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# Comparing Usage Patterns of Domain Experts and Novices in Visual Analytical Tasks

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## Abstract

Our research focuses on the use of visual analysis tools. In this paper, we examine the differences between expert and novice financial analysts using a visual analytics tool. Our formal study involving 10 experts and 10 novices indicates there are significant differences in usage patterns between the two groups that potentially impact the design of tools to aid in analysis and sensemaking.

## Keywords

User studies, evaluation

## ACM Classification Keywords

H5.m. Information interfaces and presentation (e.g., HCI): Miscellaneous.

## Introduction

We are exploring the use of visual analysis tools, focusing on several key questions. What are analyst's strategies and behaviors when using interactive visual tools for sensemaking activities [6]? How do analysts report the results of these activities [7]? How can we assist the capturing of an analyst's strategies, methods, and findings to support the documentation and

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communication of knowledge and decisions [3]? We have recently performed several user studies towards these questions, all conducted using a financial analysis visualization. In this paper, we present preliminary observations of our most recent focus, examining the differences in behavior between financial experts and novices in doing analysis using our visualization.

Understanding the differences between expert and novice users has been a research subject for years. For example, J. Nielsen has compared novice evaluators and specialists in finding usability problems through heuristic evaluation [2]. Quantitative results prove that specialists are much better than novices at discovering usability problems. Others have focused on the differences in expertise related to a specific application. For example, Hurst et al. propose that classifiers could detect whether a user is an expert or a novice in adapting to an interface [8].

However, our focus is on the impact of domain expertise on behavior and use of a tool, not expertise with the tool itself. Instead of assigning users specific tasks, our study focuses on analyzing the effect of expertise on performing more explorative and complex analytical tasks. As a result, the specialty does not only affect the actual methods used to solve a problem, but also influences the forming of high-level strategies before taking any actions.

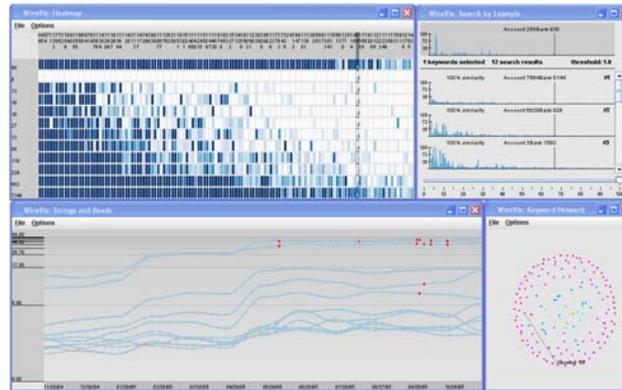
We have an additional concern, in that while our visual tools are designed for experts, obtaining expert users' valuable time for user studies is difficult and sometimes not possible. Therefore, in many research environments, graduate students who lack the domain knowledge are often used as substitutes. Thus, we also

want to understand how novices impact the use of a tool, the results of a study, and the overall design of our analytical tools.

In this paper, we report preliminary results of our user study involving 10 financial analysis experts and 10 students using a financial analytics tool WireVis [1] to discover suspicious wire transactions. We find differences between the two groups of users every step along the study. In the beginning of the study, the expert users required little training time; during the study, the experts tended to spend more time and effort in examining detailed information; and finally, at the end of the study, the experts were able to remember their strategies more clearly and described them with more confidence and accuracy. We discuss the results of our study and their implications on designing sensemaking tools.

### **WireVis Interactions**

We conducted our study with a particular visual analytics tool for investigating financial fraud called WireVis that logged all high-level (semantic) user interactions. We also developed two additional tools for visualizing user interactions within WireVis to help us explore the analyst's activities and reasoning process at both the operational and strategic levels [3]. WireVis is a hierarchical, interactive visual analytics tool with multiple coordinated views [1]. It was developed jointly with wire analysts at Bank of America for discovering suspicious wire transactions. It is currently installed at Bank of America's wire monitoring group, WireWatch, for beta testing. Although it has not been officially deployed, WireVis has already shown capabilities in revealing aspects of wire activities that analysts were not previously capable of analyzing.



