

## Visualization for Information Exploration and Analysis

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### Abstract

*Making sense of data becomes more challenging as the data grows larger and becomes more complex. If a picture truly can be worth a thousand words, then clever visualizations of data should hold promise in helping people with sense-making tasks. I firmly believe that visual representations of data can help people to better explore, analyze, and understand it, thus transforming the data into information. In this talk, I will explain how visualization and visual analytics help people make sense of data and I will provide many such examples. I also will describe my present research into visualization for investigative analysis. This project explores how visual analytics can help investigators examine a large document collection in order to discover embedded stories and narratives scattered across the documents in the collection.*

### 1. Visualization for Understanding

The amount of electronic data available to people continues to grow and grow. Berkeley's "How Much Information" project estimated that 5 exabytes ( $10^{18}$  bytes) of information was produced in 2002 [1]. International Data Corporation estimated the digital universe to be 281 exabytes in 2007 [2]. But taken in its raw form, data in the digital universe is just that: raw data (text and numbers) that may or may not be useful to people. Thus, the goal of researchers such as myself is to help people transform the raw data into *information* that carries meaning, that assists decision-making, and that generates knowledge and wisdom.

Computational techniques and tools already have been very useful in the process of transforming data into information. For instance, spreadsheets provide structure and order on data that help us to examine and think about the data better. Computational algorithms

for finding clusters and correlations in data provide us with useful meta-information about the characteristics of the data. Natural language parsing and understanding systems take raw text and extract useful features for further analysis. Data mining algorithms can identify specific data cases with particular characteristics that are difficult for us to determine in other ways.

My research focus, visualization, is another computational technique for transforming data into information. By visually depicting data in meaningful, expressive representations, we can translate it into a form that facilitates human exploration, analysis, and understanding.

The notion of visual imagery helping people to think is not new. Common clichés such as "Seeing is believing," "I see what you're saying," or "A picture's worth a thousand words" address this idea. More scientifically, visualization serves as an external cognition aid [3] and augments our memory as we perform cognitive operations [5].

But with other computational techniques and tools available, such as those mentioned earlier, when is visualization particularly useful? I believe that visual representations of data are particularly germane in situations involving unfamiliar data when a person is performing exploratory data analysis. In such situations, the person may not have a specific analytic goal in mind and may not have particular questions to be answered. Instead, the person is exploring the data, hoping to learn more about it and to discover "interesting" characteristics of the data. Throughout the exploration process, specific questions may arise and ideally the visualization will help to answer them, but the data analysis expedition likely did not initiate with all these questions in mind. Together with colleagues J.-D. Fekete, J. van Wijk, and C. North, I explore this "value of visualization" more fully in a recent book chapter [4].

In the academic community, the growing research areas of information visualization (infovis) and visual analytics address these very issues. Visual analytics augments ongoing infovis research on visual representations (and interactions) of data with studies of data transformations and analytical reasoning [9].

## 2. Investigative Analysis on Text

My recent research has focused on exploration and analysis of unstructured text document collections. Of the 281 exabytes of data estimated to exist by IDC in 2007, over 95% was said to be unstructured data [2]. Of course, much of this may be images, audio and multimedia, but an important percentage is likely text.

Together with my students at Georgia Tech, I have developed the Jigsaw system for assisting investigative analysis on text documents [7,8]. Jigsaw helps analysts with sense-making [6] activities, in particular, weaving together different chunks of information scattered across a variety of documents into a coherent story or narrative. Essentially, different documents will provide individual pieces of evidence that on their own may not be particularly illuminating. But when these individual pieces are considered together, they reveal a broader story and set of connected events. Such a capability could be useful for different types of analysts such as police investigators or news reporters.

Jigsaw provides multiple visualizations of the documents in a collection and the entities within the documents, such as people, places, organizations, phone numbers, etc. The system helps an investigator uncover and explore connections between entities across documents and it points the investigator to the documents to read next in a large collection. As such, it facilitates exploratory data analysis and sense-making activities on text documents.

## 3. References

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