Visualization of Spatial Data

Introduction by:
Mary Hegarty
Ph.D., Carnegie Mellon University
Professor, Department of Psychological & Brain Sciences
Director, Center for Spatial Studies
University of California, Santa Barbara (UCSB)

Mary Hegarty's research is on spatial thinking in complex activities such as comprehension, reasoning and problem solving. In research on mechanical reasoning and interpretation of graphics, she uses eye-fixation data to trace the processes involved in understanding visual-spatial displays (diagrams, graphs, and maps), and making inferences from these displays. A unique characteristic of her research is that she studies spatial thinking from the perspective of individual differences as well as employing more commonly used experimental methods. In her work on individual differences, she studies large-scale spatial abilities involved in navigation and learning the layout of environments, as well as smaller-scale spatial abilities involved in mental rotation and perspective taking. Her current research projects include understanding the roles of internal and external visualizations in reasoning about physical systems including molecules, machines, and meteorological phenomena and the use of visualization versus analytic problem solving strategies in scientific problem solving.

Hegarty is a fellow of the American Psychological Society, a former Spencer Postdoctoral Fellow, and is the former chair of the Cognitive Science Society. She is Associate Editor of the *Journal of Experimental Psychology: Applied*, and *TopiCS in Cognitive Science* and is on the editorial board of *Spatial Cognition and Computation* and *Learning and Individual Differences*. Her current research is funded by the National Science Foundation. Hegarty assumed directorship of the Center for Spatial Studies June 2012.

Web: http://www.psych.ucsb.edu/people/faculty/hegarty/index.php

Speaker
Jason Dykes
Ph.D., Department of Geography, University of Leicester
Professor of Visualization
giCentre
City University, London

Jason Dykes is Professor of Visualization at the giCentre at City University, London with research expertise in interactive cartography and its use in geographic data visualization and information visualization. Chair of the ICA Commission on GeoVisualization and lead editor of *Exploring Geovisualization*, he has been at the forefront of developments in exploratory interactive cartography

for nearly 20 years. Dykes and colleagues use techniques from Cartography, Information Visualization, Human Computer Interaction, Computer Science and GIScience to develop novel maps that help generate insights from data and communicate trends. This work has involved various successful collaborations with climatologists, historical geographers, animal ecologists, the defence science and technology laboratory, local government, the insurance industry, the national academic data service and energy providers. It has been recognized through four successive "Best Paper" awards at GIS Research UK meetings for innovative visualization work (2007, 2008, 2009, and 2010). Other giCentre palmares include "Honorable Mentions" at IEEE InfoVis in 2009 and 2010 and prizes in the IEEE VAST Challenge in 2009 and 2010 for innovative applied visualization and awards from Google, Nokia and The GeoInformation Group. A National Teaching Fellow of the Higher Education Academy, Dykes is Co-Chairing IEEE Information Visualization in 2013.

Dykes, Abstract:

Visualization of Spatial Data: Geo-ish Visualization—Partially Spatial Graphics

This presentation will focus on recent giCentre work in which we add structure to geographic representations to help with comparison and we add geography to non-spatial representations to reveal geographic relationships. Among other things, these partial geographies are used to track bikes and people, present the UK census on a single page, provide an exploratory public-facing interface to data on local government service provision and reveal bias in London's local elections as giCentre ideas and applications are showcased.

Web: http://www.soi.city.ac.uk/~jad7/?cont=0

Speaker

JoAnn Kuchera-Morin

Ph.D. Eastman School of Music, University of Rochester
Director, Allosphere Research Facility
California Nanosystems Institute
Professor, Media Arts and Technology and Music
Director, Center for Research in Electronic Art Technology
University of California, Santa Barbara

JoAnn Kuchera-Morin's research focuses on creative computational systems, multi-modal media content mapping, systems, and facilities design. Her years of experience in digital media research led to the creation of a multi-million dollar sponsored research program for the University of California—the Digital Media Innovation Program. She was Chief Scientist of the Program from 1998 to 2003. The culmination of Kuchera-Morin's creativity and research is the AlloSphere, a 30-foot diameter, 3-story high metal sphere inside an echo-free cube, designed for immersive, interactive scientific and artistic investigation of multi-dimensional data sets. Scientifically, the AlloSphere is an instrument for gaining insight and developing bodily intuition about environments into which the body cannot venture—abstract higher-dimensional information spaces, the worlds of the very small or very large, and the realms of the very fast or very slow. Artistically, it is an instrument for the creation and performance of avant-garde new works and the development of new modes and genres of expression and forms of immersion-based entertainment. Kuchera-Morin serves as the Director of the AlloSphere Research Facility located within the California NanoSystems Institute, Elings Hall, at the University of California, Santa Barbara.

Web: http://www.mat.ucsb.edu/allosphere, http://www.mat.ucsb.edu

Kuchera-Morin, Abstract:

Using the Creative Process and Multimodal Mapping for Spatializing Complex Information

In my research one picture is worth approximately 60 million numbers. How can one find patterns in complex information and work with the information creatively and intuitively leading to the possibility of new discoveries?

