Computers and Electrical Engineering 68 (2018) 204–214

Contents lists available at ScienceDirect

Computers and Electrical Engineering

journal homepage: www.elsevier.com/locate/compeleceng

Process mining-based medical program evolution☆

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ARTICLE INFO

Keywords:
Medical path
Process mining
Medical cloud
Evolution

ABSTRACT

Medical path of disease varies due to the changes in external factors, and the key to the changes is the decision-making in symptomatic treatment by medical experts; how to make full use of historical medical data and recommend high quality treatment options to new cases under the current circumstance of data explosion, is the research focus of this paper. This paper first presents the standard for medical path based on cloud platform, going into the construction of workflow-based flow model of medical services; finally, a process mining algorithm based on medical evolution factor is given to realize the evolution of online medical program of a disease.

1. Introduction

Medical program is the treatment models and treatment procedures established for a disease following the empirical data of contemporary medicine and the clinical experience of doctors. Based on consideration for overall situation of health care, it is individualized, data dispersed and relatively regular. Large mounts of medical data are stored in the subsystems of each hospital, and the data format is not uniform. In the cloud computing framework, how to make full use of these data is the hot spot concerned by people [1].

In recent years, service composition has been gradually applied to data management for medical program. Service composition is the technology which reuses the atomic services that exist in the system as components. It selects specific services from the existing services and combine them into a new service flow, so that to meet the needs of users and adapt to the changing environment. A multi-agent system is used as the solution for Collaborative Services [2–4], constructing unified ontology interpretation within the system to achieve service composition through the interaction between management agent and individual agent, as well as between multiple individual agents; another approach is to extend the definition of original workflow to adapt it to the dynamic, distributed and loosely coupled services.

The team currently active in process mining is the Information Systems Group under the Department of Technology Management at Eindhoven University of the Netherlands. Under the leadership of internationally renowned scholar Alast, they have actively cooperated with internationally renowned universities and conducted solid research and practice in the field of process mining with good results [5]. The team proposed an algorithm called α based on workflow network behavior reasoning, which proved to be able to successfully discover a reasonable workflow network when the log is complete [6] . They also proposed using the timestamp attribute of the event in the log to discover the performance information of the process [7].

At the University of Calabria, Italy, Greco et al. focus on the mining of a hierarchical tree of process models that describe the event log at different levels of abstraction. The root node is the most common model that contains the common characteristics of all process instances in the log. Leaf nodes represent the process model that divides the log. The nodes between the root node and the leaf node

☆ Reviews processed and recommended for publication to the Editor-in-Chief by Associate Editor Dr. Huimin Lu.

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https://doi.org/10.1016/j.compeleceng.2018.03.051
Received 16 August 2017; Received in revised form 28 March 2018; Accepted 28 March 2018

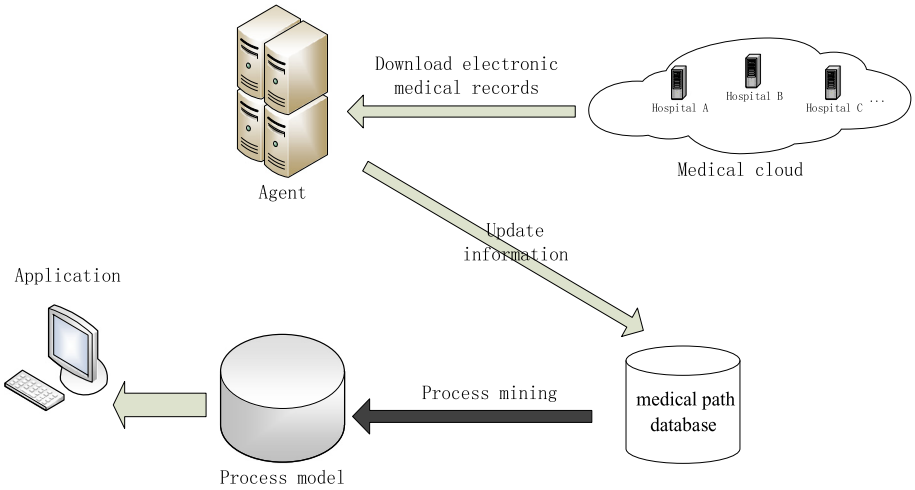

Fig. 1. Medical service flow evolution based on process mining.

exhibit the common features of the nodes in the next layer [8].

Li Jiafei, School of Computer Science and Technology, Jilin University propsed a heuristic rule-based algorithm for mining repetitive tasks. This algorithm can find limited repetitive tasks from the event log [9]. Liang from CIMS Institute of Xi'an Jiaotong University proposed a quality management process improvement plan based on workflow process mining to meet the continuous improvement of quality management system [10]. Mao from Fudan University School of Software proposed a mining method based on direct dependence matrix, and extended the directed graph to express the final workflow model [11].

Advances in computer vision and artificial intelligence enable the analysis of wound images by big data and cloud computing. Big data is popular information and communication technologies paradigms. The big data-based approaches can be combined for directing the next generation of eHealth systems [12]. Machine learning and artificial intelligence are excellent at extracting a particular pattern. However, the results of machine learning are easy to misuse. Current artificial intelligence technology depends on large-scale data and can obtain results using only numerical values, but it does not have the association function like the human brain [13].

At present, the medical log is only used to record individual medical procedures and fails to guide them. In particular, the medical log is particularly pale under the continuous advancement of automated medical check-up and automated medical services. The research on the integration and utilization of service portfolio and medical path is also relatively shallow.

In Fig. 1, through the cloud computing model, this paper defines the medical service flow based on definition of the standard for medical path, devoting to construct the initiative evolution of the medical program for disease in medical cloud. In this paper, the evaluation factors such as health distance and medical cost are proposed for the first time, and the key regions in the service flow are divided, merged and replaced so as to evolve the service flow, minimize and avoid the arbitrariness of the treatment process and improve the quality of medical services.

The organization of the paper is as follows:

In Section 2, a unified medical path standard and elaborates dependencies in flow log which is the basis for recreating the medical path during running period are described. The medical service flow model is constructed in Section 3. QoS model for medical service flow and four evaluation factors such as health distance and medical cost are proposed in Section 4. In Section 5, I use formulas to normalize the above four measures service flow evolution and divide the service flow evolution into several methods, such as replacement, split and merge. The paper would be summarized in the last section.

2. Standards for medical path

Currently, a patient's medical path is dispersed in various subsystems of the hospital, such as: the patient's electronic medical record, the patient's hospitalization record, and so on. Based on the cloud platform system, in order to achieve data sharing, a unified path standard must be defined in its structure. The system needs to be manually or semi-manually organized into a medical path that can be shared among machines [14]. A part of medical log should look like Table 1. Therefore, it is necessary to advance the development of standards for medical path.

In combination with the needs of evolution mentioned in later context, it is defined as follows:

Definition 1. - Medical Path: real-time recording of the global information for the whole medical process of a disease, as well as the running of sub-service instances. Global information includes patient's name, date of hospitalization and postoperative evaluation; sub-service information includes serial number of the service instance (case_id), name of service (service_name), work order of the service in the instance (case_order), time of beginning (begin_time), time of ending (end_time) and cost of the service (service_cost). As the communications between various medical sub-services, as well as between service and flow Management Agent [15] are all conducted through XES documents, the format for XES document of Serviceflow_log is defined as follows: