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Web Service Selection based on Fuzzification and Particle Swarm Optimization

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ABSTRACT

In current scenario the information technology acts as a business enabler for industries and organizations. They use services to realize or implement their business process requirements. The service should be selected from collection of compliant services using service discovery based on functional and non-functional requirements. The contemporary service ranking methodologies rank services using statistical or fuzzy methods to select relatively better services. The existing Service discovery is extended to improve the service selection. The proposed system combines Fuzzy, Normalization and Particle Swarm optimization approach to provide the best service as per user requirement. The system initially extracts system Quality QoS attribute values of all complaint service and constructs a matrix. This matrix is transformed into a fuzzy judgment matrix using fuzzy limits. The scores of service are calculated using normalized fuzzy values and Particle Swarm Optimization technique. The experiments are conducted using a set of benchmark web services and concludes that the proposed web service discovery process is more accurate and ranks relatively better service than the existing service ranking methodologies. The accuracies of all hybrid approach are measured using F-Measure and Normalized Discounted Cumulative Gain methods

Keywords : Fuzzy matrix, Normalization, Quality of Service, Service Discovery, Particle Swarm Optimization

I. INTRODUCTION

Service Oriented Architecture [SOA] is an architectural style to build the software applications, it provides the various services based on the parameters so that they can be reused. A service is a self-contained software module that performs a predetermined task. Service oriented architecture is a building block and can be implemented by using Web Services. Web Services are applications that can be published, located, and invoked across the Internet.

The industry and organization adapt service oriented computing for realizing their business processes like shipping industry, customized production, health-care and satellite-based observation. The services of various processes are designed, implemented and advertised by service providers. The information of services is provided in service registry using Web Service Description Language [WSDL] description. Services available in service registry is classified under various categories and sub-categories using their description. Required services are selected using the user's functional and non functional requirements.

The Service discovery process identifies the required service from service registry and lists all services. Identified services are ranked using QoS parameters. In conventional systems, services are evaluated using benchmark tools and QoS attributes value are calculated and stored along with service description using WSDL. Most of these values are either average value or maximum value or minimum value of QoS attributes of service. Existing service ranking methodologies uses co-variance, multi-utility functions, matrix method and Fuzzy techniques. Still service discovery and QoS based ranking of services is a challenging issue in service computing due to imprecise attribute values. Some of existing techniques define these imprecise QoS attribute values.

This paper proposes web service discovery process to obtain more information about QoS values. The proposed system extracts minimum, maximum and average values of each QoS attribute using available benchmark tool. If tools do not provide the required multiple values of QoS attribute, the system uses fuzzy techniques. The best service is selected and ranked by using the normalized fuzzy method and Particle Swarm Optimization approach. The selected service is cached for future reference.

II. BACKGROUND WORK

An Fuzzy approaches are used to overcome the difficulties of defining the QOS property. It applies the fuzzification process with multiple criteria decision making for QOS-based service selection [1]. QoS - aware web Service Selection by a Synthetic Weight applies the fundamental principles of fuzzy set theory which handles the undetermined fuzzy problems through fuzzy information and models the web service selection as fuzzy multiple criteria decision making [2]. Web service ranking algorithm combines the matrix method and fuzzy based ranking method. Matrix based ranking method is the effective way to capture the user needs and fuzzy method is used to define the QoS criteria precisely [3].

Web Service Ranking [4] based on Artificial Neural Network improves the accuracy of web service ranking by adjusting the weight. The weight is learnt from the early experiences through adjusting the connection weights by back propagation and can use this as Knowledge base. Web service ranking [5] method ranks the web service using Rank Aggregation. This is the effective method for ranking web services with multiple input ranking list.The QoS ontology [6] describes QoS information and also facilitates the various service participants expressing their QoS offers and demands at different levels of expectation. The QoS-based ranking algorithm adopted Analytic Hierarchy Process, a multiple criteria decision making technique as a fundamental mechanism for developing dynamic ranking algorithm.

A hybrid approach [7] for Web Service Selection uses Analytical Hierarchy Process to evaluate the weights of criteria and VIKOR (VIšekriterijumsko KOmpromisno Rangiranje) to rank the appropriate candidate services. An optimal QoS based web service selection scheme [8] uses the two different contexts. One is single QoS-based service discovery and the other is QoS - based optimization of service composition.The service filtering, ranking and selection algorithm [9] is concerned with filtering out redundant services, normalizing the QoS values of each parameter and computing the overall QoS score for each service. Finally, the algorithm arranges the relevant web services in descending order of overall QoS score and recommending the best service to the requester based on user preferences.

