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# Dynamic Web Service Discovery Model Based on Artificial Neural Network with QoS Support

Shamim Ahmed, Momotaz Begum, Fazlul Hasan Siddiqui, and Mohammod Abul Kashem

**Abstract**— The Universal Description, Discovery and Integration (UDDI) registries do not have the ability to publish the QoS information, and the authenticity of the advertised QoS information available elsewhere may be questionable. We aim to refine the discovery process through designing a new framework that enhances retrieval algorithms by combining syntactic and semantic matching of services with QoS. We propose a model of Artificial Neural Network (ANN) with Quality of Services (QoS) based Web services discovery that combines an ANN based intelligent search and an augmented UDDI registry to publish the QoS information and a reputation manager to assign reputation scores to the services based on customer feedback of their performance. We develop a service matching, ranking and selection algorithm that finds a set of services that match the consumer's requirements, ranks these services using their QoS information and reputation scores, and finally returns the web service consumer based on the consumer's preferences in the service discovery request. Finally the web service discovery with QoS gives the most cost effective and suitable services as an output. The effectiveness of the system is improved by means of Artificial Neural Network with QoS.

**Index Terms**— Web Services Discovery, Quality of Services (QoS), Web Service Broker, Artificial Neural Network, UDDI.

## 1 Introduction

THE proposed work is to provide an intelligent search for the relevant web service for the given set of requirements of the service consumer and based on the contextual information which is an input from the environment. The proposed intelligent search is planned at the consumer's end. This framework provides intelligent search to the consumer with the help of neural network. Neural network adjusts the weight of each node in the network by the trail and error method.

The consumer provides the set of inputs to system. In the proposed system, Input encoder will help to convert the user input into input vector. Artificial Neural Network (ANN) accepts only vector values. Inputs will be either real number or Boolean value. The resultant input vector is passed on to the ANN. Number of input and output nodes are defined by the designer of the network. But the number of hidden nodes and layers are not dependent to designer of the network. Normally one hidden layer is better to reduce the complexity of network. The weight is adjusted in network based on trail and error method. It will get experience and adjust the weight for each node. First ANN gives detailed possible information about various types of services. Then ANN produces the output according to that information as vector form. The vector contains the suggestion for desired services. This suggestion is passed to the Web Services Discovery with QoS for finding suitable service.

Service Oriented Architecture (SOA) is an approach to build distributed systems that deliver application functionality as services which are language and platform independent. A Web service is a technology that realizes the SOA. The current Web services architecture encompasses three roles: Web service provider, Web service consumer and Universal Description Discovery and Integration (UDDI) [1]. Web service providers use the Web Services Description Language (WSDL) [2] to describe the services they provide and how to invoke them. The service providers then register their services in a public service registry using UDDI. Application programs discover services in the registry and obtain a URL for the WSDL file that describes the service. Then, the applications can invoke the services using the XML-based Simple Object Access Protocol (SOAP) [6] in either asynchronous messaging or Remote Procedure call (RPC) mode.

Finding the suitable service in the UDDI registry that satisfies the user needs or goals (Service Discovery) is the major problem. In our proposed Web services discovery model, we extend the traditional Web service model consisting of a service provider, a service consumer and a UDDI to include a Web service QoS certifier and a reputation manger, and use an


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augmented UDDI that contains QoS information to allow QoS-based service discovery. The proposed new registry differs from the current UDDI model by having information about the functional description of the Web service as well as its associated quality of service registered in the repository. The certifier verifies the claims of quality of service for a Web service before its registration. The Web Service Broker (WSB) consists of a service consumer, a UDDI registry and a reputation manager and helps to discover Web services that satisfy the consumer's functional, QoS and reputation requirements. The reputation manager collects and processes service ratings from consumer, stores service reputation scores in a Web Service Storage (WSS) like a Rating Database, and provides the scores. We develop a service matching, ranking and selection algorithm based on a matching algorithm proposed by Maximilien and Singh [3]. Our algorithm finds a set of services that match the consumer's requirements, ranks these services using their QoS information and reputation scores, and finally returns the web service consumer based on the consumer's preferences in the service discovery request. Finally the web service discovery with QoS gives the most cost effective and suitable services as an output.