One of the most difficult tasks of understanding big and complex data is the ability to quickly find new patterns in voluminous amounts of information and to have the ability to retain in one's memory the information from pages and pages of numbers. If there is a way to translate this information into tangible visual and audio taxonomies, we may be able to retain this information much more readily. Development of a computational language that will facilitate spatializing very complex information visually and sonically in both time and space may help us to uncover important patterns in the information. By mapping very complex information through our senses, we are enabling the same right brain/left brain process that artists experience when they create a work of art, for scientists and other researchers. This will allow scientists and engineers to work with their information perceptually and intuitively, the way that artists do. Statistical data mining functions well when one knows what they are looking for. We believe that knowledge discovery through a visual and aural language that will represent the information through our senses will be especially beneficial when one is not sure what to look for. Working within the AlloSphere, one of the largest display devices in the world for multi-modal data representation and an ideal platform for designing our n-dimensional multimedia computational language, we have developed a series of prototypes and solutions for immersive multimodal mappings of complicated scientific data.

Speaker
Ross Whitaker
Ph.D., University of Northern Carolina, Chapel Hill
Professor, School of Computing
Scientific Computing and Imaging Institute
University of Utah

Ross Whitaker graduated Summa Cum Laude with a B.S. degree in Electrical Engineering and Computer Science from Princeton University (1986). From 1986 to 1988 he worked for the Boston Consulting Group, entering the University of North Carolina at Chapel Hill in 1989. At UNC he received the Alumni Scholarship Award, and completed his Ph.D. in Computer Science in 1994. From 1994–1996 he worked at the European Computer-Industry Research Centre in Munich, Germany, as a Research Scientist in the User Interaction and Visualization Group. From 1996–2000 he was an Assistant Professor in the Department of Electrical Engineering at the University of Tennessee and received an NSF Career Award. Since 2000 he has been at the University of Utah where he is a Professor in the School of Computing and a faculty member of the Scientific Computing and Imaging Institute. He teaches discrete math, scientific visualization, and image processing. He leads a graduate-level research group in image analysis, geometry processing, and scientific computing, and has a variety of projects supported by both federal agencies and industrial contracts.

Web: http://www.cs.utah.edu/~whitaker/

Whitaker, abstract:

On the Role of "Uncertainty" in the Visualization of Uncertain Data

In simulation science, uncertainty quantification (UQ) addresses the problem of how specific quantities are subject to errors, inaccuracies, ambiguities, or incompleteness. These uncertainties result from a variety of sources including imprecise or unknown boundary conditions, parameters, and physical models; inherent stochasticity in the physical systems; and numerical error. The term "uncertainty," however, suggests that a process produces a particular answer with a particular measure of confidence or uncertainty. On the other hand, visualization is often most relevant in situations where quantification is not yet feasible or may not be possible at all. In those cases the goals are often better described as data exploration, with an eye toward better defining the problem or obtaining a more holistic understanding. In cases where data is imprecise, the exploratory challenge is to understand the multidimensional structure of the stochastic processes that give rise to these data. Thus, the visualization task may not be to convey a particular answer with associated uncertainty, but rather to explore the high-dimensional probability distributions that describe the generative processes that give rise to the data. Here I will describe the implications of this viewpoint and its ramifications for understanding and visualizing the stochastic nature of multidimensional data.

Moderator:
Donald Janelle
Ph.D., Geography, Michigan State University
Research Professor
Program Director, Center for Spatial Studies
University of California, Santa Barbara (UCSB)

Donald Janelle is a Research Professor at the University of California, Santa Barbara and Professor Emeritus at Western University (aka, University of Western Ontario). He serves as Program Director for UCSB's Center for Spatial Studies and Center for Spatially Integrated Social Science (CSISS). He was on the faculty of the U.S. Air Force Academy for four years and of the University of Western Ontario for 30 years. He chaired Western's Department of Geography and served as Assistant Vice Provost. He edited *The Canadian Geographer*, the official refereed journal of the Canadian Association of Geographers, and chaired the Publications Committee for the Association of American Geographers (AAG).

Janelle's research and publications are based broadly within geography and affiliated social and behavioral sciences. Primary themes include space-time analyses of individual behavior, the time-geography of cities, the temporal-spatial ordering of social systems, locational conflict analysis, social issues in transportation, and the role of space-adjusting technologies in structuring new patterns of social and economic organization. He is a recipient of the Edward L. Ullman Award for Career Contributions to Transportation Geography and the Ronald F. Abler Honors Award for Distinguished Service from the AAG. Janelle has authored more than 120 journal articles and book chapters, and has co-edited five books. The three most recent include: *Information, Place, and Cyberspace: Issues in Accessibility; WorldMinds: Geographical Perspectives on 100 Problems*; and *Spatially Integrated Social Science.*