"Show Me Data." Observational Study of a Conversational Interface in Visual Data Exploration

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ABSTRACT

Visual data exploration poses challenges for 'InfoVis Novices'. A 'conversational interface' which would enable users to generate and interact with visualizations through natural language and gestures, while maintaining a history of the data exploration, has the potential to ameliorate many of these challenges. We performed an exploratory, observational study designed to examine the role of such a conversational interface in visual data exploration. We simulated a conversational interface, using a remote human mediator, with multiple cycles of visualization construction. We believe analysis of this data will yield concrete design goals for conversational interfaces in information visualization.

1 INTRODUCTION

Visual data exploration can be challenging to those not trained in visualization construction, but it is an increasingly necessary skill in most fields requiring data analysis. In response, applications have been created to help 'InfoVis novices' generate visualizations of data, such as Tableau and ManyEyes [8]. However, even with the aid of robust visualization software, such users may face challenges when attempting to translate their questions into appropriate visual encodings, or interactively refining the representation to achieve a desired result. [3] and [4] have noted visualization construction challenges for InfoVis novices, including selecting an inappropriate template for the desired task and mapping selected data attributes to visual encodings. Natural language has the potential to address these visualization construction errors, by allowing a user to directly ask questions about their data or specify the desired task through speech. With such an interface, InfoVis novices would be able to focus on higher-order tasks, such as hypothesis generation and question formulation, without the cognitive burden of translating questions into concrete representations through a graphical interface. Our own early work on this approach in [7] presents promising results and suggests that this direction of development is valuable. However, in practice visual data exploration is a process that involves repeated cycles of question formulation, visualization construction and interaction. This process may involve reasoning across many visualizations, generated over the course of an exploratory session, and may involve references to prior observations and insights [2]. Managing this process presents a challenge for users above and beyond the challenges of constructing discrete visualizations. A 'conversational interface' which maintains a dialog with an InfoVis novice through natural language and gestures in visual data exploration and stores the complete history of the analysis has the potential to ameliorate such difficulties. [1] demonstrated the power of using interaction behavior histories of a user to aid in visual data exploration. Since natural language allows users to interact in ways that also directly specify their intention, it is likely that similar advantages could be noted in a conversational interface. In this work, we will present the findings from an exploratory observational study designed to examine the role of such a conversational interface in visual data exploration. To perform this study, we simulated a conversational interface, through a human mediator, with multiple cycles of visualization, construction interaction and interpretation. We believe analysis of this data will yield concrete design goals for conversational interfaces in information visualization.

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2 METHODOLOGY

2.1 Study design

We conducted an observational, exploratory study to observe the interaction between a subject and a remote data analysis expert (DAE) who assists the subject in an exploratory data analysis task: analyze crime data from 2010-2014 to provide suggestions as to how to deploy police officers in 4 neighborhoods in the city of Chicago. Subjects were not exposed to a visual interface for visualization construction, but were instructed to ask question directly to the DAE that they deemed relevant to the performance of their data analysis task. The subjects were given no resistrictions with regard to communication and were encouraged to think-aloud as they viewed visualization responses and formulated new questions. Users had access to data and the problem description, and viewed visualizations and communications from the DAE on a large, tiled-display wall. This environment allowed analysis across many visualizations at once, including visualizations developed to address questions at earlier phases on the data analysis session. The DAE, shown in figure 2, worked out of an adjacent room and viewed the subject through two high-resolution, direct video feeds, one showing the full display from behind and one showing the subject's face and gestures. The setup is pictured in figure 3. The DAE also had a mirrored copy of the tiled-display wall on two 4K displays. Sage2 [5], a collaborative large-display middleware, was used to drive the display wall, as it allowed the remote DAE to quickly push and position new visualizations to the user, as well as communicate through an on-screen chat-box and a 'status bar' showing pre-programmed messages indicating the DAE status. The DAE generated responses

to questions using Tableau. When a user indicated that they were finished with a visualization, the DAE would move it to the side for later access as needed.

Figure 1: A subject examining a series of bar charts depicting Chicago crime data in an observational, exploratory user study of conversational interfaces to enable visual data exploration.

Figure 2: DAE creates and pushes visualizations and responses to subjects from an adjacent room. Mirrored large display wall on two 4K displays, with two video feeds of subject allows DAE to monitor subject gestures, movements and facial expressions, as well as view the content on the wall at high resolution.

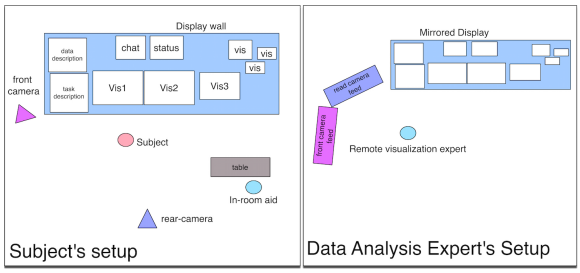

Figure 3: Illustration of the setup for the data analysis expert (DAE) and the subject.

2.2 Participants

4 Pilot studies were conducted to refine the experimental design. 15 subjects, 8 male and 7 female, between ages 18 and 34 participated in the study for between 45min-1.5 hrs. Participants had varied experience with visualization and data analysis, with most expressing moderate familiarity with information visualization.

2.3 Data Analysis

A team of 3 coders is analyzing video recordings as well as complete transcripts from the data analysis session and follow-up interview. The coding approach involves multiple passes across the transcripts, identification of relevant themes and iterative refinement of codes.

3 Initial Findings

Initial coding had yielded a set of broad categories to group related conversational elements in the dialog between subject and DAE. First, we are dividing the speech elements of the subject into 'actionable' and 'non-actionable' communications. 'Actionable' communications are ones where a direct response is expected from the system, and include questions or commands for new visualizations (eg. "Can I see number of crimes by day of the week?"), window management instructions (eg. "Can we bring these to the center?" "Can you minimize this?"), requests for clarification (eg. "Is this just showing 2014?", "What does this plot show?"), social interaction with an expected response (eg. "What's your name?"). Non-actionable communications include statements indicating the user's intention or goal (eg. "I want to identify the places with violent crimes."), noting observations and insights, thinking aloud or expressing preferences (eg. "I like these charts"). Within actionable communications concerning the desire for new visualizations or changes within a visualization, we are isolating commands to explore a new question through a new visual encoding from 'interaction' commands, and then categorizing the interaction commands in terms of the interaction task typology in [9]. One of our major goals is to understand how non-actionable communications can enhance the responses to actionable communications, since some non-actionable communication conveys indirect requests [6]. We have noted several instances of 'task and visualization query mismatch', where the user indicates tasks during think-aloud portions of data analysis that do not match the task expressed in the question to the system.

We are currently annotating transcripts and videos with the codes we devised to develop models of how conversational interfaces support visual data analysis for InfoVis novices.

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