Neural Network is a machine learning technique. It is an interconnected group of artificial neurons uses a mathematical or computational model for information processing based on a connectionist approach to computation. Due to their parallel computing nature of neurons, it can perform computations at a higher rate compared with classical method. Neural network has adaptive nature. Due to this adaptive nature, system will adapt to the environment and input. It will produce the output depends upon its input. The output of one node will be the input of another node and the final result or output depends on the complex interaction of all nodes.

## 2 RELATED WORKS

Several Web services may share similar functionalities, but possess different non-functional properties. When discovering Web services, it is essential to take into consideration functional and non-functional properties in order to render an effective and reliable selection process. A number of research efforts have studied either QoS-based service discovery or reputation management systems. Invoking a low quality service in the system could affect the overall performance of the system, among the basic QoS factors are service performance (throughput, response time, latency, transaction time), viability, accessibility, reliability, scalability, exception handling, execution cost, reputation, regulatory, accuracy, integrity, interoperability, security (authentication, authorization, confidentiality, traceability, data encryption, non-repudiation), privacy, network-based factors (network delay, delay variation, packet loss), etc. [4]. Assuring the quality of the selected Web services was discussed in many proposals [4][7][8]. In [4] Ran extend the traditional service discovery model with a new role called a Certifier, in addition to the existing three roles of Service Provider, Service Consumer and UDDI[1] Registry. The Certifier verifies the advertised QoS of a Web service before its registration. The consumer can also verify the advertised QoS with the Certifier before binding to a Web service. This approach prevents publishing invalid QoS claims during the registration phase, and help consumers to verify the QoS claims. Although this model incorporates QoS into the UDDI, it does not provide a matching and ranking algorithm, nor does it integrate consumer feedback into service discovery process. QoS can be used to select and rank the Web services by extending standard service oriented architecture (SOA) [10]. In this architecture, the Web service is selected by matching requested QoS property values against the potential Web service QoS property values [11].

Web service is the most interesting research area in Service Oriented Architecture (SOA). Finding a suitable web service at right time is a potential issue, needs to be addressed by the researchers. Available techniques for web service discovery are not proved to be efficient enough neither to discover the right and suitable services nor to find the services in time. The client will request the service according to their needs, situation, and environment conditions. The services are discovered based upon requests of the clients and the contexts. Context aware service discovery aims to find the exact services based on the contexts at which the requests were given by the service consumers. Just-In-Time will provide the right service in right time to the right users. A framework for JIT-Oriented web service discovery using Neural Network. The effectiveness of the system is improved by means of neural network. The system will learn from its experience to predict user requirements and provide the services accordingly.

## 3 ARCHITECTURE OF HYBRID MODEL FOR EFFECTIVE INTELLIGENT SERVICE SEARCH

Let 'W' be the proposed Intelligent Service Search system. It can be defined as a set of elements {**I, X, S, O**}, where

**I** is the set of inputs ($I_i$=$I_1$, $I_2$, $I_3$…….$I_n$), where i=1,2,3…….n.

**X** is the input vector ($X_i$=$X_1$, $X_2$, $X_3$……...$X_n$) for ANN, where i=1,2,3…….n.

**S** is the set of suggestions ($S_i$=$S_1$, $S_2$, $S_3$,…….. $S_k$) ,where i=1,2,3…….k. 'S' value may be real number or Boolean.

**O** is the set of desires output services ($O_i$=$O_1$, $O_2$, $O_3$….$O_m$) from the proposed system to the consumer. It is the collection of desired services. where i=1,2,3…….m.

