Web Services Based Medical IR Multi-Agent System for Cloud Environment

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Information Retrieval (IR) Systems are important key players for every Internet user and there are many Information Retrieving frameworks and algorithms which are currently using or under development. As the technology trend is always changing and current industrial and business world is willing to emphasize on not only providing knowledge but also supporting service, Cloud Computing and Web Services become popular. Cloud Computing is Internet based system development in which large scalable computing resources are provided "as a service" over the Internet to users and has attracted more and more attention from industry and research community. Web Service plays important role in Service Oriented Computing (SOC) in World-Wide-Web and Cloud environment. Developing a Cloud Wide Information Retrieval System using Web Services can fill one blank of Cloud Environment because the concept of Cloud Computing does not provide the facilities of knowledge discovery and information retrieval ; i.e. Cloud needs to be intelligent and autonomous. In this case, retrieving desired specific information from Web Services on Cloud Environment cannot be done by single Web Service. So, there should be a way to build an Information Retrieval System based on a set of related Web Services in order to fulfill users' requests and provide desired services. To compose Web Services, Multi-Agent System can give great help. Agent systems are self-contained software programs embodying domain knowledge and having ability to behave with a specific degree of independence to carry out actions needed to achieve specified goals. Therefore, this paper mainly focus on providing a Web Services Based IR Multi-Agent System framework and Agent Processing Algorithm which will be running on a Private Cloud Environment. The implementation and testing of this system utilizes the real datasets of clinics in the Yangon area.

1. Introduction

Cloud computing provide elastic services, high performance and scalable data storage to a large and everyday increasing number of users. Cloud computing enlarged the arena of distributed computing systems by providing advanced Internet services that complement and complete functionalities of distributed computing provided by the Web, Grid computing and peer-to-peer networks. In fact, Cloud computing systems provide large-scale infrastructures for high performance computing that are dynamically adapt to user and application needs. [1]

According to the current situation, most of ongoing works or researches are intended at developing the techniques and constructing cloud platforms, such as Amazon, Google AppEngine, Microsoft Azure, and manjrasoft Aneka. [2] We need more researches in information retrieval and knowledge discovery area. As Web Services play the major role in Cloud Environment since Cloud's main feature is also "as-a-service", to achieve the user desired information correctly and completely may depend on numerous Web Services' supports.

Web Services are considered as self-contained, self describing, modular applications that can be published, located, and invoked across the Web. Amount of products and services available now on the Web increases dramatically and goes beyond user's ability to analyze them efficiently. At the same time the number of potential customers available via the Internet also increases significantly and starts to be beyond service providers' ability to perform efficient targeted marketing. In particular, if no single Web service can satisfy the functionality required by a user, there should be

a possibility to combine existing services together in order to fulfill the request. [3]

At the same time, multi-agent systems (MAS) represent another distributed computing paradigm based on multiple interacting agents that are capable of intelligent behavior. Multi-agent systems are often used to solve problems by using a decentralized approach where several agents contribute to the solution by cooperating one each other. One key feature of software agents is the intelligence that can be embodied into them according to some collective artificial intelligence approach that needs cooperation among several agents that can run on a parallel or distributed computer to achieve the needed high performance for solving large complex problems keeping execution time low. [1]

Therefore, for the Cloud-wide Information Retrieval system based on Web Services, it is sure that not a single Web Service can fulfill the user needs. To get the complete and desired information results, numerous related Web Services should be cooperated. In this case, we propose to get the help of multi- agents systems.

The remainder of this paper is organized as follows. In the next section, we will introduce the background knowledge and theory of Cloud Computing, Service Oriented Computing (SOC), Web Services and Agent Computing. Section 3 describes the related work. Section 4 discusses about our proposed framework and describes the functions of each main component. Section 5 presents proposed Algorithms for our Medical IR Multi-Agent System. Section 6 states how to select the most appropriate web method. System implementation and testing are stated in Section 7. Section 8 describes evaluating performance result. The paper concludes with titled Conclusion.

