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WEB BASED SERVICE FOR OPTIMIZING MEDICAL DATA USING MULTI-AGENT

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ABSTRACT

One of the most important issues in e-healthcare information systems is to optimize the medical data quality extracted from distributed and heterogeneous environments, which can extremely improve diagnostic and treatment decision making. Our project proposes a multi-agent web service framework based on service-oriented architecture for the optimization of medical data quality in the e-healthcare information system. Based on the design of the multi-agent web service framework, an Evolutionary Algorithm (EA) for the dynamic optimization of the medical data quality is proposed.

The framework consists of two main components; first, an EA will be used to dynamically optimize the composition of medical processes into optimal task sequence according to specific quality attributes. Second, a multi-agent framework will be proposed to discover, monitor, and report any inconstancy between the optimized task sequence and the actual medical records. To integrate heterogeneous healthcare information systems and to support healthcare organization decision making, this project presented a multi-agent framework based on SOA architecture for healthcare information systems.

KEYWORDS: Evolutionary Algorithm (EA), Healthcare Information Systems

I. INTRODUCTION

It was reported that between 44000 and 98000 deaths occur annually as a consequence of medical errors within American hospitals alone, and the U.S. National Association of Boards of Pharmacy reports that as many as 7000 deaths occur in the U.S. each year because of incorrect prescriptions. The World Health Organization (WHO) reported in the article Medical Error in Top Ten Killers: WHO that unintended medical errors are a big threat to patient safety. Therefore, there is a great desire to improve access to new healthcare methods, and the challenge of delivering healthcare becomes significant nowadays. In an attempt to meet these great demands, health care systems have increasingly looked at deploying information technology to scale resources, to reduce queues, to avoid errors, and to provide modern treatments into remote communities[1].

In dynamic optimization of medical data quality, the information regarding suitable medical data service components needs to be acquired from many medical data service providers whose components are registered in a UDDI registry repository. The next step is to negotiate with different medical data service providers in order to integrate suitable medical data components.

The optimization of medical data selection is successful when multi objectives set by a medical data service requester are met such as reliability of medical data components, results of diagnosis, and cycles of consultation. To improve the medical data quality, the medical task sequence or workflow needs to be optimized; in our paper, we are proposing a unique evolutionary algorithm (EA). EAs have been applied as the searching algorithms to search for optimal solutions to combinatorial problems. “Survival of the fittest” is a principle in the natural environment which is used in the searching algorithm to generate survivors, the optimal solutions, for a given problem[8].

To establish the basis of the evolutionary computing (EC) field, several studies were reviewed. The principles of the EC theory are based on Darwin's theory of natural selection to solve real-world problems. EAs have been successfully applied in optimizing the solutions for a variety of domains. The strength of EC techniques comes from the stochastic strategy of search operators. The major components in EC are search operators acting on a population of chromosomes. EC was developed to solve complex problems, which were not easy to solve by existing algorithms [4].

This project aims to apply the SOA of web service concepts specified previously to put forward a model of multiple intelligent agents (IAs) based assistance in improvement of medical data quality in the distributed e-healthcare information system environment, which is able to optimize the medical task sequence according to data quality aspects. Furthermore, to improve accuracy of doctors' diagnostics, many methods for medical diagnostic and treatment advice systems have been developed to assist medical doctors in decision making such as rule-based reasoning, fuzzy inference, neural network, etc[6].

Few researchers in current literature used web services and SOA technology to improve medical data quality. On the other hand, many researchers tried to optimize quality of service (QOS) attributes for web services composition. However, none of the researchers tried to improve medical data quality by optimizing the medical task sequence rather than optimizing the service components, which support doctors' decision making in this section [2]

II. OBJECTIVES OF THE STUDY

- Authentication
- User Interaction
- Data Extraction
- Data processing
- Data analysis

III. SYSTEM ARCHITECTURE

One of the most important concerns of this study is the medical data selection for quality improvement over a distributed e-healthcare information environment. The foundation of satisfying data quality over the distributed medical data environment compiles the analysis and construction of medical data service task sequence, the automation of composing/optimizing suitable medical data components, and medical data component reusability. To satisfy the data quality criteria, we proposed a framework in figure where we integrated an IA, a medical data repository section, and several modules into the SOA. EAs have been applied as the searching algorithms to search the optimal medical data in the distributed e-healthcare information environment as specified in figure1 and for optimal composition of web services [3].

Here, we use SOA with a grid overlay to offer distributed health-related services to hospitals. Part of this system calls for remotely tracking the health status of patients, so we designed and implemented a sensor and actuator framework to provide intelligent remote monitoring (the "Further Reading" sidebar lists sources for the details).We also developed a semantic service for exchanging information between sensors, providers, and the framework. This service uses two description languages to define monitoring resources and the interaction between data and service users and the framework [7].