**Figure 1.** Overview of WireVis. It consists of four views including a Heatmap view (top left), a time series view (bottom left), a Search by Example view (top right), and a keyword Relation view (bottom right).

Through a multi-view approach, WireVis depicts the relationship among accounts, time and transaction keywords within wire transactions (see Figure 1).

### Evaluation

We conducted a qualitative, observational study of two groups of subjects analyzing wire transactions with WireVis. The goal of the experiment was to understand the user's behaviors and strategies as she interacted with the visualization while performing fraud detection analysis. The "expert" group comprised 10 financial analysts with an average of 9.9 years of financial analysis experience while the "novice" group consisted of 10 graduate students with visual analytics background.

At the beginning of the study, the novice users were trained on the concept of wire fraud for about 5 minutes. And then both novice users and experts were

trained on the use of WireVis for approximately 10 minutes. Following the training, the novices were provided hints as to what kinds of patterns they might investigate in the analysis. Then both groups of users were asked to spend 20 minutes using WireVis to look through the dataset to find suspicious activities. We also asked the participants to think-aloud to reveal their strategies. After the exploration using WireVis, a post-session interview was conducted for the participant to describe his experience and additional findings.

Several methods were used to capture each participant's session as thoroughly as possible. Commercial usability software was used to capture the screen. A separate microphone was used to record the user's audio during the session. Lastly, functions built into the WireVis system captured the user's interaction with the tool itself in terms of semantic information relevant only to the WireVis system. Instead of recording every mouse movement or keystroke, WireVis captures events that generate a visual change in the system. For example, a mouse movement that results in highlighting a keyword in the Heatmap view will generate a time-stamped event noting that the user has highlighted a specific keyword.

### Transcribing

The video and think-aloud of each participant was used to create a detailed textual timeline of what each participant did during their session, along with their reasoning and thinking process. This transcript thus contains the "ground truth" of what each participant did during analysis with WireVis.

### **Difference between novices and experts**

Based on our detailed transcripts, we were able to discover a large number of differences between the two groups of users. Here we present 3 major differences chronologically according to the way our user study was conducted.

At the beginning of the study, after all training had been completed, the financial experts always jumped right into the search based on their domain expertise and without hesitation, demonstrating curiosity and eagerness to explore. The novice users usually started by asking questions about financial analysis or eliciting hints from the observer on how to proceed. The contrast is obvious yet interesting. Since both groups of users were all at the beginning of their reasoning processes, they needed to utilize past experience to formulate plans of actions [4]. The experts, with a great deal of experience, were able to formulate their strategies immediately. As quoted from one of our expert user: "I am assigned to specific locations and media at work, so I will first look at transactions related to keywords 'Brazil' and 'Cars & Parts' ". In contrast, novices required more guidance and assurance due to the lack of domain expertise.

During the user study, the experts interacted more slowly with WireVis than novices. Experts spent a great deal of time examining account and transaction details. Instead of relying solely on the visual representations of the data, they drew from their knowledge on financial analysis and looked more closely at the underlying data. Their analysis processes were therefore much slower, but deeper than the novices. However, by combining the use of the visualization and the close inspection of data, the experts were able to

make more decisions on whether the examined transactions were suspicious. On the other hand, we observed that novices were only able to determine the suspiciousness of transactions based on abnormal visual patterns, but could not make a more concrete decision when examining the actual transaction details.

As a result, in the post-session interviews, the novices revealed that they did not feel confident about their findings. "You kind of told me what I was supposed to look for, but I guess I just don't have the expertise." Subsequently, they did not have clear memories of their discoveries nor the strategies and methods utilized during the investigations. Even while they reviewed the (video and audio) recordings of their sessions, novices could not remember what they were trying to do or what their strategies were. In contrast, while most of the experts were not able to recall the low level methods they employed to get to the findings, they usually remembered what their high level strategies were throughout the study. Based on our analysis of the transcribed strategies, we discovered that most of the strategies used by the experts were based on their experience as financial analysts, thus the strategies or at least the cues of the strategies were in their long-term memory [6].