3. Related Work

Yue-San Chang, Chao-Tung Yang and Yu-Cheng Luo presented an Ontology based Agent Generation for Information Retrieval on Cloud Environment. [2] While user submitting a flat-text based request for retrieving information on a based on predefined ontology and reasoning rule, and then be translated to a Mobile Information Retrieving Agent Description File (MIRADF) that is formatted in a proposed Mobile Agent Description Language (MADF). A generating agent, named MIRA-GA, is also implemented to generate a MIRA in accordance with MIRADF. In short, this research paper mainly focus on building Information Retrieval System for specific field (music field in this paper) using related ontology to generate mobile agent moving around cloud nodes.

G.Vadivelou, E.Ilavarasan and M.S.Yasmeen presented an agent and ontology based approach that supports the semi-automatic composition of Web Services. [3] This paper provided the way to select an optimal composition of services and it also propose a framework for Semi-Automatic Web Services Composition.

Energy-Saving Information Multi-agent System with Web Services for Cloud Computing was given by Sheng-Yuan Yang, Dong-Liang Lee, Kune-Yao Chen and Chun-Liang Hsu from St. John’s University in Taiwan. [5] It employs the concept of SQL IC to construct the operational interface of cloud database as a data warehouse. It presented the three-stage intelligent decision processing strategy with four agents: Interface agent, Data Mining agent, Reasoning agent and Web-Service-Based Information Agent System (WIAS).

Vishal Jain proposed the information retrieval practical model through the multi-agent system with data mining in a cloud computing environment. [6] He recommended that users should ensure that the request made to the IaaS is within the scope of integrated data warehouse and is clear and simple. The use of cloud computing allows the users to retrieve meaningful information from virtually integrated data warehouse that reduces the costs of infrastructure and storage. This paper mainly focus on building Information Retrieval System that retrieves information and knowledge from data warehouse by means of data mining concepts supplied MAS.

Our proposed system applies Web Services in order to retrieve information instead of mobile agents. By the use of web services, it does not need to know each Machine’s database detailed schema and does not need to handle the whole database so that it can solve database security issue. By the help of agents, desired information can be searched in a set of Web Services instead of single Web Service so that searching will be more effective at one sitting. Moreover, decision making on which web methods to be called can also be solved by agents’ knowledge so that system will be more intelligent.

4. Proposed System Framework

We propose a framework for Web Services Based Information Retrieval Multi-Agent System for Cloud Computing Environment. The proposed system framework is intended to apply in Medical field. We have already assumed that a private Medical Cloud Environment was been founded. In that environment, a number of hospitals, clinics and health care services are hosted and are providing Web Services. Each Web Service of a specific hospital offers specialists (doctors) information worked at that hospital by numerous Web Methods. By using our Medical IR multi-agent System, users (patients) can easily search the desired information by day (Monday, Tuesday,...), by time (1pm-4pm,…), by doctor's name (Prof: Dr. Nay Win,…), by specific clinic (Asia Royal, SSC,..) and by disease type (Liver, Lung, OG,…).