User – centered design of a QoS based web service selection [10] could handle both exact and fuzzy requirements, return two categories of matching namely super-exact and partial matches and rank them using a two-level ranking algorithm. Service Selection [11] based on QoS ranking Using Associative Classification is implemented and tested to address service selection in the context of QOS aware middleware for dynamic service environments.

Selecting and ranking business processes with preferences describes an service retrieval approach [12] that refers the service process model and relies both on preference satisfiability and structural similarity. User query and target process models are represented as annotated graphs, where user preferences on QoS attributes are modelled by means of fuzzy sets. A flexible evaluation strategy based on fuzzy linguistic quantifiers has been introduced for ranking the process model. Service Selection [13] based on QoS ranking using Associative Classification is to address service selection in the context of QOS aware middleware for dynamic service environments. An overall service selection framework classifies the candidate services to different QOS levels respect to the user's requirements and preferences with an associative classification algorithm and then rank the most qualified candidate services based on semantic ranking. Web Service cloud computing [14] synthesizes the nonfunctional attributes which support advanced web service discovery process with QoS applied in registration, verification, certification and confirmation. Service Matching ranks and service filtering using QoS nonfunctional attributes. Web service selection approach [15] compute the qualities of web service using fuzzy rule based system. This allows imprecise information and helps to model highly complex problems that have multi-dimensional data. Web service selection with end-to-end constraints [16] uses the specific utility function in two ways which maximize an application. The combinatorial model defines the problem as a Multi-dimension Multi-choice 0-1 Knapsack problem. The graph model defines the problem as Multi-constraint optimal path problem. Efficient heuristic algorithms for service processes of different composition structures are presented and their performances are measured.

QoS based selection mechanism [17] is based on QoS metrics. Fuzzy rule based algorithm composes the selection of web service and composition for selection. Fuzzy modeling technique is the idea of linguistic variable which is found by using a membership function which uses triangular and trapezoidal membership function. A user centric approach [18] is presented for evaluating the service compositions which attempts to obtain based on the user requirements. This approach uses fuzzy logic in order to inference based on quality criteria ranked by user and genetic algorithms to optimize the QoS-aware composition problem. The Fuzzy based Genetic algorithm systems enables user to participate in the process of web service composition efficient. An optimization method [19] with constraint using Fuzzy Petri Net and Differential Evolution, which can transforms solving the optimal service composition problem into locating the trust value in the Petri net model. The algorithm is used to locate the optimal legal sequences in order to obtain the optimal web service composition.

A Service composition framework [20] applies a evolution strategy to solve the optimal programming problem of multiple QoS Constrained service composition. It includes the time dependent tactics to offer the quality. For Genetic Algorithm [21], need to encode with suitable genome. The fitness function is calculated to maximize QoS attributes like reliability while minimizing the cost. QoS- aware composition adopts the Genetic algorithm which are more suitable for QoS attributes.

III. PROPOSED METHOD

Ranking entails assigning a score to each web service, quantifying its suitability for the given request. In web service and selection process, the user searches for the service that satisfy their requirements based on the overall functionality and Quality of Service (QoS).

Each user could have various QoS requirements, these QoS values are difficult to express accurately. For example, user may be interested on high performance, low cost service than the low performance and expensive service. The users may not aware of characteristics of these criterion in advance to give preference. Here the system segregates the quality factors into maximization and minimization attribute for normalization.Service discovery process identifies various required services from the service registry. Service registry provides the information such as service definitions, interfaces, operations and QoS parameters like response time, availability, throughput, success rate, reliability, latency. Unlike the existing methods, this web service selection combines the matrix, Fuzzy, Normalization, particle swarm optimization approach to rank the QoS aware web services as shown in the figure 1.

