Panel Session gIV07

Geovisualization and synergies from InfoVis and Visual Analytics

Panel Organizers: gIV07

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Abstract

Geovisualization (GeoViz) is an intrinsically complex process. The analyst needs to look at data from various perspectives and at various scales, from "seeing the whole" to "attending to particulars" (Andrienko and Andrienko 2006). The analyst is also supposed to "see in relation", i.e. make numerous comparisons. This inherent complexity is multiplied by the complexity of the data that is explored and analyzed. The complex, multivariate data structure and heterogeneous components of most contemporary datasets necessitate a combined use of multiple techniques and approaches. There is no single visualization method capable to show "the whole". The analyst has to decompose this whole into views, examine these views and then try to synthesize the whole picture from the partial views. Also, because of large data volumes, we must use methods capable of simultaneously providing an overall view and exposing various "particulars". Looking for "particulars" requires therefore different techniques than "seeing the whole". Some existing visualization tools such as GeoVista and CommonGIS have successfully demonstrated the advantage of multiple-linked views and the use of information visualization (InfoViz) methods such as Parallel Coordinates and Heat maps to explore spatial multivariate data.

GeoViz tools support interactive visual representation and analysis of spatio-temporal data, enabling analysts to explore geospatial and multivariate data from multiple perspectives. GeoViz is differentiated from GIS because it focuses on exploratory visual analysis rather than the pre-defined mapping. GeoViz research focuses particular attention on integrating cartographic approaches with interactive visual representations from information visualization, analytical data dissemination and visual analytics. Emerging geovisualization tools will feature increasingly new or extended methods of visual representations and integrate many supplementary data types such as text, pictures, sound, and video.

This panel will discuss result and experience from existing synergies between GeoViz and InfoViz and future potential synergies from, for example, visual analytics technology not yet explored that could benefit the evolution of geovisualization.

Besides the synergy issue, data analysts do not only need tools that allow them to make discoveries and generate hypotheses but they also need the means to verify these discoveries and to test the hypotheses. Can exploratory tools be linked with appropriate confirmatory techniques, and, for example, implemented as extensions to statistical packages.

One more challenge, which does not yet seem to be properly realized in the visualization research community, is related to the fact that observations and discoveries that people make in the course of visual data exploration cannot be conveniently captured for later recall and for communication to others. The difficulty of recording and reporting the findings is a serious obstacle to wide recognition and use of visualization tools.

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1. Panellists statements

1.1 Gennady Andrienko

GeoVisualization faces a number of key challenges:

1) The complexity of geographic phenomena, including the...
   - Diversity of properties;
   - Multitude and diversity of objects and phenomena;
   - Strength of relationships between phenomena, data and space;
   - Temporal aspects of geographic phenomena.
2) The complexity of the information that needs to be analyzed, which is...
   - Multi-dimensional
   - Heterogeneous
   - Increasingly voluminous
   - Diverse in form

To address these challenges properly, it is necessary to coordinate visualization with computations. D.Keim proposed to replace B.Shnederman's Information Seeking Mantra "Overview, zoom & filter, details-on-demand" by the Visual Analytics Mantra: "Analyze First - Show the Important - Zoom, Filter and Analyze Further - Details on Demand". The Visual Analytics Mantra stresses the fact that fully visual and interactive methods do not properly work with big datasets. It is necessary to start with database operations and computations ("Analyze First") and apply visualization to the results obtained ("Show the Important"). The user may interact with the visualization and the secondary data it represents (i.e. the outcomes of the analysis but not the original data), in particular, zoom and filter, and trigger further analysis, which, again, requires visualization of the results. In this way, visual analytics is an iterative process involving three major steps, computational analysis, visualization of the results of the computational analysis, and interactive visual analysis of these results. A detailed consideration ("Details on Demand") is possible for small data portions when they require, for some reason, a special attention of the analyst. This does not necessarily happen at the end of the process.