### **Discussion**

We have thus far presented just some highlights of the differences we observed; analysis is ongoing. We believe our results will have several interesting implications on investigating various aspects of user behaviors, memories, and mental models. The first finding in the amount of "hand-holding" necessary for novices to begin their investigations indicates that for such subjects, more time is needed in providing domain

knowledge. This affects not just the training time in the user study, but has implications on how the novices can be influenced by the tools they are using. We found that since novices were constantly seeking guidance and reassurance, it was possible that their actions and strategies can be inadvertently affected by the structure or the visualization, and feedback of the tool and other users (or observers in our case). Since the subjects were initializing their understanding of the fraud detection in general at this stage, we argue that adequate amount of “hand-holding” were needed to for the novices to build their mental models [5] of what suspicious activities might be.

Our second finding addresses the “quality” of the findings and discoveries during an investigation. Novices performed shallow investigations because they lacked the necessary knowledge to determine the suspiciousness of the discovered activities. The 20 minutes allocated for the investigation process was thus too long for these novices. We found that novices started to perform “random” explorations after they had exhausted the strategies that they learned during the training phase. For experts, however, 20 minutes were not enough for some to perform deeper and more complex investigations.

The last finding is on the accuracy of the memories of the investigations[7]. Since novices had poor memories of their strategies and the results of their investigations, the outcomes of the post-interviews were less meaningful. The novices therefore were less likely to produce accurate reports or communicate their findings. This tells us that in order to assist the novices in remembering their reasoning processes, additional tools should be in place to help annotate and document

their activities [6]. Such tools also apply to the experts as well: while experts had better recollection of their strategies, their memories were by no means perfect.

From the aforementioned three findings, we might be able to find a way to train novice users based on the difference we discovered on initializing the understanding of the task, building mental model to extract information from complex visualizations and the memory of investigations. Furthermore, due to the distinguishable differences in usage patterns, we suggest that highly explorative visual analytics tools like WireVis should have at least two different modes for experts and novices respectively so that different needs could be addressed.

## Conclusion

We are interested in general in the strategies and behaviors of users interacting with visual tools to aid in their analysis and sensemaking. Our research along these lines is ongoing, and investigating various aspects of user behaviors, memories, and mental models. In this paper we highlight preliminary observations regarding domain expert and novice behaviors. We believe these and other findings can have significant impact on the design of future tools supporting various aspects of sensemaking activities.

## References

- [1] R. Chang, M. Ghoniem, R. Kosara, W. Ribarsky, J. Yang, E. Suma, C. Ziemkiewicz, D. Kern, and A. Sudjianto. Wirevis: Visualization of categorical, time-varying data from financial transactions. In IEEE Symposium of Visual Analytics Science and Technology, pages 155–162. October 2007.

- [2] J. Nielsen, Finding usability problems through heuristic evaluation. Proceedings ACM CHI'92 Conference. Pages 373-380.
- [3] D. H. Jeong, W. Dou, F. Stukes, W. Ribarsky, H. R. Lipford, and R. Chang. Evaluating the relationship between user interaction and financial visual analysis. Visual Analytics Science and Technology. In IEEE Symposium of Visual Analytics Science and Technology, pages 83–90. October 2008.
- [4] H. Lam A Framework of Interaction Costs in Information Visualization. IEEE Transactions on Visualization and Computer Graphics, pages 1149-1172. 2008.
- [5] J. G. Trafton, S. S. Kirschenbaum, T. L. Tsui, R. T. Miyamoto, J. A. Ballas and P. D. Raymond.. Turning pictures into numbers: extracting and generating information from complex visualizations. In International Journal of Human Computer Studies, Vol 53, pages 827-850, 2000.
- [6] W. Dou, D. H. Jeong, F. Stukes, W. Ribarsky, H. R. Lipford, R. Chang. Recovering Reasoning Process From User Interactions. In submission.
- [7] F. Stukes, W. Dou, D. H. Jeong, R. Chang, H. R. Lipford. Visual Analysis – Recall vs. Reality. In submission.
- [8] A. Hurst, S. Hudson, J. Mankoff. Dynamic Detection of Novice vs. Skilled Use without a Task Model. In Proceeding of the SIGCHI Conference on Human Factors in Computing Systems, pages 271-280. 2007.