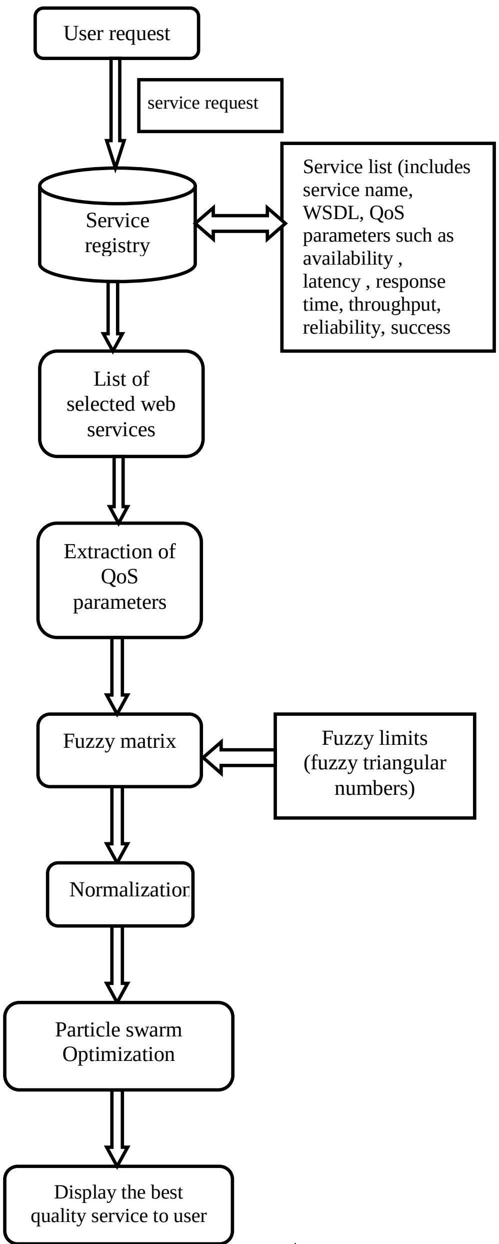

Figure 1. System Architecture for Web Service Selection

The proposed system uses fuzzy approaches to improve the web service selection process. This method is based on the theory of linguistic variables. To determine the QoS parameters correctly, the proposed system uses the fuzzy approach represented by the fuzzy triangular matrix. These Triangular matrix also called as fuzzy limits for each QoS parameter represented as [L, M, U] where L represents the lower value, M represents the medium value and U represents the upper value for that QoS parameter. These fuzzy limits are assigned manually according to the QoS parameters defined in the WSDL documents. Each value in the fuzzy matrix needs to be calculated using the membership function for each parameter

$$Q_{ij} = \begin{cases} \dfrac{Q_{ij} - L}{M - L}, ifL \leq Q_{ij} \geq M \\ \dfrac{U - Q_{ij}}{U - M}, ifM \leq Q_{ij} \geq L \\ 0, otherwise \end{cases} \quad (1)$$

The use of fuzzy logic allows a wide number of web services to be taken into account, to define the imprecise QoS criteria. The fuzzification process builds a fuzzy judgement matrix as shown in the figure 2.

$$f_{ft}' = \begin{bmatrix} f_{11} f_{12} f_{13} & \cdots & f_{1t} \\ f_{21} f_{22} f_{23} \vdots & \ddots & f_{2t} \\ f_{31} f_{32} f_{33} & \cdots & f_{3t} \\ \vdots & & \\ f_{f1} f_{f2} f_{f3} & \ldots\ldots & f_{ft} \end{bmatrix}$$

Figure 2. Fuzzy judgement matrix

Each QoS attribute may vary in terms of its units and magnitude. Normalization assists to accomplish uniform distribution over the QoS parameters. The normalized value q_i is calculated according to the following equations:

1. If quality attribute is to be maximized, the normalization should be performed as shown in the equation (2).

$$Q_i^{'} = \frac{(q_{\max} - q_i)}{(q_{\max} - q_{\min})}, where q_{\max} \neq q_{\min} \qquad (2)$$

2. If the tendency of the quality attribute is to be minimized, the normalization should be performed as shown in the equation (3)

$$Q_i^{'} = \frac{(q_i - q_{\min})}{(q_{\max} - q_{\min})}, where q_{\max} \neq q_{\min} \qquad (3)$$

The proposed method uses Particle Swarm Optimization (PSO), each particle is initialized with a group of random particles, which are solutions; optima are searched for by updating subsequent generations. In every iteration, each particle is updated by following two best values. The first best value is the best solution or fitness it has achieved so far. The variable pbest contains the best fitness value. The best value obtained so far by any particle in the population which is tracked by the particle swarm optimizer is global best and called as gbest. These best solutions are obtained from a relation maintained by the current particle‟s velocity and position

v[] = v[] + c1 * rand() * (pbest[] - present[])
+c2 * rand() * (gbest[] - present[]) (4)

present[] = persent[] + v[]

Where v[] is the particle velocity, present[] is the current particle (solution). rand () is a random number between (0,1). c1, c2 are learning factors. usually c1 = c2 = 2.

Normalization method takes the fuzzy matrix and performs the assessment based on the restraints of QoS parameters. Finally, Web Service Ranking is computed using the normalized fuzzification value and Particle swarm optimization approach as shown in the equation (5)

$$Score(ws_j) = \sum_{i=1}^{m} f_{ft} \times v[] \qquad (5)$$

The highest web service relevancy score is ranked first.

IV. RESULTS AND DISCUSSION

For experimentation benchmark web service dataset with 2507 services is used. The web services in data set are classified under various categories as shown in the Table I. Experiments are extended to hybrid approaches by combining existing methods to improve the performance.

TABLE I

CATEGORIES OF SERVICE

S.No	Category of Services	S.No	Category of Services
1	holiday	21	Web
2	google	22	Phone
3	Tax	23	Sms
4	Hotel	24	Sky
5	weather	25	Server
6	flight	26	Online
7	book	27	Map
8	data	28	Music
9	games	29	Compound
10	email	30	Number
11	users	31	Name
12	address	32	Bank
13	wizard	33	analysis
14	version	34	lab
15	math	35	implement
16	card	36	tree
17	Research	37	match
18	Log	38	manage
19	Document	39	graph
20	Transfer	40	soap

For ensuring the accuracy of ranking methods, Precision, Recall, F-measure and Normalized Discounted Cumulative Gain [NDCG] are used. F-Measure computes some average of Information retrieval and it is computed using the harmonic mean as shown in the equation (6). Precision measures how much of the information the system returned is accurate. Recall measures how much compatible information the system has extracted.

$$F-measure = \frac{2 * Precision * Recall}{Precision + Recall} \quad (6)$$

Where

$$precision = \frac{HighestRankScore}{TotalRankScoreofAllTheService}$$

and

$$Recall = \frac{HighestRankScore}{ScoreOfSecondHoghestRankingService}$$

Cumulative Gain is a measure of ranking quality and it is a predecessor of Discounted Cumulative Gain and does not include the position of a result by considering the result set. The value computed in cumulative gain function is unaffected by changes in the ordering of search results. Normalized Discounted Cumulative Gain [NDCG] provides the more effectiveness of ranking algorithm and its usefulness or gain as shown in the equation (7).DCG takes the actual ranking order of the web services based on the hybrid ranking and IDCG takes the sorted Ranking Scores of the web services.

$$NDCG = \frac{DCG}{IDCG} \quad (7)$$

where

$$DCG = RankScore_1 + \sum_{t=2}^{n} RankScore_t + \log_2 t.$$

and

$$IDCG = HighestRankScore_1 + \sum_{t=2}^{n} RankScore_t + \log_2 t$$

The resultant rank values of Holiday services for all the Ranking Methods are shown in the table II and corresponding chart is shown in figure.3

TABLE III

RANK VALUES FOR VARIOUS WEB SERVICE SELECTION METHODS

SERVICE NAME	MATRIX RANKING METHOD	FUZZY RANKING METHOD	FUZZIFI-CATION WITH PSO RANKING
GBNIRHolidayDates	5	9	9
GBEAWHolidayDates	8	10	10
GBNIRHolidayService	6	3	3
HolidayService	1	7	6
USHolidayDates	10	5	5
USHolidayService	3	1	1
USHolidayService	4	4	4
USHolidayDates	7	8	8
HolidayService	2	6	7
GBSCTHolidayService	9	2	2

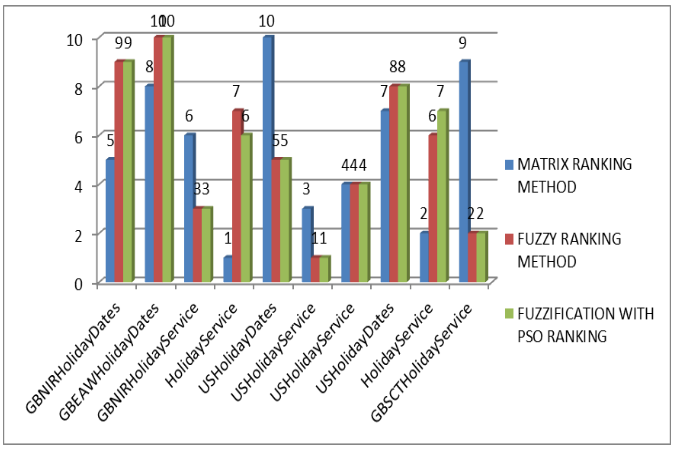

Figure 3. Rank Values for holiday Ranking Service

Based on two accuracy algorithms, it is evident that Fuzzification with Particle swarm optimization approach is more accurate (Average Accuracy) than the other ranking methodologies.

V. CONCLUSION

The proposed work have implemented various service discovery methodologies which extracts the QoS values of all web services and constructs the matrix for service selection. The proposed system has implemented normalized Fuzzy Ranking method with Particle Swarm Optimization approach. Out the existing ranking methodologies, normalized fuzzification with Particle Swarm Optimization is more accurate in ranking which is confirmed by the F-Measure and NDGC accuracy algorithms.

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