An important task is to design computational data analysis methods so that they integrate visualizations and interactive visual interfaces in order to involve users in the process of data analysis.

Synergetic visual analytics methods should be designed so as to be able to deal with the specifics of geographical space and time. Geographical space is not limited to just two or three coordinates but includes the geographical context, which has many aspects and is difficult to formalize. Time has two models, linear and cyclical, and it is often necessary to consider simultaneously several temporal cycles (monthly, weekly, daily etc.; these cycles may overlap). A combination of several ordinary dimensions with space and time dramatically increases the complexity and is not properly supported by visual analytics yet.R

Research on geovisual analytics and development of visual analytics methods for spatial and temporal data is coordinated by the Commission on Geovisualization of the International Cartographic Association (http://kartoweb.itc.nl/icavis/index.html) which regularly organizes scientific meetings and publishes books and special issues of journals. Recently the commission has developed a research agenda on geovisual analytics for spatial decision support (to appear in International Journal Geographic Information Science, 2007).

Bio: Dr. Gennady Andrienko is a research fellow at the Fraunhofer Institute Intelligent Analysis- and Information Systems (IAIS) Schloss Birlinghoven, Sankt Augustin; 53754 Germany

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Gennady Andrienko received a Masters degree and Ph.D. equivalent in Computer Science from Kiev State University in 1986 and from Moscow State University in 1992, respectively. He undertook research on knowledge-based systems at the Mathematics Institute of Moldavian Academy of Sciences (Kishinev, Moldova), then at the Institute on Mathematical Problems of Biology of Russian Academy of Science (Pushchino Research Center, Russia). Since 1997 Dr. Andrienko has a research position at GMD, now Fraunhofer Institute IAIS.

He is a co-author of a monograph "Exploratory Analysis of Spatial and Temporal Data" (published in December 2005 in Springer), 30+ peer-reviewed journal papers, 10+ book chapters, and 100+ papers in conference proceedings. He has been involved in numerous international research projects.

Research interests include geovisualization, information visualization with a focus on spatial and temporal data, visual analytics, interactive knowledge discovery and data mining, spatial decision support and optimization.

1.2 Mikael Jern

During the course of the analysis, it's important to provide the analyst the capability and tools to share the visualization and associated analytics reasoning that led to the resulting conclusions. Little research has been done to integrate presentation and dissemination with the analytical process. The visual analytics research

agenda “Illuminating the Path” [Thomas & Cook 2005] addresses the need to conduct research that enable the capture of the explorative process into information packages that allow the analysts to communicate their discovery and decision recommendations.

In geovisualization practice, tools are generally entirely separate from presentation and reporting tools. Results from using geovisualization can be visual impressions, or mental images, which are hard to verbalize or express in any other form without referring to the discoveries from which they originate. The passive disseminations are characterized by the personal view of the author. The difficulty of recording and reporting the findings is a serious obstacle to wide recognition and use of geovisualization tools. The visual presentation of analytic results needs to be clear and concise, and it must take place as soon as possible after the analyst reaches a conclusion.

An integration of interactive and reporting tools would improve the communication and dissemination process. Geovisualization must therefore equip the analyst with tools that easily reveal what is going on already during the course of the analysis and be able to share with colleagues, visualizations and associated visual analytical reasoning that led to the resulting conclusion. It must be essential for analysts to be able to:

- Records the status (attributes) of a data navigation experience (events, conditioning, views, highlights, colour, etc);
- Helps in visual communication of gained insight, constructed knowledge and recommended decisions;
- Allows team members to share their understandings of unfolding events and see what their colleagues are thinking;
- Framework for producing interactive electronic documents - communicating analytical assessments to colleagues and operation management;