Let 'IS' be the intelligent Search module. It can be represented as-

$$SI = \begin{pmatrix} X_1, X_2, X_3 \ldots\ldots\ldots\ldots\ldots X_n \\ H_{11}, H_{12}, H_{13} \ldots\ldots\ldots\ldots\ldots H1_i \\ W_{11}, W_{12}, W_{13} \ldots\ldots\ldots\ldots\ldots W1_i \\ IS = H_{21}, H_{22}, H_{23} \ldots\ldots\ldots\ldots\ldots H2_j \\ W_{21}, W_{22}, W_{23} \ldots\ldots\ldots\ldots\ldots W2_i \\ \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \\ \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \\ H_{k1}, H_{k2}, H_{k3} \ldots\ldots\ldots\ldots\ldots H_{kl} \\ S_1, S_2, S_3 \ldots\ldots\ldots\ldots\ldots\ldots\ldots S_m \end{pmatrix}$$

Where,

'X' is the input vector to the ANN. Where 'n' is the number of input elements.

'H' is the Hidden nodes in artificial neural network. 'i' is the number of nodes in 1st layer. 'j' is the number of nodes in IIst layer. And so on.' k' is the number of layers in the network.

'W' is the weight is passed to each node in network. Each weight has different value. Based upon input and output the weight can be modified.

'S' is the output vector. It gives set of suggestions to the Service Manager. 'm' is the number of elements in suggestion set. It will be either real number or Boolean values.

*Working principle of Intelligent Search System* Effective Intelligent search system working can be divided into five stages. These stages are.

### 3.1 *Request and Input Stage*

Consumer requests the services by providing input to intelligent system to get desired services. The input for this stage can be defined as {$I_1$,$I_2$,$I_3$…..In}. Overview of this stage can be defined as

Request and Input Stage => I= {$I_1$, $I_2$, $I_3$…..In}.

### 3.2 *Encoding Stage*

Input encoder converts the user input into vector. Input of this stage can be defined as {$I_1$, $I_2$, $I_3$…...In} and produce the output as { $X_1$, $X_2$, $X_3$……...Xn}.. The overall working of intelligent search is illustrated in figure 3. Overview of this stage can be defined as

Encoding Stage =>{ I1, I2, I3…...In } -> { X1, X2, X3……...Xn}.

### 3.3 *Execution Stage*

The input vector is passed into ANN and it will adjust automatically based on the weight and produce the set of suggestions. The input for this stage can be defined as { $X_1$, $X_2$, $X_3$……...Xn } and construct output can be defined as { $S_1$, $S_2$, $S_3$……Sk }. The overview of this stage can be defined as

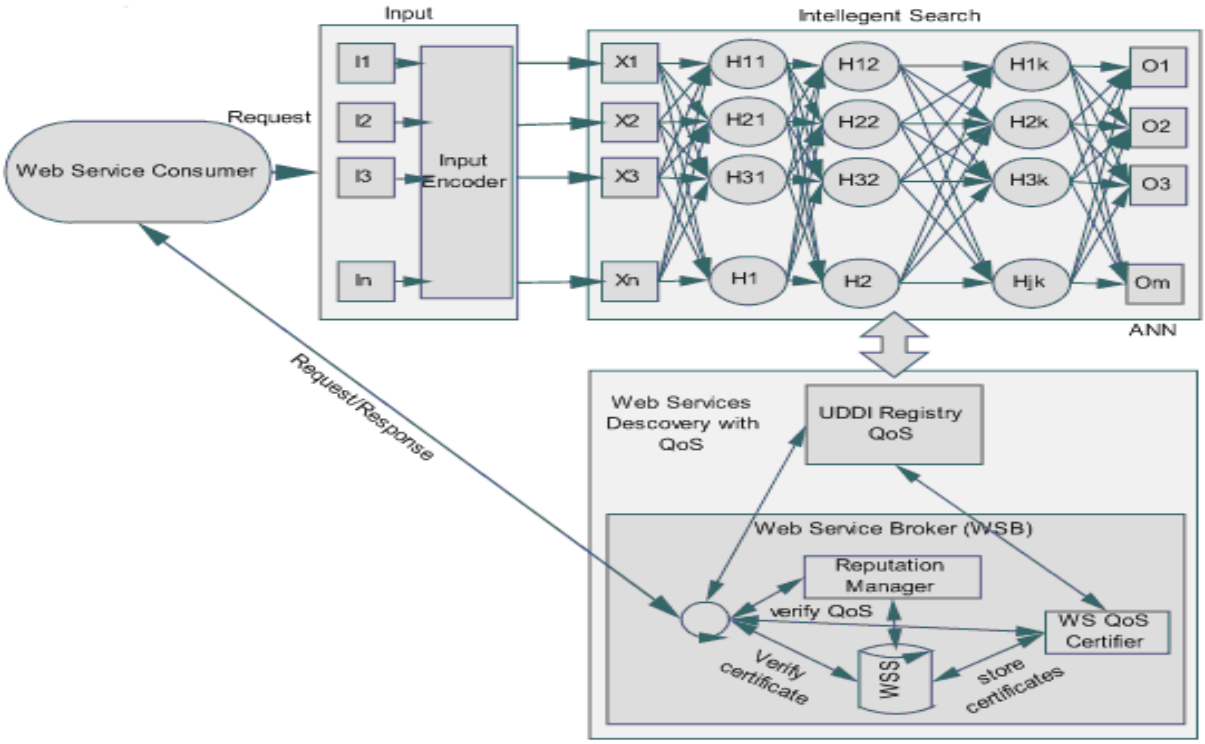


Fig 1. Architecture of Hybrid Model for Intelligent Service Search

Execution Stage =>{ $X_1, X_2, X_3$…..Xn } -> { $S_1, S_2, S_3$…Sk }.

### *3.4 Web Services Discovery with QoS Stage*

This stage consists of UDDI [1] registry and Web Service Broker (WSB). The Web Service Broker (WSB) consists of Reputation Manger, Web service QoS certifier, and Web Service Storage (WSS). The web services discovery with QoS stage fetches the services with the help of suggestion vector based on output of ANN. The input for this stage be defined as { $S_1, S_2, S_3$…$S_k$ }. The certifier verifies the claims of quality of service for a Web service before its registration. The reputation manager collects and processes service ratings from consumer, stores service reputation scores in a Web Service Storage (WSS) like a Rating Database, and provides the scores when requested by web service consumer. The ANN acts as a broker between a service consumer, a UDDI registry and a reputation manager and helps to discover Web services that satisfy the consumer's functional, QoS and reputation requirements. The Output defined as { $O_1, O_2, O_3$….$O_k$ }. The overview of this stage can be defined as

Web Services Discovery with QoS Stage => { $S_1, S_2, S_3$……Sk } -> {$O_1, O_2, O_3$…….$O_k$ }.

### *3.5 Output and Termination Stage*

Web Services Discovery with QoS Stage returns the more relevant service { $O_1, O_2, O_3$…….Ok } to the Service Consumer.

Output and Termination Stage =>list of services=> { $O_1, O_2, O_3$…...$O_k$}.

## 4 THE WEB SERVICES DISCOVERY WITH QoS

The Web Services Discovery with QoS consists of UDDI Registry, Web Service Certifier with QoS, Reputation Manager and Web Service Storage (WSS).

