Chapter 2
Interactive Data Visualization to Understand Data Better:
Case Studies in Healthcare System

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ABSTRACT

This paper focuses on interactive data visualization techniques and their applications in healthcare systems. Interactive data visualization is a collection of techniques translating data from its numeric format to graphic presentation dynamically for easy understanding and visual impact. Compared to conventional static data visualization techniques, interactive data visualization techniques allow users to self-explore the entire data set by instant slice and dice, quick switching among multiple data sources. Adjustable granularity of interactive data visualization allows for both detailed micro information and aggregated macro information displayed in a single chart. Animated transition adds extra visual impact that describes how system transits from one state to another. When applied to healthcare system, interactive visualization techniques are useful in areas such as information integration, flow or trajectory presentation and location related visualization, etc. In this paper, three case studies are shared to illustrate how interactive data visualization techniques are applied to various aspects of healthcare systems. The first case study shows a pathway visualization representing longitudinal disease progression of a patient cohort. The second case study shows a dashboard profiling different patient cohorts from multiple perspectives. The third case study shows an interactive map illustrating patient geographical distribution at adjustable granularity. All three case studies illustrate that interactive data visualization techniques help quick information access, fast knowledge sharing and better decision making in healthcare system.

1. BACKGROUND

Data visualization is a collection of techniques translating data from its numeric format to graphic presentation for easy understanding and visual impact. It is all about presenting various types of data in graphical forms for more effective information communication (Cairo, 2013). The history of data visualization can be traced back to 2nd century AD (Few & Perceptual, 2007). Most development of data visualization came along with the development of statistical graphics in the 19th century (Tufte, 2001). William Playfair, the founder of statistical graphics, invented fundamental diagrams including line chart, bar chart and pie chart (Heyde et al., 2013). Almost all types of modern forms of data visualization tools were invented during that period: scatterplot, histogram, contour plot, time series plot and geographical map (Friendly, 2008; Friendly & Daniel, 2008), etc. There are numerous data visualization tools in the current market. Microsoft Excel (Microsoft Excel, 2015) is extensively used for data analysis and visualization and PowerPivot (PowerPivot, 2015) is a powerful add-on enhancing Excel's capabilities significantly. Most statistics packages such as SAS (SAS, 2015), SPSS (SPSS, 2015), STATA (Stata, 2015) and R (R project, 2015) have comprehensive built-in data visualization functions.

With the surging development of computer and web technologies, interactive data visualization surfaced and is evolving rapidly. Similarly, interactive data visualization is a collection of techniques translating data from its numeric format to graphic presentation *dynamically* for easy understanding and visual impact. It gains more popularity as it provides more flexibility and visual impact over traditional static counterpart (Ward, Grinstein, Keim, & more, 2010). Many specialized tools focused on interactive visualization have emerged in recent years. Some popular commercial packages include Tableau (Tableau, 2015), SiSense Prism (Sisense, 2015), Spotfire (Spotfire, 2015), FusionCharts (Fusioncharts, 2015). All of them provide flexible and user friendly solution for interactive data visualization. Besides above mentioned commercial software or packages, there are many free/open source alternatives. They provide same quality of solutions and flexible options of sharing and deployment. Many open source tools are built upon standard web techniques such as HTML, Javascript, SVG and CSS. For instance, D3.js (D3.js, 2015) is a Javascript library for data visualization. It provides a framework to realize sophisticated and highly interactive data visualization solutions and supports almost all kinds of charts from traditional bar chart, scatter plot to heatmap, treemap, geographical information system (GIS) maps. D3.js accepts generic data formats such as csv, tsv or json as inputs and publishes the results in format of HTML pages, which can be accessed by web browsers without additional requirements. Such flexibility makes it possible to deploy the results developed by D3.js anywhere without incurring extra costs. Other than above mentioned packages or library, there are also online data visualization API provided by big companies such as Google Charts (Google Charts, 2015) and Many Eyes (Many Eyes, 2015). Both websites provide one stop solution from data import to publication and provide various visualizations types.

Data visualization is used everywhere within a modern hospital ranging from monitor system tracking detailed operational parameters to annual executive reports summarizing aggregated performance indicators of whole organization. With development of IT infrastructure, healthcare decision makers have easier accesses to all types of patient, operations-related raw data. However, it also comes with challenges regarding data handling and analysis. Large data volume is a big problem. Data volume accumulated over past years is huge and is growing at faster rate. New sources of information are collected and existing sources of information are collected at finer granularity. Meanwhile, information variety increases significantly due to multiple categories of information co-existing in same system, e.g., re-

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