Perspective Wall Technique for Visualizing and Interpreting Medical Data

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ABSTRACT

Increasing the improvement of confidence and comprehensibility of medical data as well as the possibility of using the human capacities in medical pattern recognition is a significant interest for the coming years. In this context, we have created a visual knowledge discovery from databases application. It has been developed to efficiently and accurately understand a large collection of fixed and temporal patients’ data in the Intensive Care Unit in order to prevent the nosocomial infection occurrence. It is based on data visualization technique which is the perspective wall. Its application is a good example of the usefulness of data visualization techniques in the medical domain.

Keywords: Data Visualization, Knowledge Discovery from Databases, Nosocomial Infection, Perspective Wall, Temporal Data

1. INTRODUCTION

Most of the medical data have a temporal dimension. Data visualization deals with this dimension and helps the user to comprehend large sets of complex data.

The field of data visualization as a research topic has been growing exponentially since the 1980s thanks to more and more powerful personal computers (Wong & Bergeron, 1997). It is based on various research topics (Ward et al., 2010). According to Kapusova (2004), it combines aspects of scientific visualization, human-computer interfaces, data mining, imaging and graphics. For Fekete (2005), the data visualization distinguishes three related areas: Human-computer interaction, statistical analysis and mapping, and scientific visualization.

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The goal of data visualization is to exploit the natural perceptual skills of the user to understand the information. Works in visual perception have shown that human beings have a first global perception of a scene, and then the attention turns to details. This feature is the basis for many visual illusions. The work of Tufte (1983) and Bertin (1977) showed how to use intuitively or ad hoc, these characteristics of global perception.

Our research work concerns the mining of a large amount of linear medical data in the intensive care unit of Habib Bourguiba Teaching Hospital (HBTH) in Sfax, Tunisia. The data mining system is developed to help the physicians, who are the current users of the system to understand, predict and prevent nosocomial infections (NI).

For this reason, we propose to use a visualization technique in order to help the user to get and understand information efficiently and to involve him/her in the data mining process thanks to his/her perception possibilities in order to make decisions.

Information visualization of large amounts of time-oriented data is essential for effective decision making. Many efforts have been dedicated to create effective visualizations of the information. An example is the classic series of books by Edward Tufte on methods to display information (Tufte, 1983; Tufte, 1990; Tufte, 1997).

In our context, each patient has two kinds of data to mine: fixed and temporal. The birth date, the date of entry, ... are fixed data. The results of a medical analysis, medical acts given to the patient, ... are temporal data. The quantity of the temporal data is very significant in the intensive care unit and its representation is more difficult than that of the fixed data. In fact, various approaches have been proposed for visualizing temporal data (Müller & Schumann, 2003; Ltifi et al., 2009). Among these techniques, we have chosen the perspective wall (MacKinlay et al., 1991). It is a 3D technique well suited for visualizing large amounts of information arranged chronologically. It is intuitive and easy to use and to learn (Ltifi et al., 2009).

This paper is organized into five sections. In Section 2, we present our theoretical background. In Section 3, we address our visualization context. In Section 4, we present the visualization technique used in our context. In Section 5, we demonstrate the development of the chosen technique. Finally, we discuss and evaluate the visualization tool then we present our conclusions and our future research perspectives.

2. THEORETICAL BACKGROUND

Traditional decision-support tools (e.g., OLAP, Info-center, dashboard, ERP) leave the initiative for the users to choose the elements that they want to observe or analyze. In Knowledge Discovery in Databases (KDD) (Fayyad et al., 1996; Hand & Mannila, 2001), the system often takes the initiative to discover the connections between the data elements. It is then possible, to a certain extent, to predict the future based on the past. The goal of the KDD is to be able to extract data elements, in other words, knowledge. We can also say that we try to “[extract] new, useful, and valid knowledge from a mass of data” (Fayyad et al., 1996).

The KDD is an interactive and iterative process which proceeds according to a succession of stages; the results can thus be refined by repeating several times these stages under the control of an analyst. The various stages of the KDD process are as follows (cf. Figure 1): (1) set the problem by determining the objectives, defining the targets and checking the needs, (2) research data (to identify information and sources, to check their quality as well as their accessibility), (3) select data having a relationship with the analysis requested in the base, (4) clean data in order to correct their inaccuracies or errors, (5) transform data in a format which prepares them to mining (transform dates into durations, etc), (6) mine data, application of one or more techniques (neuronal networks, Bayesians networks, decision tree, etc.) to extract interesting patterns, (7) evaluate the
Mining of Medical Trends Using Social Networks
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