtained defuzzified degrees are ranked to find the highly available and reliable web services. Fig 3 ranks the Holiday services based on the calculated degree. Fig. 3 shows ranking of various Holiday services using Fuzzy Rules. This shows the list of ranked similar Holiday services obtained based on the Fuzzy rule based ranking approach

D. Conventional Rule Based Ranking of Holiday Services

The ranking of highly available and reliable web services using the conventional rules based system is shown in Fig 4. The method for finding the degree is to get the mean of the QoS values. This shows the list of similar Holiday services which are ranked by taking mean of QoS values as the (*Degree*) in conventional rule base ranking approach

VI. Results

The system is analyzed for similar Holiday services with the help of its availability and reliability values and ranked based on Fuzzy rule block as in Table 3. Table shows the initail QoS availability and reliabiltiy values for each Holiday service, then the calculated intermediate

TABLE 3.
ANALYSING QOS OF HOLIDAY SERVICES

Services	Availability	Reliability	Fuzzy Availability	Fuzzy Reliability
Holiday Service	100	65	High	Medium
GBSCT Holiday Service	100	62.9	High	Medium
GBNIR Holiday Service	100	89.2	High	High
US Holiday Service	62	69.1	Medium	Medium
GBEAW Holiday Service	98	63.7	High	Medium
GBSCT Holiday Dates	100	42.3	High	Medium
GBNIR Holiday Dates	77	81.1	Medium	High
GBEAW Holiday Dates	43	17.6	Medium	Low
US Holiday Dates	83	13	High	Low

Fuzzy availability and Fuzzy reliability from the Fuzzy Engine is displayed.

Table 4 shows the ranks of holiday services listed as per Table 3. The ranking is altered as seen from the table. Higher the rank, higher is the hit for the service.

TABLE 4.
ANALYSING RANKS OF HOLIDAY SERVICES

Services	Conventional rank	Fuzzy rank
Holiday Service	80	70
GBSCT Holiday Service	70	80
GBNIR Holiday Service	90	90
US Holiday Service	30	30
GBEAW Holiday Service	60	60
GBSCT Holiday Dates	40	50
GBNIR Holiday Dates	50	40
GBEAW Holiday Dates	10	10
US Holiday Dates	20	20

A. Availability of the Holiday Services

The graph shows the variation of availability rate for various types of Holiday services. It has the Holiday service name in X-axis and availability rate (percentage) in Y-axis. Fig 5 shows that the availability varies depending on the accessibility of the service provider. For example in this case, HolidayService, GBSCTHolidayService and GBNIRHolidayService is available for 100 percentage whereas GBEAWHolidayDates is available only for 43 percentage.

Fig. 5. Availability of holiday service providers.

B. Reliability of the Holiday Service

The graph shows the variation of reliability for the Holiday services. It has the service name in X-axis and reliability in Y-axis as in Fig 6. Reliability varies with the number of failures. GBNIRHolidayService shows the highest reliable service and USHolidayDates which is highly available has lowest reliability rate as in Table 2.

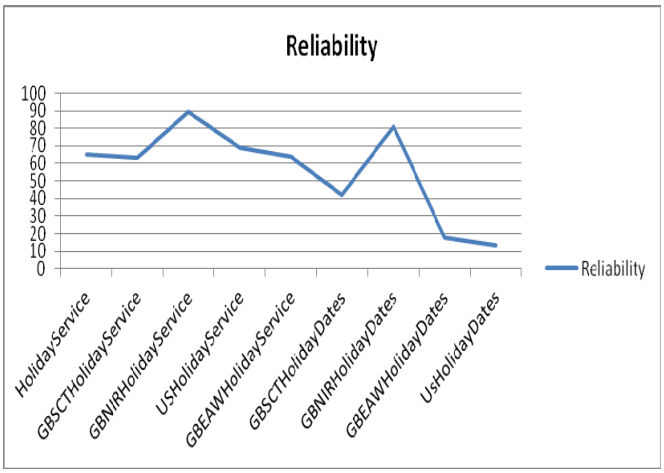


Fig. 6. Reliability of holiday service providers.

C. Conventional Rule base selection Vs Fuzzy Rule based selection

The chart shows the comparison of various Holiday service providers for two different approaches. It has the service name in X-axis and rank value to which it is reliable and available in terms of ten units in Y-axis as in Fig 7.

