Chapter 65
Visual Analytics for Crime Analysis and Decision Support

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ABSTRACT

Today, the amount of digital data increases exponentially due to the rapid growth of the Internet, mobile, and sensory data. Crime data are arriving from multiple sources and formats. The major challenge for crime analysis is to store, manipulate, manage, and analyze data efficiently. To gain useful insight from a great amount of raw data, visual analytics techniques have been drawn attention to law enforcement agencies and researchers. The visual analytics applications do not erase the need for crime analysts' insight. To make better predictions and smarter decisions, data mining, text mining, information visualization, human-computer interaction, and analytics techniques are important to explore. This book chapter provides an overview of different types of crime data, discusses how to analyze and visualize different types of data, and explores popular visualization toolkits that have been used for crime analysis.

INTRODUCTION

Motivation

A massive volume of structured and unstructured data posts great challenges on data processing, search, analysis, and visualization. Crime data such as crime reports and criminal information are digitized and stored for later use. However, raw crime data have limited value in itself. Data mining and information visualization techniques enable users to explore data and hidden patterns and relationships, and use interactive graphical tools to gain an understanding of data by highlighting, comparing information and

even revealing patterns, trends, and outliers (Heer, Bostock, & Ogievetsky, 2010; Purchase, Andrienko, Jankun-Kelly, & Ward, 2008). More recently, the term visual analytics (Stone, 2009) has been emphasized to analyze extremely large volumes of data to gain insight and facilitate decision making. Graphical presentation requires careful selection of colors, sizes, positions, and typography to avoid graphical distortion and inadequate presentation (Stone, 2009). Today, human-computer interaction (HCI) attracts considerable attention to better understand human's requirements and perceptions and to enhance design of visual interfaces. Basic design techniques such as zoom, filter, and details-on-demand are prevalent approaches for effective visual displays.

Objective

This chapter explores visual analytics for crime analysis; in particular, how information visualization can be used to display different types of crime data and support decision making. The sections present various visual representations that have been used to reveal the meaning of crime data.

The emphasis is on reviewing data analysis techniques and toolkits for visualization that can be used for crime analysis and on introducing a variety of graphical representations such as force-directed layout, histogram, arc diagram (Heer et al., 2010), network visualization (Didimo, Liotta, & Montecchiani, 2014), heatmap visualization, tag clouds (Wang et al., 2012), and GIS-based solutions that can be used to create effective crime data visualizations.

The review of visual analytics for crime analysis follows the framework shown in Figure 1. Visualization tools that have been used in the analysis of crime data allows four types of data analysis: statistical, textual, multimedia, and spatio-temporal. The four types of data analysis are discussed in this chapter along with example cases where these have been used and the toolkits that support these analyses.

The toolkits that can be used for crime analysis include for example the toolkits D3 (M. Bostock, Ogievetsky, & Heer, 2011) and Visualization Toolkit (Heer et al., 2010). These toolkits have been studied and used frequently to visualize datasets. The review of current research studies shows that tools have been used in combination to further extend the analysis of datasets. However, these combination requires extra effort and time to import and export data from one tool to another. A more desirable solution is to use platforms that offer added capabilities – the one that combines data mining algorithms with visualizations techniques.

In this chapter, the authors explore the following questions:

- How visual analytics can be used to facilitate crime analysis and gain insights of crime data?
- What types of visual graphics have been used to visualize the various types of crime data?
- What open-source and proprietary tools and toolkits have been used for crime analysis and information visualization?

The outline of this chapter is the following. Visual analytics and information visualization is first introduced. A classification of crime data analysis is then provided: statistical data analysis, textual data analysis, multimedia data analysis, and spatio-temporal data analysis. After discussing four types of data analysis, visualization tools including popular open-source and proprietary toolkits are examined. Next, the combined solutions such as an integration of data mining and information visualization are discussed. Last, principles of human computer interaction (HCI) and human perception that should guide the creation of visualizations are emphasized.

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