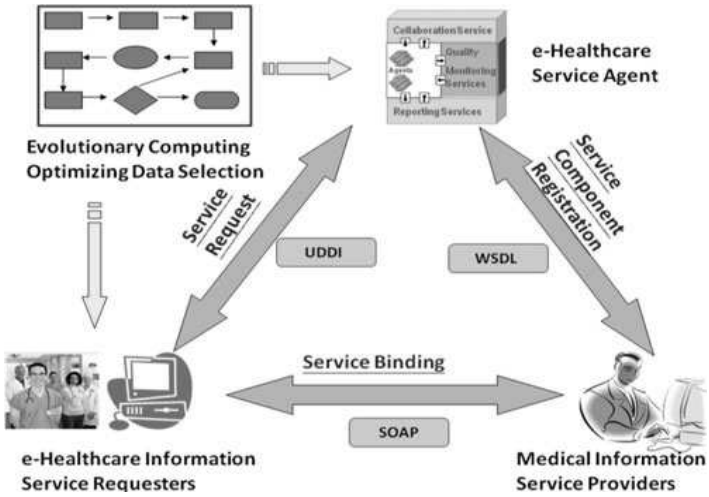
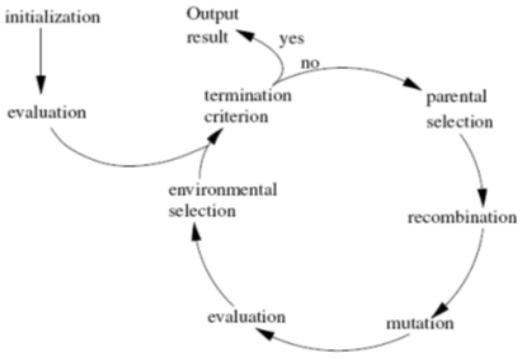


Figure 1: Optimizing Medical Data Quality Frame Work in a Distributed Medical Data Environment

IV. MODULES DESCRIPTIONS

Evolutionary Algorithm

This section outlines a general generic evolutionary algorithm and, very briefly, presents the four major paradigms, namely genetic algorithms, evolution strategies, evolutionary programming, and genetic programming. Figure shows the general evolutionary cycle which is the generic basis for all evolutionary algorithms (EA). The fundamental idea of evolutionary computing is the mimicry of natural evolution: an initial multi-set of candidate solutions undergoes a process of simulated evolution. That means that candidate solutions are able to reproduce themselves and are subject to an additional selection pressure. Following the biological terminology, a candidate solution is referred to as individual and a multi-set (or a tuple) of individuals is called a population. Usually populations in EAs are of a fixed size contrary to the varying population sizes in nature, where changes in the population size are one means of direct response to changing environmental conditions.



Schematic description of the generation loop in evolutionary algorithms.

Figure 2: Evolutionary Algorithm

In the evolutionary cycle in Figure 2 parental and environmental selection, recombination, and mutation are clearly biologically inspired components where the initialization, the direct evaluation of individuals, and the termination criteria are additional elements, necessary for the use of evolution as an optimization method. The components are discussed in more detail in the next paragraphs. One pass through the evolutionary cycle is called a generation. In the initialization a first population of individuals is created. Usually, those individuals are chosen at random – under certain circumstances also concrete individuals, e.g. known good candidate solutions, are included in the initial population.

Since individuals in simulated evolution do not live in a real environment struggling for survival, the quality function of the optimization problem replaces the interaction of individuals with the environment: it establishes a means of comparison of individuals to guide the evolutionary search process. In the context of evolutionary optimization we refer to the quality of an individual as fitness[8].

Patient Monitoring System

A remote EHMS would monitor a patient's condition by, for example, taking a blood pressure reading and relaying that information, as necessary, to hospitals or e-health applications. Such an approach would free hospital personnel from routine checks and visits, allowing them to concentrate scarce resources on more difficult tasks. This would provide wider access to hospital and healthcare services, including rapid access to specialist care. To best serve this scenario, we propose a grid computing overlay to support this EHMS. Merging a grid overlay with services requires several components, as Figure 3 shows. The EHMS consists of several modules: a monitoring system, a health monitoring system, autonomic and alert services, a grid overlay, and hospital or e-health applications.

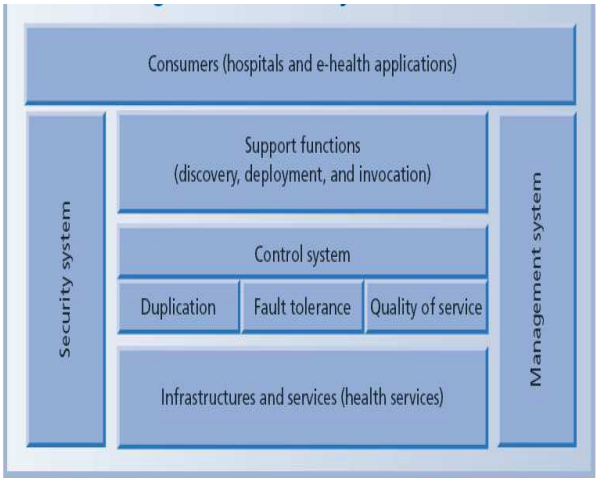


Figure 3: Patient E-Health Monitoring System

V. CONCLUSIONS

To integrate heterogeneous healthcare information systems and to support healthcare organization decision making, this paper presented a multi agent framework based on SOA architecture for healthcare information systems. This study starts with creating static and dynamic models for medical data quality in terms of data extraction so that the domain of objects and processes is defined. The open design of healthcare IAs follows the definitions from the medical data quality models. The design of the IA enables the IA to provide external communication for collaborative service, internal inference shells for monitoring and tracking of the data extraction process, and a printing report service. To solve the problem of data selection and quality optimization in a distributed e-healthcare environment, an evolution computing algorithm was integrated into the SOA of web service.

In the SOA, the healthcare IA also plays a major role as the service agent in medical data registration and data requesting services. This multi agent framework has been developed using JESS and JADE. The system will be practically deployed and integrated with e-healthcare information systems for our local hospitals. The experimental results show that the proposed EA was able to optimize the medical data workflow on a medical experimental data for breast cancer case study. The results proved that the algorithm is able to function accurately and efficiently on multi domains with multi objectives QOS attributes. Furthermore, a comparison between the proposed fitness function and penalty fitness function

has been proposed. The results show that the proposed algorithm was able to find the optimal solution in fewer generations which means better performance. In this study, we have focused on medical data extraction for the SOA-based healthcare systems [7].

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