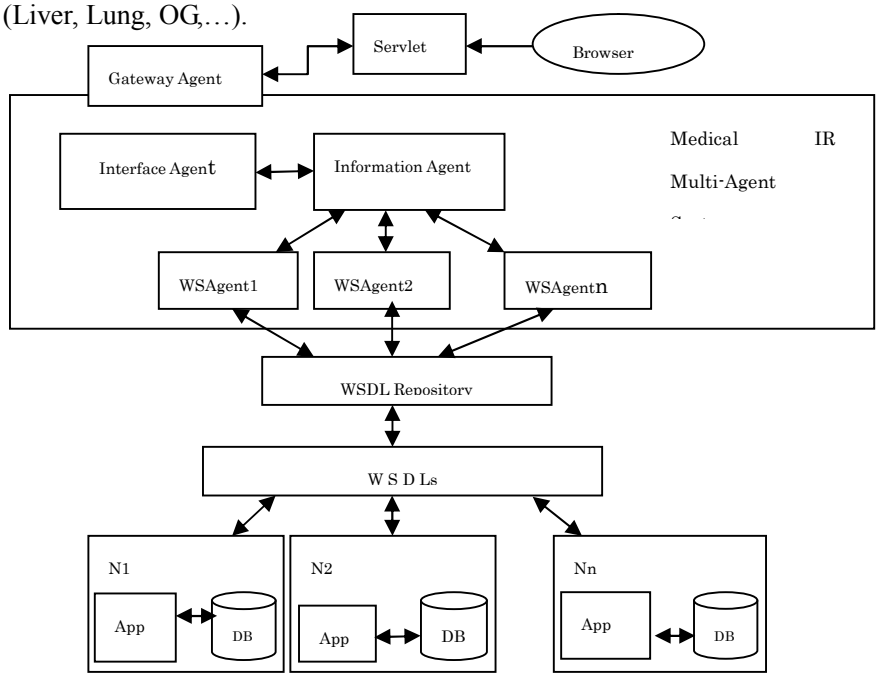

Fig. 1 Medical IR Mulit-Agent System Architecture

There are six main components:

1. *Gateway Agent*
   Gateway Agent is the connection point between proposed Information Retrieval Multi-Agent System and JSP Servlet; in other words, it is the gate way of JADE Agent Platform to the Cloud environment.
2. *Interface Agent*
   The system will start from Interface Agent. Receiving queries from end users to search required information from distributed databases and showing back the queries result may be done by interface agent in this proposed system. The duty of Interface Agent in this system is to receive queries from end users, prepare the queries into a format match for Information Agent's working style, pass the well formatted data to Information Agent and to show back the queries results.
3. *Information Agent*
   Information Agent is the main agent who distributes user input query to a set of WSAgents depending on conditions and then combines the returned result of WSAgents and sends the final result to Interface Agent.
4. *WS Agents*
   There are a set of WSAgents which invoke specific web service associated with them. One WS Agent has to handle one WSDL. In that case, one WSDL may contain more than one web methods. The duty of WS Agents is to make the best choice in selecting the web

method according to the data parameters sent by Information Agent. They will send back a message to Information Agent whether they get the desired data or not.

5. *WSDL Repository*
   WSDL Repository stores Web Service Description files published by various web applications hosted on the cloud nodes. In our system, to make comfortable for WS Agents in sending message and carrying data, we generate each WSDL into a set of client classes and so WS Agents can handle the retrieved results in object and can carry inside the messages.
6. *Cloud Nodes (Ns)*
   Several web application systems from Ns (Cloud Nodes) support services for Information Searching and Retrieving purpose**.** One N represents one hospital. Each N contains a web application (dynamic web projects) for each hospital which desires to coordinate with our Medical Information Retrieval Multi-agent System. They support Web Service with many web methods. They possess databases with different schemas. Each web method contains SQL statement to access the database according to the received parameter values.

5. Proposed Multi-Agent Algorithm for Medical IR System

- Request is defined as Req.
- Refined Request is defined as RefineReq.
- Final Result is defined as FinResult.
- The Returned Result from each Web Service is defined as ResWS.
- ResWS1, ResWS2,…, ResWSn ϵ ResWS
- WS is the set of Web Services published in WSDL Repository.
- WS1, WS2,…, WSn ϵ WS
- AG is the set of all agents in the System.
- InterfaceAG, InfoAG,WSAG1,WSAG2,…,WSAGn ϵ AG
- Interface Agent is defined as IfAG.
- Information Agent is defined as InfoAG.
- Web Service Agent is defined as WSAG.

Begin
FinResult←NULL.
SelectedWSAG ←NULL.
User sends Req to IfAG.
RefineReq←Req refined by IfAG.
IfAG sends RefineReq to InfoAG.
SelectedWSAG ←InfoAG determines which WSAGs to be called.
While not receiving the FinResult from InfoAG
InfoAG sends RefineReq to WSAG1, WSAG2, …, WSAGn ϵSelectedWSAG.
For All WSAG1, WSAG2, …,WSAGi…, WSAGn
WSAGi determine which web method of WSi to invoke according to the received RefineReq parameters.
If WSAGi can solve RefineReq
It will return ResWSi to InfoAG.
Else
Return NULL.
End If
FinResult←FinResult+ ResWSi.
End For
End While
End

6. Selecting the most appropriate Web Method

Selecting the most suitable web method is the special duty of Web Service Agents

(WSAGs). There will be more than one web methods are resided in one WSDL with various parameter types and values. For example, WSDL of Hospital1 possesses searchByDoctorName(String DoctorName) method. The return type is Class Hospital1DoctorSchedule Array.