### *4.1 UDDI Registry and Web Service Certifier with QoS*

Web service provider needs to supply information about the company, the functional aspects of the provided service as requested be the current UDDI registry, as well as to supply quality of service information related to the proposed Web service. The claimed quality of service needs to be certified and registered in the repository [4]. Once the verification is passed successfully, the certification process is initiated. The certification process consists of issuing a certificate to the service provider. These certificate states that the offered QoS are conform to their descriptions. The Web service provider first needs to communicate its QoS claim to the Web service QoS certifier. The certifier checks the claims and either certifies or down grade the claim. The outcome is sent back to the provider with certification identification information. A certificate is sent to the Web services provider and a copy is stored in the broker's database (WSS) identified by a certification Id for future use. A certificate includes information such as certificate number (certification Id), certificate issue date, and number of years in business, and services location. The certifier provides a set of Web services for any interested parties to access its repository about QoS claims for verification purposes. After the QoS certification been issued by the certifier, the supplier then registers with the UDDI registry with both functional description of the service and its associated certified quality of service information. The UDDI registry communicates with the certifier to check the existence of the certification. After successful checking, the registry then registers the service in its repository [4].

### *4.2 Reputation Manager*

The reputation manager collects feedback regarding the QoS of the Web services from the service consumers, calculates reputation scores, and updates these scores in the Rating DB. For this work, we assume that all ratings are available, objective and valid. Service consumers provide a rating indicating the level of satisfaction with a service after each interaction with the service. A rating is simply an integer ranging from 1 to 10, where 10 means extreme satisfaction and 1 means extreme dissatisfaction [9]. Our service rating storage system is similar to the one proposed by Wishart et al. [5]. A local database contains the reputation information which consists of

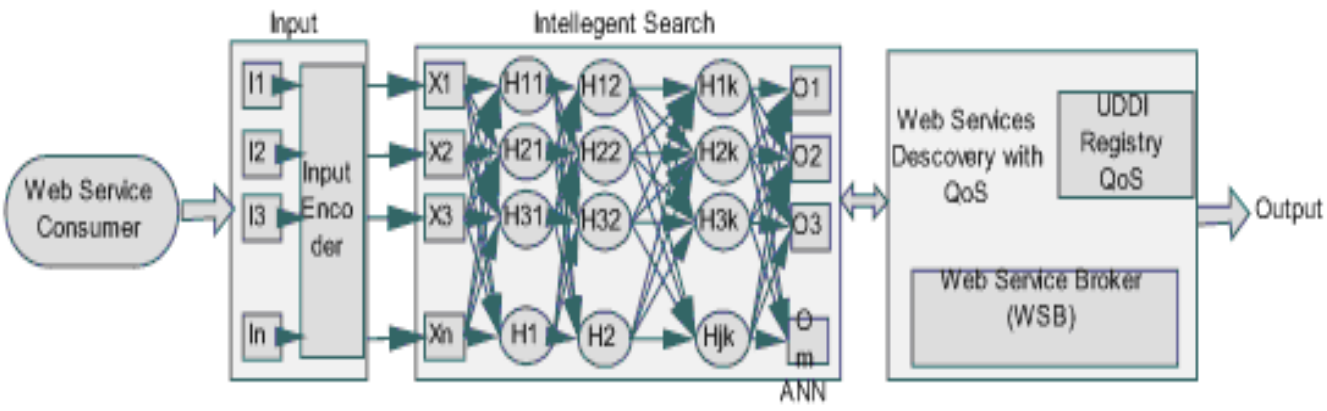


Fig 2. Overall Working of Intelligent Search

service ID, consumer ID, rating value and a timestamp. The service key in the UDDI registry of the service is used as the service ID, and the IP address of the consumer is used as the consumer ID. Only the most recent rating by a customer for a service is stored in the table. New ratings from the same customers for the same service replace older rating [9].

### *4.3 Service Matching, Ranking and Selection Algorithm*

When the discovery agent receives a discovery request, it executes fMatch which returns a list of services LS1 that meet the functional requirements. If QoS requirements are specified, qosMatch is executed next on the set of services LS1 and it returns a subset of services LS2 that meet the QoS requirements. selectServices always returns a list of M services to the customer where M denotes the maximum number of services to be returned as specified in the discovery request. If QoS requirements are not specified, selectServices returns M randomly selected services from LS1. If only one service satisfies the selection criteria, it returns this service to the customer [14].

