Information Visualization

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The field of computer-based information visualization, or *infovis*, is about creating tools that exploit the human visual system to help people explore or explain data. Interacting with a carefully designed visual representation of data can help us form mental models that let us perform specific tasks more effectively.

Finding a spatial mapping for an abstract data set that's cognitively useful for a specific task is a considerable design challenge. Information visualization draws on ideas from several intellectual traditions, including computer graphics, human–computer interaction, cognitive psychology, semiotics, graphic design, cartography, and art. The synthesis of relevant ideas from these fields with new methodologies and techniques made possible by interactive computation has led to the emergence of the infovis field over the past several years.

Questions about visual encoding are even more central to information visualization than to the somewhat older field of scientific visualization. The subfield names grew out of an accident of history and have some slightly unfortunate connotations when juxtaposed: information visualization isn't unscientific, and scientific visualization isn't uninformative. Although not all of us agree on the distinction between the two, the definitions I'll use are that information visualization hinges on finding a spatial mapping of data that's not inherently spatial, whereas scientific visualization uses a spatial layout that's implicit in the data.

Many scientific data sets have naturally spatialized data as a substrate. For instance, airflow over an airplane wing is given as values of a 3D vector field sampled at regular intervals that provides an implicit 3D spatial structure. Scientific visualization would use the same 3D spatialization in a visual representation of the data set, perhaps by drawing small arrows at the spots where samples were taken, pointing in the direction of the fluid flow at that spot, with color coded according to velocity. Scientific visualization is often used as an augmentation of the human sensory system, by showing things that are on timescales too fast or slow for the eye to perceive, or structures much smaller or larger than human scale, or phenomena such as x-rays or infrared radiation that we can't directly sense.

In contrast, a typical information visualization data set would be a database of film information, with the title, length, year of production, and genre for each film. Such a data set is more abstract than the fluid flow example because there's no underlying spatial variable. One possible spatialization would be to show a 2D scatterplot with the year of production on one axis and the film length on the other, with the scatterplot dots colored according to genre.[1] This choice of spatialization is an explicit choice of visual metaphor by the visualization designer and is appropriate for some tasks but not for others.

Progress in the field

One of the major venues in this field is the IEEE Symposium on Information Visualization, which started in 1995. More information about the symposia, including the latest InfoVis2001, is available at http://www.infovis.org. A signpost of progress in the field is the publication of three major books, one in each of the past three years. The 1999 book *Readings in Information Visualization: Using Vision to Think* is a collection of seminal papers, which includes nearly 80 pages of overview and analysis written by the three editors.[2] In 2000, the text *Information Visualization: Perception for Design* appeared, with a heavy emphasis on the cognitive underpinnings of human perception and a considerable amount of prescriptive design advice.[2] The latest book in 2001, *Information Visualization*, provides a catalog of visualization techniques interwoven with analysis of the field's goals.[4]

In this issue

The four articles in this special issue chronicle recent developments in the infovis field. The authors describe visualization systems aimed at a wide range of application domains.

André Skupin presents a visualization system for document repositories using self-organizing maps. Although his data set of conference paper abstracts is nongeographic, cartographic principles inform his choice of spatial representations. Skupin uses hierarchical clustering to create scale-dependent spatializations that have information densities appropriate for a given level of abstraction.

Robert Kosara, Silvia Miksch, and Helwig Hauser present further results about semantic depth of field, a visual emphasis technique that was originally presented at InfoVis2001. They present several sample applications where they direct the user's attention to the relevant objects by blurring the currently irrelevant objects in the scene.

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Robert Erbacher, Kenneth Walker, and Deborah Frincke tackle the application domain of intrusion detection, providing a concise visual interface that lets system administrators inspect log files for evidence of machine misuse.

Ugur Dogrusoz and his colleagues from Tom Sawyer Software offer a look at the many applications of graph layout and interactive editing software. Tom Sawyer is one of the success stories of infovis: the company has been at the forefront of technology transfer from research in industry since its inception 10 years ago.

Future outlook

In the future, information visualization systems will become increasingly pervasive. Future processors' speed will no doubt continue to advance according to Moore's Law, but the amount of data to process will increase even faster. This explosion of data comes from many sources:

- processors with the ability to log events have become interwoven with the fabric of daily and business life;
- sensors that have become small, cheap, and networked; and
- the growing feasibility of simulation that allows the gathering of data about virtual rather than real-world events.

Data collection isn't an end of itself, but a means to the end of helping humans deal with the world. Computer-based visualization lets humans wend their way through these mountains of data, making decisions based on understanding. ■

References

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