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During 1970-1976, he worked with Professor Hertz at the University of Lund. Together they invented the Color Graphics System based on the first ink jet plotter for raster based visualisation software in the world. In 1980 he founded UNIRAS to address the industry with a more general-purpose raster graphics approach. UNIRAS became a world-leading supplier of Visual Data Analysis and Presentation graphics software for scientists and engineers. UNIRAS was also a supplier of raster software to IBM, Tectronix and Versatec. When Advanced Visual Systems (AVS) acquired UNIRAS in 1993, he was appointed to the position of AVS Fellow to recognize his contributions to the evolution of AVS. Prof Jern is committed to graphics standards and was the project leader in a joint UNIRAS-IBM project to develop the standard graphics software system (GKS) for IBM in Hursley UK. He has coordinated several large EC funded projects in the domain of knowledge-based information visualization. He was awarded for his innovative research about interactive documents “SmartDoc”. He has also consulted with the EC Commission as a technical expert in visualization. He has published more than 200 technical papers and several books in visual computing and visualization application areas. At SIGGRAPH 93, he was elected "pioneer of computer graphics" based on his breaking new ground research together with professor Hertz in raster graphics. In Sept 1999, he returned to academic research and was appointed professor in information visualization at Linkoping University, Sweden and also serves as the Vice Director for Norrkoping Visualization Centre NVIS. His latest research interest includes InfoViz, GeoViz and Visual Analytics with focus on visual interaction methods.

1.3 Chris Weaver

Bio: Dr. Chris Weaver, Research Associate / Research Scientist GeoVISTA Center / North-East Visualization and Analytics Center Department of Geography, Penn State University, US; Email: cweaver@psu.edu;

Dr Weaver is a Research Associate with the North-East Visualization and Analytics Center (NEVAC) and the GeoVISTA Center at The Pennsylvania State University. My primary research interests are in geographic and information visualization, with a focus on domain-specific query languages and highly coordinated user interface architectures. Recent projects concentrate on applications of and extensions to the Improvise information visualization environment. This research aims to support a broad range of applications in scientific data analysis, business planning, intelligence analysis, and crisis management through acquisition, exploration, and dissemination of information in a collaborative live design visualization environment that is rapid and flexible yet accessible to users with minimal training.

1.4 Sara Fabrikant

The analytics portion of „Visual Analytics“ (VA) is not only about solving societal needs or problems in the world using visual tools, but also analysing how people make inferences with visual tools for problem-solving. How do visual tools shape, modify and influence people's inferences? What kind of knowledge about the world can be gained from visual displays?

How can this potential knowledge be modified through display design decisions? The current emphasis in VA seems to be too much on the technical challenges. While important, we still know little about visual-spatial thinking, inference making, and problem solving. Tools need to be designed based on empirical evidence, thus based on results of evaluations with actual users in real world situations.

Bio: Sara Irina Fabrikant is currently an Associate Professor of Geography and head of the Geographic Information Visualization and Analysis (GIVA) group at the GIScience Center at the Geography Department of the University of Zurich, Switzerland. Her research and teaching interests lie in geographic information visualization (geovis), GIScience and cognition, graphical user interface design, dynamic cartography and hypermedia. She received an M.S. in geography from the University of Zurich and a Ph.D. in geography from the University of Colorado at Boulder. She was awarded a Rotary International Ambassadorial Scholarship to study Geographic Information Science for one academic year at the University of Canterbury, Christchurch, New Zealand, in 1993. She publishes in a variety of GIScience/Geovis related journals and is currently a member of the Editorial Boards of Cartographic Perspectives, Cartographica, Revue Internationale de Géomatique, and Transactions in GIS, in addition to her Program Committee memberships for various GIScience/Geovis related conferences (e.g., GIScience, COSIT, InfoVis (UK), Diagrams, etc.). She has made various presentations (in English and in German) at national and international professional meetings, including invited keynotes and other lectures at universities in North America, Europe, Asia, and New Zealand. Other service includes memberships of the Association of American Geographers (including an elected post as academic director of the cartography specialty group), the International Cartographic Association's Commission on Visualization and Virtual Environments, the North American Cartographic Information Society, and the Swiss Society of Cartography. sara@geo.unizh.ch