Web services matching, ranking and selection algorithm:

```
1 findServices (functionRequirements, qosRequirements, repuRequirements,
  maxNumServices)
  { // find services that meet the functional requirements
2   fMatches = fMatch (functionRequirements);
3   if QoS requirements specified
      {// match services with QoS information
4       qMatches = qosMatch (fMatches, qosRequirements);
      }
5   else
      { // select max number of services to be returned
6       return selectServices (fMatches, maxNumServices, "random");
      }
7   if reputation requirements specified
      { // matches with QoS and reputation information
8       matches = reputationRank (qMatches, qosRequirements, repuRequirements);
        // select max number of services to be returned
9       return selectServices (matches, maxNumServices, "byQoS");
      }
10  else
      { // matches with QoS information
11      matches = qosRank (qMatches, qosRequirements); // select max number of
        services to be returned
12      return selectServices (matches, maxNumServices, "byOverall");
      }
  }
```

Fig 3. Service matching, ranking and selection Algorithm

## 5 INTELLIGENT SEARCH IN TRAVEL

Let us consider the scenario; Mr. Sam, Manager for a small company residing in India has to attend conference in London. The mode of transport from India to London may be either through airlines or by ship. The proposed system, suggests the consumer about the convenient and comfortable service, using intelligent search. The system retrieves user SSN, date, time and destination as input from user. The system learns with the help of neural network to suggest whether the customer can travel either by airlines or ship or any other mode of transport. According to the customer's scheduled conference date the system will check and infer that it is better to choose airlines instead of ship which may be a direct flight or connecting flight which ever is feasible to the customer. Based on his prior travel information the system will book his flights either in economy class or in business class. The proposed system retrieves the services based on suggestion of ANN.

The output of ANN feed into the web service discovery with QoS. Finding the suitable service in the UDDI registry that satisfies the user needs or goals (Service Discovery) is the major problem. We extend the traditional Web service model consisting of a UDDI to include a Web service QoS certifier, Web Service Storage (WSS) and a reputation manger, and use an augmented UDDI that contains QoS information to allow QoS-based service discovery. The proposed new registry differs from the current UDDI model by having information about the functional description of the Web service as well as its associated quality of service registered in the repository. The certifier verifies the claims of quality of service for a Web service before its registration. The Web Service Broker (WSB) consists of a service consumer, a UDDI registry and a reputation manager and helps to discover Web services that satisfy the consumer's functional, QoS and reputation requirements. The reputation manager collects and processes service ratings from consumer, stores service reputation scores in a Web Service Storage (WSS) like a Rating Database, and provides the scores. Finally the web service discovery with QoS gives the most cost effective and suitable services.

### Working Principle of Traveler Intelligent Search System

#### *5.1.1 Requesting Stage (RS)*

The Traveler (consumer) requests the service by providing set of inputs to the system. The input can be defined as {I1, I2, I3, I4…In}. That input set is {SSN, Distance, Date, Time}. SSN is the user Social Security Number. Distance is defined as distance between source and destination of journey. Date and time attribute represent the Departure date and time. User input I1 is passed into Input Encoder. Overview of this stage is defined as

**RS=>Input= I1= {SSN, Distance, Date, Time}**

### *5.1.2 Encoding Stage (ES)*

In encoding stage, user input is converted into vector. i.e. The user input set {SSN, Distance, Date, Time} is converted into input vector {X (SSN), X (Distance), X (Date), X (Time)} and produce as {13, 2000, 25, 9}. The resultant vectors either a real number or Boolean value. Because ANN accept either real numbers or Boolean values. The input vector $I_2$ is passed into ANN for retrieving suggestion vector. $I_2$ is defined as {13, 2000, 25, 9}. This stage can be defined as

**ES =>$I_2$= {X(SSN), X(Distance),X(Date),X(Time)} →{13, 2000, 25, 9}**

### *5.1.3 Execution Stage (EXS)*

The input vector 'X' be defined as {X1, X2, X3……..Xn} passed into ANN to get a suggestion set. First ANN gives detailed possible information about various types of services as preliminary output shown in table 1, table 2, and table 3.

**Table 1. Illustrate the differences between various airlines according to available flight date, duration (including delay), and cost.**

| Airline | Available Flight date | Duration (include delay) | Cost |
|---|---|---|---|
| Singapore Airlines | 27 | 9 hours | 760$ |
| Thai Airlines | 26 | 10 hours | 800$ |
| American Airlines | 26 | 9 hours | 710$ |

**Table 2. Illustrate the differences among train, bus, and ship according to duration (including delay), and cost.**

| Transportation | Duration (include delay) | Cost |
|---|---|---|
| Train | 12 days | 556$ |
| Bus | 23 days | 400$ |
| Ship | 17 days | 600$ |

**Table 3. Illustrate the differences between various hotels according to the cost.**

| Hotel | Cost |
|---|---|
| Skyline Hotel | 60$ /night |
| Dream Night Hotel | 71$/night |
| Sun and Moon Hotel | 90$/night |

The weight is adjusted automatically in ANN and retrieves the set of suggestion {S1, S2, S3……$S_k$} as output. i.e. input vector {13, 2000, 25, 9} is passed into ANN and produce suggestion vector as output O1 is defined as {1, 0, 0, 0}. The values for suggestion set are {Flight, Ship, Train, Bus}. The value for each element will be either 1 or 0. The value "1" suggests to use a particular travel commodity else 0. For this example, the ANN suggests to take fight travel. The output can be defined as {1, 0, 0, 0}. The output of ANN also is vector. It may be a single output or set. This suggestion set is passed to Web Service Discovery with Qos model. This interaction can be defined as:

**Possible suggestion sets:**

**Transport => {Airline, Train, Bus, Ship} → {1, 0, 0, 0}**

**Airline => {Singapore Airlines, Thai Airlines, American Airlines} → {0, 0, 1}**

**Hotel => {Skyline Hotel, Dream Night Hotel, Sun and Moon Hotel} → {1, 0, 0}**

**EXS => O1=set of suggestion= {13, 2000, 25, 9} → {Airline, Train, Bus, Ship}→{1, 0, 0, 0}**

### *5.1.4 Web Service Discovery with QoS Stage and Output Stage:*

The possible suggestion set is passed to Web Service Discovery with Qos model. The Certifier verifies the QoS claims from the Web service provider. An ANN helps finding services that meet the functional and QoS requirements specified by the consumers. With the assumption that the consumers provide non-malicious and mostly accurate QoS ratings to the reputation manager, these matched services are then ranked based on both their reputation scores generated by the reputation manager and their non-functional QoS attributes values. The top ranked services are returned to the service consumers. Finally the Web service discovery with QoS gives the most cost effective and suitable services as an output.

## 6 CONCLUSION

In this paper we have presented a new approach for Web Service discovery process. Due to the increasing popularity of Web services technology and the potential of dynamic service discovery and integration, multiple service providers are now providing similar services. QoS is a decisive factor to distinguish functionally similar Web services. We proposed a simple yet novel approach to provide most cost effective and suitable Web service discovery is achieved using Artificial Neural Network with QoS. Context-awareness is utilized to find the perspective of users query. The system will discover the service based upon their consumer input. It helps to provide matching services to consumer by eliminating irrelevant services. Intelligent search is performed using Artificial Neural Network. Experience is fed as input to the intelligent search system. In scenario, Travel intelligent system, fetch desired services to traveler based upon their request. The paper presents an algorithm for effective service matching, ranking and selection. A mass of services is needed where we can test the performance of our system. For future work, we plan to extend QoS parameters to include information such as reliability, fault rates and Security.

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