Computational Diagnostics: A Novel Approach to Viewing Medical Data

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Abstract

A transition from traditional paper-based medical records to electronic health records is underway. The resulting massive amounts of electronic patient records offer tremendous potential to personalize patient diagnosis and treatment. In this paper, we discuss a computational diagnostics tool that uses digital medical records to help physicians gain better insight about a patient's medical condition. The paper details different interactive features of the tool and discusses the tool's potential in the practice of evidence-based medicine and for advancing patient diagnosis practices.

Keywords - Information Visualization, Computational Diagnosis, Electronic Health Record System

1. Introduction

Over the years, advanced medical research has led to a better understanding of different medical conditions. This knowledge is used to design improved diagnosis and treatment solutions for patients. However, traditional paper-based medical record systems make it hard or impossible to fully utilize existing knowledge and patient records for patient diagnosis [1, 2]. Hence, there is a movement towards electronic health records (EHR) that store patient medical records in digital format [2, 3]. Yet, making sense of individual or multiple EHR is challenging. Attempts have been made to replicate the original medical sheet design on the computer screen; to show the medical history of a patient in a graphical time-series format [4, 5]; and to augment EHR with 2D/3D images from imaging devices [6]. These approaches fail to take advantage of an EHR being much more than just an 'electronic view' of a paper record or an index into a collection of images from imaging devices.

In this paper, we present a 'Computational Diagnostics Tool' (CDT) that supports clinical decision making by providing context and details of EHRs together with the means to aggregate over multiple EHRs. The tool was partially inspired by a matrix visualization discussed in [7].

Specifically, the CDT provides two complementary views of medical data that are highly interactive. Physicians can load in or select a set of patients, examine their medical and clinical conditions, compare the values for one patient with all other patients, and request details. The tool helps answer questions such as: What patients show the worst values for a given set of variables? What patterns are seen in the medical variables of patients undergoing the same treatment? From a clinical dataset, what patient population has severity values for different variables? Do a selected group of patients share similar trends across different variables of interest? Do two patient groups share similar trends across different variables? How do trends and patterns for selected patients compare?

The paper is organized as follows: Section 2 describes the medical dataset used and the insight needs of physicians. Section 3 details the general architecture of the computational diagnostic tool together with the interactive visualizations it provides. Section 4 demonstrates the utility of multiple coordinated views in data analysis. The paper concludes with discussion of results and future work.

2. Details of the Medical Dataset

The sample dataset used in this study was compiled and provided by Dr. Susan Ragg, Julie Hayden, and Jada Pane, of Indiana University, Indianapolis. It consists of medical records of patients diagnosed with acute lymphoblastic leukemia (ALL). The medical dataset includes EHRs for 81 patients. Each record comprises values for 19 different medical variables that were retrieved from different data