To accomplish it, every WSAG requires three main components. The first is Input Data Format File (IDFF) to learn the input parameter contained in the message sent by InformationAgent. The second is Web Methods Description File (WMDF) which states what web methods possess how much parameter passing values, describes what that values type are (String, Integer, etc),describes the return type and states their purpose. The mappings between IDFF and WMDF are described in Mapping Parameter and Methods File (MPMF) in which what web methods should be called according to the received parameter values are stated. In IDFF, there are 5 input field: DoctorName(String), Disease(String), Day(String), StartTime(Integer), EndTime(Integer). These 5 input type format and received message parameters have to perform miss or match value checking. If the received message contains only one parameter that is for DoctorName field, the related web method must be with one String parameter passing type. So, according to the predefined rules and knowledge in MPMF, WSAG decides the method "searchByDoctorName(String DoctorName) to be called.

7. Implementation and Testing

We implemented this proposed system based on J2EE and JADE platforms. We used apache tomcat server, axis for web development and MySQL database. The system has run on 5 machines and host OS are Ubuntu 12.04 LTS because of its private cloud building facilities. One machine is for main MAAS cloud server and others are represented as nodes in the same cluster. Fig. 2 represents the MAAS (Metal-As-A-Service) main cloud server api opened by browser. There are total of 4 nodes in this MAAS. Each cloud node status, FQDN and MAC are described in Fig 3. Fig. 4 is the sample Search Page for Medical IR Multi-Agent System. Users can find their desired doctors' schedule by name, by doctor's specialized field (eg. Cardiologist), by Day (eg. Tuesday,..), by Time (eg. 11 am to 8 pm). Users can search by using at least one criteria or all .The example searching result will be in the form of Table 1.

Fig 2. Cloud Main Page

Fig 3. Cloud Nodes Status and Descriptions

Fig 4. Information Search Page

Table 1 Sample Testing Result

Name	Specialist Field	Hospital	Day	From	To
Prof. Dr. Cho Lay Mar	Cardiologist	Bahosi	Tuesday	1 PM	3PM
Dr. Ni Ni Win	Cardiologist	Asia Royal	Tuesday	5PM	7 PM

8. Evaluating performance result

In the proposed Medical IR Multi-Agent system, there are three main agent types: Interface Agent, Information Agent and Web Service Agents. The number of Web Service Agents depends on the number of WSDLs they must handle in the system. So, the more WSDLs exist, the more WSAgents the system require and the more complex the system will be. Therefore, more time will be consuming. But according to our testing, the processing time difference between increasing WSAgents usage and increasing retrieving data size (datasets) is quite small and is acceptable.

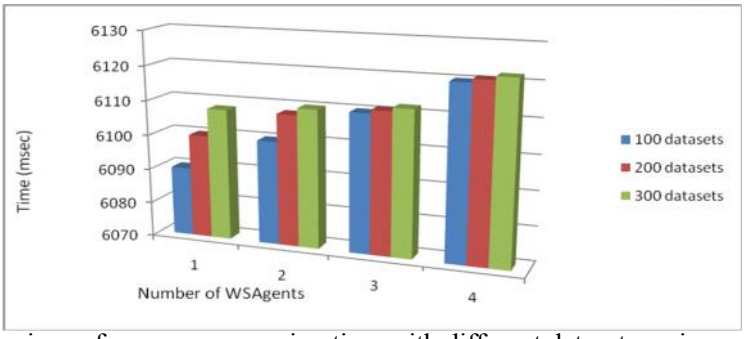

Fig 4.Comparison of average processing time with different datasets on increasing WSAgents

Conclusion

A Web Services Based Medical IR Multi-Agent System for Cloud Environment is proposed. Efficiently composed cloud Web Services using multi-agents features can give new form for cloud wide information retrieval systems. The proposed system will become an intelligent way for searching or retrieving information from Cloud environment. By implementing the propose system, it can give a good hand for the public to get the desired specialists' schedule completely and perfectly at one sitting and can make the right choice with their current situations. Moreover, this framework can be applied in other domain area efficiently.

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