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Pairgrams: Understanding Collaborative Analysis Behavior with Visualization

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ABSTRACT

We report on our work towards understanding analytic reasoning processes in face-to-face collaborative analysis using visualization techniques. How analysts reason is an active topic of research and in our community we know even less about how a group forms an understanding, insight, and reasons about data. We report on our effort in capturing the richness of reasoning activities through mixed-method approaches and show how Pairgrams—a visualization of interactions with an analytics workspace by pairs of participants—helped us to understand collaborative analysis and reasoning.

Author Keywords

Collaborative visual analytics, analytic provenance

INTRODUCTION

Collaborative reasoning is a complex and subtle process that is difficult to analyze with statistical methods. In collaborative reasoning activities, we not only have to understand how each individual arrives at meaning, insight, and what this insight entails; we also have to understand how the collaboration influences this process. Deriving a better understanding of collaborative reasoning activities is critical if we want to build better data analysis tools which support not only taskwork but also better teamwork around visual analytics tasks. We need tools that will help us understand both how individuals reasoned, but also how their reasoning processes influence each others' work. In this paper we report on a visualization tool, Pairgrams, which we designed to help us answer the following main questions: what were the temporal processes of search and analysis activities of two analysts sharing a workspace and how did their analysis activities build on each other.

COLLABORATIVE ANALYSIS SCENARIO

Pairgrams were developed as part of the analysis of a user study on collaborative visual analytics [3]. In this user study 15 pairs of analysts solved the VAST 2006 challenge [1]. They used Cambiera [2], a collaborative visual analytics tool, and searched for and read the contests' documents on a Microsoft Surface multi-touch tabletop display. From the perspective of this research, Cambiera is much like a query interface: users search for documents, and then read the documents that they find. In the VAST challenge some documents are helpful to solving the analytics task as "key" documents; others are "distracters." It is interesting to understand when team members found critical documents and how this information influenced the team's solution to the task. To understand the collaborative analysis behaviors of team members in this study, we collected a wealth of data including field notes from direct observation, video+audio data, and system logs. The Pairgram visualization was developed to form a better understanding of search and analysis activities and was used in conjunction to a two-pass video- and audio-coding in which the analysis activities were further categorized [3].

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PAIRGRAMS

Pairgrams were designed to help us visually understand log files in the context of observational data. We specifically analyzed the patterns of reading and searching in the process of the collaborative analysis. Observational data alone was not sufficient to understand which documents participants searched for, read, and passed to each other. Yet, the log file data alone did not provide sufficient context to understand the questions that teams were attempting to solve at any given moment. For example, during the study, some users read documents two or three times and passed documents to each other; the log files did not provide us with details of whether participants were re-visiting a hypothesis, verifying data, or asking a partner for help. We wanted a visualization that would help us understand participants' behaviors, would let us tease them apart, and help us understand the ways that pairs worked together on their tasks. The design was influenced by several major criteria. We wanted Pairgrams to help us see:

- temporal trends of document search and read activities
- distinguishable encodings of each person's activities
- repeated actions—were documents re-read and searches re-issued and when?
- which documents and keywords were successful in finding key documents, rather than distracters?

As the Cambiera study covered pairs of people working together, Pairgrams are meant to visualize two users, working together. We refer to these two users as Bob and Gina.

