Visual Analytics to Support Medical Decision-Making Process

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Abstract. Massive and complex data impose a challenge on the medical community. This study explores the use of Visual Analytics in a collaborative Paired and Group Analytics sessions to enable medical professionals to efficiently explore complex data to synthesize valuable information and make informed decisions about dynamic medical events and situations. Based on the conducted Analytics sessions, Visual Analytics facilitated stakeholders’ collaborative data exploratory analysis process and enabled stakeholders to generate insights, build knowledge and potentially decide on critical medical situations.

Keywords. Visual Analytics, Paired Analytics, Group Analytics, Decision-making.

Introduction

Advanced technologies enable the production and collection of massive amount of complex and multidimensional medical data. The medical community is faced with the challenge of synthesizing valuable information from these complex and dynamic data to make informed decisions. Visual Analytics exploits humans’ visual capabilities to amplify their perceptual skills to facilitate the analysis of massive data. Visual Analytics (VA) defined as the “science of analytical reasoning facilitated by interactive visual interface” [6], enables medical professionals to visually explore large databases in order to expedite data analysis, accelerate knowledge translation and dissemination as well as support decision-making. Visual Analytics offers medical professionals interactive and intuitive visualization tools and techniques to amplify their cognitive skills and enhance their initial understanding of massive data [4].

In this study, we exploited Visual Analytics in Paired and Group Analytics sessions to enable stakeholders to collaboratively and productively build knowledge and make informed decisions. Previous studies addressed social aspects of Visual Analytics. Heer et al. argued that social interactions contribute to the perceptual and cognitive process and improve the data analytical process [3]. Other research presented a framework for Visual Analytics multiple-analysts collaboration to conduct exploratory data analysis through interactive visual displays. To supplement previous research on the impact of collaboration for the advancement of Visual Analytics and the way analysts collaboratively explore data visualizations, synthesize information and build knowledge, this paper examines how Paired and Group Analytics fosters collaboration to improve exploratory data analysis and support decision-making.

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1. Data and Methods

We used Mortality and Morbidity injury indicators data in British Columbia, Canada to create the visualizations using Tableau Software. The injury data are segmented into categories including patients’ injury types, gender, socioeconomic status as well as geographic locations. Multiple visualizations were created and integrated together to build an Interactive Visual Analytics Dashboard. The created VA Dashboard is a comprehensive visual representations of the most relevant information required for stakeholders to reach specific goals [2]. It encompasses multiple Visual Analytics displays (Bar Chart, Stacked Bar Chart, Geospatial, Temporal visualizations) to efficiently depict the injury data [Fig.1]. The Dashboard provides stakeholders with advanced visualization techniques applying Shneiderman’s Visual Information Seeking Mantra: overviews first, zoom and filter, then details on demand [5].

![Figure 1. Interactive Visual Analytics Dashboard.](image)

We adopted Paired Analytics and Group Analytics Methodologies. During the Analytics sessions, a Subject Matter Expert (SME) collaboratively worked with visualization Tool Expert (TE), either one-on-one or in a group setting, to solve an analytical problem using the visualization tool [1]. SME are stakeholders from diverse backgrounds including injury practitioners, researchers, epidemiologists and medical policy makers. After the Analytics sessions, stakeholders were asked to complete a questionnaire about the VA Dashboard’s perceived usefulness and its potential to help stakeholders generate insights and build knowledge to support decision-making.

2. Results

We compiled the feedback data and analyzed them using JMP Software. Compiled feedback proves that stakeholders perceived the visualizations to be useful (average rating = 6.3/7, Std Dev = 0.65) and time saving (average rating = 5.6/7, Std Dev = 1.2). The three graphs in Fig 2 show a graphical summary of the computed trend lines and illustrate the strong correlations between variables. These empirical results suggest that there are strong and significant associations between stakeholders’ data overview and getting insights into relevant information about the injury data (r= 0.6, p <=0.02), stakeholders’ data exploration and generating knowledge about injury situations (r = 0.6, p<=0.01) and finally between stakeholders’ perceived knowledge construction and making informed decisions and initiating appropriate actions(r= 0.6, p <= 0.02).
The collaborative Analytics sessions promoted an engaging and cooperative environment. While the Paired Analytics served to address stakeholder’s individual preferences and needs to explore specific injury data, build essential knowledge and strengthen their personal perspectives, Group Analytics enabled stakeholders to pool their expertise and fuse various perspectives and scenarios about the injury situations to collaboratively explore and accurately analyze the data.

3. Discussion

Visual Analytics proved to be powerful in helping medical stakeholders reveal valuable information about massive injury data and construct fundamental knowledge. It offered stakeholders advanced visualization techniques such as zooming and filtering, details on demand and brushing and linking capabilities to enhance their cognitive and perceptual skills and allow them to competently understand the injury data. The empirical results showed that there are strong correlations between variables, which emphasized existing associations between exploring and understanding data and the ability to get insights, generate knowledge and make informed decisions.

Collaborative Visual Analytics should be incorporated into the medical community to enable medical researchers and analysts with limited time to explore multidimensional and complex medical data, synthesize valuable information and generate decisive knowledge that is critical to initiate appropriate actions. These empirical results provide insightful approaches for future work related to collaborative Visual Analytics and its implications for the medical community to help medical professionals and researchers optimize the decision-making process.

References