Data visualization is a vibrant area of applied computer graphics. The aim is to enable people to get insight into large amounts of data through interactive, visual means. Research in this area accelerated about 20 years ago, when high-performance processing and fast graphics hardware became commonly available, and continues to develop rapidly.

One example of this was the 2010 IEEE Pacific Visualization Symposium, which took place in Taipei from 2 to 5 March. Although the conference is only in its third year, it has seen a strong increase in participation from researchers around the world. The conference received 84 high-quality submissions, 27 of which were accepted for publication. For this special issue, we feature articles based on four of those papers focusing on visual design and applications. These articles also cover a range of applications in scientific visualization, information visualization, and graph visualization, showing the field’s breadth.

In This Issue

Visualization plays an important role in not only analyzing features but also verifying underlying physical models and simulation codes. Model verification is particularly important when the underlying problem has multiple solutions and obtaining the ground truth is difficult. In “Verifying Scientific Simulations via Comparative and Quantitative Visualization,” James Ahrens and his colleagues present two such cases in cosmological and oceanographic simulations. They propose four-step verification: defining features, formulating a hypothesis, and performing qualitative and quantitative comparisons. They demonstrate that in both qualitative and quantitative analysis, visualization plays a central role. Although it has been commonly accepted that visualization is crucial in many computational-science disciplines, the concrete simulation-and-analysis workflow proposed here is particularly inspiring.

Realistic lighting is essential to the perception of 3D shapes. Computer graphics researchers have proposed many sophisticated illumination models to enhance synthesized images’ visual realism. Because of high computational cost, however, most direct volume-rendering techniques still employ simple local-lighting models that rely on local-gradient calculations. Unfortunately, not only is gradient approximation susceptible to noise, but local-lighting models also fail to include scattering and shadowing effects, which are important for making convincing pictures. In “Advanced Volume Illumination with Unconstrained Light Source Positioning,” Timo Ropinski and his colleagues present a physically plausible, yet efficient global-illumination model that can produce high-quality volume-rendering images at interactive rates. By “unconstrained light source positioning,” Ropinski and his colleagues mean that users can arbitrarily change light positions and see global-lighting effects in real time. The authors exploit modern GPUs and show how to implement the algorithm effectively. A user evaluation confirms the algorithm’s efficacy.

On the other hand, for visualizing abstract data, realism provides insufficient guidance; we must
devise creative visual encodings. The other two articles in this special issue concern information visualization, which addresses these problems.

Word clouds have become a popular way to give an overview of items of interest described textually. They can show what topics, products, and other items are hot, given a certain context. Another reason for their popularity is simply the fun factor: they provide playful, often intriguing images. Word clouds show up everywhere on the Web, but standard versions have limitations. Recent research has addressed optimizing the layout area and positioning words in a semantically meaningful way. Furthermore, during interactive exploration, users would like to see word clouds change smoothly and coherently. “Context-Preserving, Dynamic Word Cloud Visualization” addresses these issues. In that article, Weiwei Cui and his colleagues present a clever method to generate sequences of word clouds, in which related words stay close and changes are controlled. One use case they present is the interactive exploration of large document collections. A great example of their research is the visualization of the history of CG&A articles. It shows clearly that one particular topic has grown strongly in importance.

Networks are a classic topic in information visualization. One goal is to enable people to see clusters and other global structure in networks. An obstacle is that visualizing large networks is notoriously difficult. Simply projecting nodes to points on the plane, connected by links, yields cluttered diagrams that are difficult to read and don’t provide informative overviews. In “Visualizing Graphs and Clusters as Maps,” Emden Gansner and his colleagues propose a cartographic-map metaphor and describe an algorithmic framework to render graphs as maps. Their approach positions points, aggregates them into clusters, computes regions based on the clusters, and colors the regions. Gansner and his colleagues present several applications, including music, books, and economics. The resulting images are intriguing and invite further exploration and discovery.

Looking at the articles, we’re impressed by the breadth, usefulness, and creativity of the results. We hope you enjoy reading the articles and viewing the results as much as we did.

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Stephen North is the executive director of Information Visualization Research at AT&T. He’s interested in applied algorithms and software systems for visualizing and exploring large network datasets. North has a PhD in computer science from Princeton University. He has been technical-program cochair for the IEEE Information Visualization Symposium, the IEEE Pacific Visualization Symposium, and the International Graph Drawing Symposium. He’s one of the authors of the Graphviz system, which won an Apple Design Award, and is an AT&T Fellow. Contact him at north@research.att.com.

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Correction

The Projects in VR article “Experimental Platforms for Computational Photography,” by Marc Levoy (Sept./Oct. 2010, pp. 81–87), has an error on page 86. The sentence “Although this article emphasizes still photography, the computational photography community is also interested in video” should appear as the first sentence under the “Computational Video” section rather than where it’s currently placed in the “Grand Challenges” section. We apologize for this error.