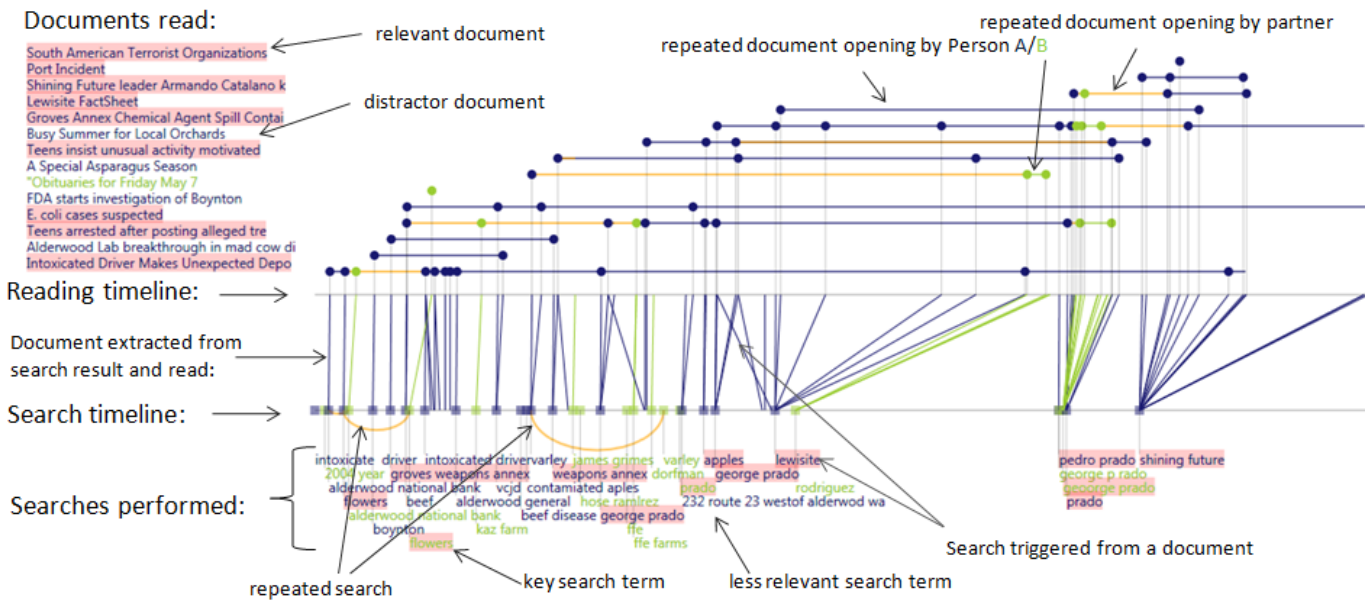

Figure 1: Pairgram of one group in our study. The top timeline indicates reading activities, the bottom search activities. Blue and green color indicate activities of Participant A and B; orange lines indicate repeated activities.

READING PAIRGRAMS

Pairgrams (Figure 1) are drawn over two parallel timelines. The bottom timeline encodes search activities and the top document reading activities. Three main colors distinguish between activities by Bob in Blue, Gina in Green, and activities which have been performed by both Bob and Gina in orange. We can see that Bob did many more searches (blue) than Gina (green), indicating that the team members had different search and analysis strategies; we confirmed this through the video analysis. Bob also used many key search terms which are highlighted in red indicating that the he was mostly on the right track to solving the problem while Gina was following a different hypothesis and only later converged with Bob. We also see that the pair only opened five distracter documents—key documents are highlighted in red—and that they re-visited the first document (bottom) many times over the study.

Thus, Pairgrams provides an overview of which searches participants performed at which moment in time and which documents they opened. It further shows which documents have already been read and by whom. By highlighting key searches and documents, we can see whether and when participants were able to identify the key documents in the search results; we can use the timeline to link this to the video to see how they used those insights. Futhermore, Pairgrams provides an overview of the pairs' different approaches to solving the task. For example, some groups searched only infrequently but browsed documents very thoroughly while others used many search terms and only quickly glanced at the search results. Furthermore, patterns of collaboration were visible. We could see participants taking on roles and when sharing of documents and validation processes occurred.

PAIRGRAMS USAGE

Pairgrams are a specialized tool, built to analyze user study data. They were invaluable in forming initial hypotheses about the reasoning activities of each group, which were later confirmed in the videos. They also help link the interaction of the participants with the workspace to the communication and gesturing above the table, which could not be captured with logging activities. In addition, they were invaluable to compare the activities of different groups and how different strategies manifested in different search and reading behavior. Furthermore, they served as a visible memory aids for us when documenting the results of the study.

LIMITATIONS

Pairgrams are limited in several ways. Most critically, they can only allow an analyst to see data that has actually been logged. After the first analyses we found that we could not properly track documents which were opened once and left in an opened state in the workspace. We did not log reading behavior (e. g., scrolling) and hence could not visually capture when an opened document was re-accessed after periods of inactivity. Logging and then encoding additional data visually for analytic provenance would have benefited our analysis. In the workshop, we are interested in discussing how to overcome these limitations and how to build extended and generalizable visualization tools for team analytic provenance.

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