The Final Oral Examination
for the Degree of
DOCTOR OF PHILOSOPHY
(Computer Science)

Narges Mahyar
2008 University of Malaya MSc
1998 Azad University of Tehran BSc

“Supporting Sensemaking during Collocated Collaborative Visual Analytics”

Thursday, September 4, 2014
2:00 p.m.
Engineering/Computer Science Building, room 468

Supervisory Committee:
Dr. Melanie Tory, Department of Computer Science, UVic (Supervisor)
Dr. Margaret-Anne Storey, Department of Computer Science (Department Member)
Dr. Adel Guitouni, Peter B. Gustavson School of Business, UVic (Outside Member)

External Examiner:
Dr. Jeff Heer, Computer Science and Engineering, University of Washington

Chair of Oral Examination:
Dr. Janelle Jenstad, Department of English, UVic
Abstract

Sensemaking (i.e. the process of deriving meaning from complex information to make decisions) is often cited as an important and challenging activity for collaborative technology. A key element to the success of collaborative sensemaking is effective coordination and communication within the team. It requires team members to divide the task load, communicate findings and discuss the results. Sensemaking is a part of the human activities involved in visual analytics (i.e. the science of analytical reasoning facilitated by interactive visual interfaces). The inherent complexity of the sensemaking process imposes many challenges for designers.

Therefore, providing effective tool support for collaborative sensemaking is a multifaceted and complex problem. Such tools should provide support for visualization as well as communication and coordination. Analysts need to organize their findings, hypotheses, and evidence, share that information with their collaborators, and coordinate work activities amongst members of the team. Sharing externalizations (i.e. recorded information such as notes) could increase awareness and assist team members to better communicate and coordinate their work activities. However, we currently know very little about how to provide tool support for this sort of sharing.

This thesis is structured around three major phases. It consists of a series of studies to better understand collaborative Visual Analytics (VA) processes and challenges, and empirically evaluates design ideas for supporting collaborative sensemaking. I investigate how collaborative sensemaking can be supported during visual analytics by a small team of collocated analysts. In the first phase of this research, I conducted an observational study to better understand the process of sensemaking during collaborative visual analytics as well as identifying challenges and further requirements. This study enabled me to develop a deeper understanding of the collocated collaborative visual analytics process and activities involved. I found that record-keeping plays a critical role in the overall process of collaborative visual analytics. Recordkeeping involves recording material for later use, ranging from data about the visual analysis processes and visualization states to notes and annotations that externalize user insights, findings, and hypotheses. Based on my observations, I proposed a characterization of activities during collaborative visual analytics that encompasses record-keeping as one of the main activities. In addition, I characterized notes according to their content, scope, and usage, and described how they fit into a process of collaborative data analysis. Then, I derived guidelines to improve the design of record-keeping functionality for collocated collaborative visual analytics tools. One of the main design implications of my observational study was to integrate record-keeping functionality into a collaborative visual analytics tool. In order to examine how this feature should be integrated with current VA tools, in the second phase of this research, I designed, developed and evaluated a tool, CoSpaces (Collaborative Spaces), tailor-made for collocated collaborative data analysis on large interactive surfaces. Based on the result of a user study with this tool, I characterized users’ actions on visual record-keeping as well as their key intentions for each action. In addition, I proposed further design guidelines such as providing various views of recorded material, showing manually saved rather than automatically saved items by
default, enabling people to review collaborators' work unobtrusively, and automatically recommending items related to a user's analytical task.

In the third phase, I explored how automatic discovery and linking of common work can be employed within a "collaborative thinking space" (i.e. a space to enable analysts to record and organize findings, evidence, and hypotheses, also facilitate the process of sharing findings amongst collaborators), to facilitate synchronous collaborative sensemaking activities in visual analytics. The main goal of this phase was to provide an environment for analysts to record, organize, share and connect externalizations. I expected that this would increase awareness among team members and in turn would enhance communication and coordination of activities. I designed, implemented and evaluated a new tool, CLIP (Collaborative Intelligence Pad), that extends earlier thinking spaces by integrating new features that reveal relationships between collaborators' findings. Comparing CLIP versus a baseline tool demonstrated that linking collaborators' work led to significant improvement in analytical outcomes at a collaborative intelligence task. Groups using CLIP were also able to more effectively coordinate their work, and held more discussion of their findings and hypotheses. Based on this study, I proposed design guidelines collaborative VA tools.

In summary, I contribute an understanding for how analysts use VA tools during collocated collaboration. Through a series of observational user studies, I investigated how we can better support this complex process. More specifically, I empirically studied recording and sharing of analytical results. To this end, I implemented and evaluated two systems to be able to understand the effects of these tools on collaboration mechanics. These user studies along with various literature surveys on each specific topic resulted in a collection of guidelines for supporting and sharing externalizations. In addition, I proposed and evaluated several mechanisms to increase awareness among team members, resulting in more effective coordination and communication during the collaborative sensemaking process.

**Awards, Scholarships, Fellowships**

2014  Best paper award, Visual Analytics Science and Technology (IEEE VAST)
2014  Best Research Note Honourable Mention, Graphics, Animation and New Media (GRAND) 2014
2008–2012  ARC North America Fellowship
2011  Women in Development Award

**Presentations**


Publications