This graph shows the comparison of (*Fuzzy rule base*) and (*Conventional rule base*) ranking approach for the Holiday services with their (*availability*) and (*reliability*) values

From the testing results, it is inferred that, the proposed system lists the similar services by prioritizing the QoS parameters while ordering the services.

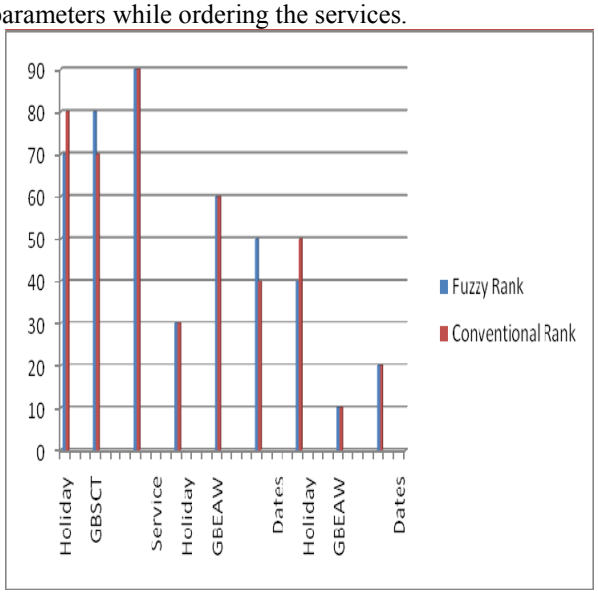


Fig. 7. Conventional rule based vs fuzzy rule based selection.

Higher the availability or reliability of a service, then it is highly accessible to the user. On comparing Fuzzy Rule base and Conventional Rule base approach Fuzzy Rule base gives the better ranking of services when multiple Quality of Service are taken into account during

service selection. Consider the two services GBSCTHolidayDates and GBNIRHolidayDates as in table 1, both the services have high and medium level QoS attribute. But the ranks are different in Conventional and Fuzzy approach. So the inference is Fuzzy Rule base approach gives better ranking for high accessibility of services to the end user.

Also, from the simulation results, the response time of Fuzzy Rule based approach is 12.03 seconds, and the conventional rule based approach gives 20 seconds, as per Fig.8.

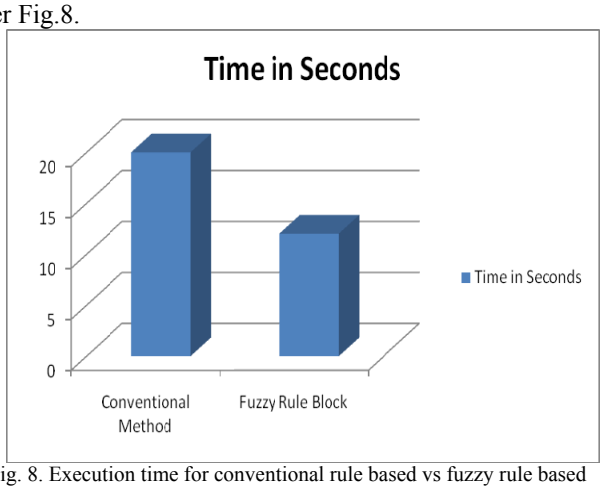


Fig. 8. Execution time for conventional rule based vs fuzzy rule based selection

VII. Conclusion and Future Enhancement

Ranking of web services is becoming a challenging task while ordering the services. So, it can be done with the help of user requirements and non functional requirements like QoS. These ranking can be done using combinational model and graph based models. But the problems with these models are highly complex and time consuming. So, to improve this methodology other approaches like multi attribute optimization, constraint satisfaction problem, genetic algorithm and fuzzy technique are used. In this approach Fuzzy logic rule based web service selection with respect to the users' preference and QoS values of the service is formulated.

The need for having an automated web service selection at the broker, based on the users' query is discussed. A detailed study about various QoS criteria while selecting the web service is described and fuzzy rule based algorithm for automated selection of web service at the broker is proposed. At last, an implementation procedure and the results using rule based web service selection and composition for selection is given. Reliable and available services are selected using this setup. In this project two main QoS criteria like availability and reliability for web service selection were concentrated. As future work, other QoS attributes can also be considered for composition, while selecting the service which is presumed to provide more optimized results.

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