

Perception-Based Visualization

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Course

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NOTES

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Summary

Visualization is an emerging discipline in its infancy. As such, it is based more on examples and anecdotes that are often detached from scientific theory. As researchers and practitioners address the increasing demands for visualization, they find the need to relate the theory to human perception. This is becoming perhaps *the major requirement* for producing effective, information-conveying visualizations.

This course introduces the foundations of perception as related to visualization, illustrates their usage with examples and case studies, and thereby prepares researchers and practitioners to develop perception-based visualizations and thus to improve their effectiveness. Engineers and scientists taking the class will learn how to create, build, and critique visualizations that take advantage of, and thus enhance, users' perception of the data.

Course Objectives

1. To teach visualization researchers and practitioners the basics of visual perception.
2. To tie this general perception understanding to the task of developing more effective visualizations.

Prerequisites

Basic understanding of computer graphics and imaging concepts.

Who Should Attend?

Visualization researchers, scientists, engineers, visualization systems developers, and users will learn the mechanisms of human perception and how they can improve visualizations.

Course Organizer and Instructors

Haim Levkowitz is an Assistant Professor of Computer Science and a founding faculty member of the *Institute for Visualization and Perception Research* at the University of Massachusetts Lowell, in Lowell, MA. Since 1982, he has been studying the mathematical and computer science aspects of multidimensional, multiparametric imaging and visualization. Since 1985, his research efforts have concentrated on the development of methods for multiparametric representation and presentation of information. He has developed new color methods for computer graphics representation of parameter distributions. He is the developer of the Generalized Lightness, Hue, and Saturation (GLHS) family of color models, the Linearized Optimal Color Scale (LOCS), and the Color Icon. He has also developed and implemented tools for automated psychometric evaluation of the developed display methods and has used these tools to conduct observer performance evaluations of some of his methods.

Dr. Levkowitz has presented or was co-author of papers on color and texture in graphics and visualization at the SPIE conferences in 1988, 1990, 1992, and 1993; the First Conference on Visualization in Biomedical Computing 1990; Electronic Imaging 1990; the Radiology Society of North America (RSNA 90); Visualization '91; ICCG '93; and the 46th IS&T meeting (Boston, May 93).

He chaired the Visualization '91 panel on color vs. black-and-white visualization, which was voted Best Panel. He was the organizer/instructor of courses and tutorials on color theory and models at Visualization '91, SIGGRAPH '92, Visualization '92, The First Eurographics Workshop/Symposium on Multimedia Distributed Systems (1994), and Visualization '94, as well as chair/instructor of the SIGGRAPH '94 course "Introduction to Perceptually-based Visualization." He is chair/instructor of the forthcoming SIGGRAPH '95 course "Perception-based Visualization," organizer/instructor of the forthcoming Eurographics '95 course "Color theory and modeling for computer graphics, visualization, and multimedia applications" (Maastricht, The Netherlands, August 1995), the forthcoming Visualization '95 course "Color theory and modeling for computer graphics, visualization, and multimedia applications" (Atlanta, October 95) and of the forthcoming Compugraphics/Edugraphics '95 course "Introduction to the Foundations of Vision, Color, and Perception-based Visualization" (Portugal, December 1995).

Dr. Levkowitz was video co-chair for Visualization '91; Registration Chair and on the conference organizational committee for Visualization '92; Workshop Co-chair for the 1992 Boston Workshop on Volume Visualization; program committee member and chair of the session on color and visualization at the 46th IS&T meeting (Boston, May 93); and tutorials co-chair for Visualization '93. He was co-chair of the IFIP 93 Workshop on Perceptual Issues in Visualization (October 1993, held in conjunction with Visualization '93).

Dr. Levkowitz is Co-Editor of the forthcoming Springer-Verlag volume "Perceptual Issues in Visualization" and Author of the book "Color Theory and Modeling for Computer Graphics, Visualization, and Multimedia Applications," scheduled to be published by Kluwer Academic Publisher at the end of 1995.

Stephen G. Eick is the Technical Manager of the Data Visualization Research group at AT&T Bell Laboratories. His educational background includes a B.A. from Kalamazoo College (1980), M.A. from the University of Wisconsin at Madison (1981), and his Ph.D. in Statistics from the University of Minnesota (1985).

At Bell Laboratories his research group focus on extracting the information latent in large databases using novel visualizations. This involves inventing the techniques, developing the software tools, and building an infrastructure to mine knowledge from corporate databases so that it can be put to competitive and commercial advantage. His group has developed a suite of visualizations including tools for visualizing geographic and abstract networks, software source code, text corpora, log files, program slices, and relational databases, among others.

Dr. Eick is an active researcher, is widely published, holds several software patents, and is currently the program co-chair for the Information Visualization Symposium at Visualization '95, the ASA graphics program chair elect, and on the program committee for VL '95. He is particularly interested in visualizing databases associated with large software projects, networks, and building high-interaction user interfaces.

Penny Rheingans is a visualization specialist for Martin Marietta at the US Environmental Protection Agency Scientific Visualization Center. She is actively involved in developing visualization tools and techniques for the more effective display of environmental data to scientists, policy-makers, and citizens. She has developed systems for the dynamic design and manipulation of color mappings for bivariate data, the design of opacity-modulating textures for molecular surfaces, and the display of high-dimensional statistical data. Her current research interests include multivariate visualization, dynamic manipulation, the design of effective color mappings, perceptual issues in visualization, the application of texture mapping to data visualization, and the experimental validation of visualization techniques. Dr. Rheingans received a BA in Computer Science from Harvard University in 1985 and a Ph.D. in Computer Science from the University of North Carolina, Chapel Hill in 1993.

Contents

1. Introduction (Levkowitz; 8:30 - 9:00 A.M)
2. Vision, Perception, and Color (Levkowitz; 9:00 - 10:00 and 10:30 - 11:15 A.M.)
3. Visual Attributes (Eick; 11:15 - 12:00 A.M.)
4. Motion, Interaction, Animation, and 3D (Rheingans; 1:30 - 2:15 P.M.)
5. Case Studies/Applications (Eick; 2:15 - 3:00 P.M.)
6. Evaluation and Verification (Rheingans; 3:30 - 4:15 P.M.)
7. Conclusions and Summary (Team; 4:15 - 5:00 P.M.)
8. Bibliography