Opportunities for Information Visualization

Information visualization has been an active research topic for more than a decade.[1] Products are starting to appear. This article discusses some of the research and commercial opportunities for information visualization over the next decade.

Visualization and presentation

Visualization is related to presentation, which has its roots in the work of William Playfair, an English political economist who in 1786 published the first known time-series.[2] Presentation is primarily about using visual representations to communicate. In 1967, the French cartographer Jacques Bertin emphasized that visual representations should also be used to think.[3] Visualization, in particular, is about using computer graphics to think about more cases, more variables, more relations. The goal is to think clearly, appropriately, with insight, and with conviction to act.

Unlike presentations, visualizations are typically interactive and animated. For example, Figure 1 shows a screen shot of the cone tree, a 3D visualization of hierarchical data.[4] Hierarchies have the problem that they generally grow wider faster than they grow deep, creating an awkward aspect ratio. The cone tree tames this ratio with 3D graphics and interactive animation. Although many nodes are occluded in the static image in Figure 1, interactive animation provides rapid access to those nodes and fosters a percept of them even when occluded.

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Information visualization

Visualization divides roughly into two areas, depending on whether physical data is involved. Scientific visualization, discussed elsewhere in this issue, focuses primarily on physical data such as the human body, the earth, molecules, and so on. Information visualization focuses on abstract, nonphysical data such as text, hierarchies, and statistical data.

The challenge for nonphysical data is designing a visual representation. One approach is to map the nonphysical data to a virtual object such as a cone tree, which can be manipulated as if it were a physical object. Another approach is to map the nonphysical data to the graphical properties of points, lines, and areas. For example, Figure 2 shows a tree map, a visualization invented by Ben Shneiderman for hierarchical data that subdivides a quantitative value.[5] In this case, the area of rectangles represents the capitalization of companies on the stock market.[6] Green (red) shows positive (negative) changes in price.

Visualization and computation

Computation creates content. Visualization has an opportunity to make computation and its content accessible to humans. For example, visual data mining uses visualization to augment data mining, which uses algorithms to find patterns in databases.[7] These algorithms are difficult for decision makers to use. Visualization can make the data and the patterns more accessible, allowing comparison and verification of results.[8] Visualization can also be used to steer the data mining algorithms.[9]

Human perception

The power of visualization to exploit human perception offers both a challenge and an opportunity. The challenge is that incorrect patterns can be perceived in visualizations, leading to incorrect decisions and actions. The opportunity is to use knowledge about human perception when designing visualizations. However, existing knowledge about human perception and presentation design is insufficient. Visualization creates a feedback loop between perceptual stimuli and the user's cognition. A hot topic for research in the coming decade will be characterizing this feedback loop, understanding the cognitive impact of visualization and the perceptual impact of cognition.

3D graphics

3D graphics offers a controversial opportunity for information visualization, even though it's often used for physical data in scientific visualization. Nonphysical data, such as the hierarchical data in Figures 1 and 2, can be shown in either 2D or 3D. Although 3D is visually exciting and provides an additional dimension for showing data, it often requires specialized graphics hardware. Furthermore, the perspective and texture mappings degrade font quality, which is often a key aspect of information visualization. However, the next decade will bring improved software graphics performance and high-resolution LCD displays that will make 3D more practical for information visualization.

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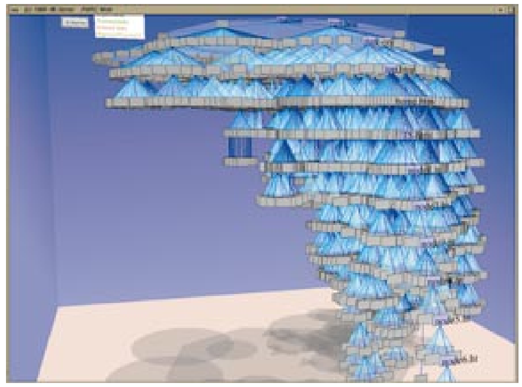
Visualization for e-commerce

Visualization has the potential to help e-commerce customers manage the overwhelming choices available on the Web. Consider eBay, which has thousands of pages describing auctions and commenting on the reliability of participants. The effort required to click and scroll through these pages makes comparison shopping difficult. Another example is any e-commerce site that provides a one-stop shopping service. Their success depends partially on giving the customer an unbiased impression of their product offerings. Visualization can be used in both of these examples to give potential customers a powerful tool for comparison shopping. Rapid interaction can lead to a confident consumer and hence a sale.

Integration

Over the past decade, research on information visualization has focused on developing specific visualization techniques.[10] An essential task for the next decade is to integrate these techniques into larger systems that support information work, which has three steps: (1) foraging for data, (2) thinking about data, and (3) acting on data. With attention to standards for connecting visualizations to databases, computation, and other visualizations, visualization can support all aspects of this process. Foraging can be supported by making databases visible. Thinking about data can be supported by choosing the appropriate visualization, which can be done in a specialized visualization called an information workspace.[10] Finally, actions can be supported by integrating visualizations into the user interfaces of applications.



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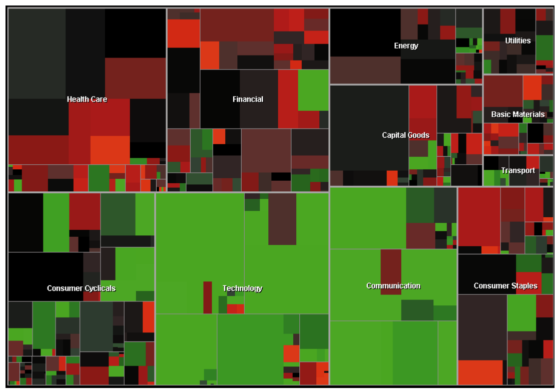
1 Cone tree of 10,000 pages from the PARC Web site.



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2 Market map, a tree map of market value.

Conclusion

The prospect for information visualization in the marketplace looks promising. However, external issues often make it difficult to time the movement of research to products. In particular, the Web has created a client-server model for disseminating information that works poorly for information visualization, which requires high-bandwidth access to data. Unfortunately, the market encourages user interface design to focus on the lowest common denominator, which currently doesn't include technology that could deliver information visualization products. Although these obstacles make the precise timing difficult to predict, advances in hardware over the coming decade will surely move information visualization from research to products. ■

Acknowledgments

I thank the following people for their helpful comments and suggestions: Polle Zellweger, Allison Woodruff, Ed Chi, Stuart Card, Ben Shneiderman, George Robertson, and Tamara Munzner.

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