July 2006

VAC Views

A publication of the Visualization and Analytics Centers

Introducing Visualization and Analytics Centers

VACs are a national and international resource providing strategic leadership and coordination for visual analytics technology and tools.

Features:

National Visualization and Analytics Center™
Richland, WA 99352

July 1, 2006

I am very pleased to introduce you to *VAC Views*. Our goal is to help advance the field of visual analytics and encourage its rapid use in numerous areas, including homeland security. In each issue, we will provide information about visual analytics applications, outreach efforts including recent and upcoming conferences and workshops, and educational highlights.

VAC Views has been created to meet the needs of the diverse community interested in visual analytics: the government leaders building programs around this growing field; the research community from academia, industry and national laboratories; the industrial community who can transform some of this technology into their products; and the students who will help define our future.

We will convey what is going on as this field of visual analytics emerges—not just the science and technology but also the opportunities for programs, information on how to get engaged, and emerging needs and requirements. We will also ask end users to express their critical needs in their terms.

We will promote collaboration from various disciplines and sectors. We want to collaborate with our many international partners—not only because of the enormous talents worldwide but also because inter-cultural analytics is a core part of the visual analytics agenda.

Our expectations for visual analytics are grand. Turning information overload into the opportunity of the decade—a phrase many of you have heard me use—requires new thinking and will enable new interfaces and interaction styles for a mixed-initiative discourse with information spaces.

We look forward to your comments and suggestions about our inaugural issue of *VAC Views*.

Jim Thomas
Director, National Visualization and Analytics Center

Current Happenings

To keep the VAC community aware of upcoming events, *VAC Views* will include a Current Happenings section in each edition. A more extensive list is available on our website at http://nvac.pnl.gov/events/.

- **IEEE Visualization/Symposium on Information Visualization/ Symposium on Visual Analytics Science and Technology**
  October 29–November 3, 2006 in Baltimore, Maryland, USA (http://vis.computer.org/vis2006/)
- **Special Interest Group on Information Retrieval**
  August 6–11, 2006 in Seattle, Washington, USA (http://www.sigir2006.org/)
- **VAC Consortium** October 4–5, 2006 in Richland, Washington, USA (http://nvac.pnl.gov/meeting_fall06/)

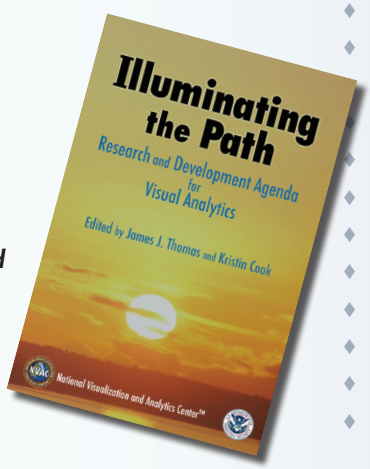
Several journals are planning special editions on visual analytics related topics. These will provide exceptional opportunities for the VACs and others to publish their research. Keep an eye out for special-edition calls for articles from *IEEE Computer Graphics and Applications, IEEE Transactions on Information Forensics and Security,* and *Computer & Graphics.*

If you know of other events and happenings that you would like us to consider adding to the list, please send a note to

Richard May
VAC Views Editor
nvac@pnl.gov

We are always looking for input to make *VAC Views* useful and of interest to the entire community. Please send us a note if you have thoughts or suggestions on other *VAC Views* material as well.

VAC Views is published under the NVAC™ program with funding provided by the U.S. Department of Homeland Security.



***Illuminating the Path: The Research and Development Agenda for Visual Analytics* is available from IEEE Press or for download at http://nvac.pnl.gov/agenda.stm**

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For more information, visit the National Visualization and Analytics Center™ website at http://nvac.pnl.gov/

This edition of VAC Views is also available at http://nvac.pnl.gov/vacviews/

Inside Visualization and Analytics Centers

The unique partnerships created under VACs... represent an ongoing commitment to collaboration in the discipline of visual analytics.

The U.S. government faces critical challenges in identifying and preventing attacks on U.S. soil. At the same time, businesses have a driving need to understand rapidly changing markets to remain financially healthy. Disaster management requires rapid assessment of complex and dynamic situations to save lives and property. The Visualization and Analytics Centers are a national and international resource, fulfilling a fundamental need to provide leadership, coordination and advanced analytical tools to make progress in effectively understanding and addressing these challenges.

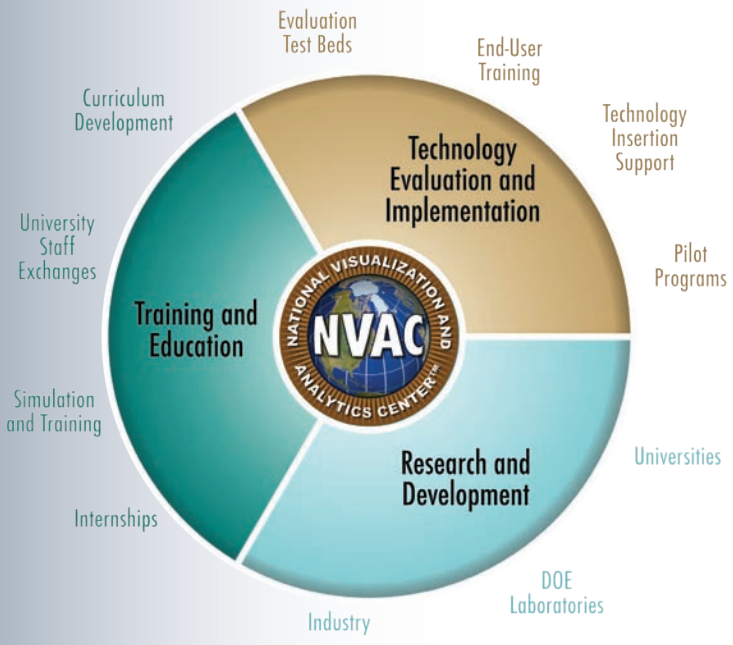
In 2004, the Department of Homeland Security chartered the National Visualization and Analytics Center™ at the Pacific Northwest National Laboratory to define a long-term research and development agenda for visual analytics. NVAC established the family of visualization and analytics centers through academic, government and industrial partnerships.

VACs' primary task is supporting DHS's mission by giving analysts and emergency responders technology and capabilities to:

- Detect, prevent and reduce the threat of terrorist attacks
- Identify and assess threats and vulnerabilities to our homeland
- Recover and minimize damage from terrorist attacks, should they occur.

VAC Approach

VACs are more than research and development. They are fostering a culture that brings together the resources necessary to create the next generation of science and train the next generation of scientists to advance the state of visual analytics. VACs provide and encourage leadership, technology, coordination and education.



The VAC approach involves research, education, evaluation and leadership

- **Research and Development Leadership**: Provide stewardship for the visual analytics R&D agenda (*Illuminating the Path*), ensuring that a continual stream of advanced analytical tools for information discovery are developed and implemented for stakeholders.
- **Technology Evaluation and Implementation**: Evaluate new methods and support the adoption of new tools for analysts and emergency responders.
- **Training and Education**: Build the intellectual capital and workforce capacity at all levels for research, education and training on homeland security issues. It is paramount that the education elements for undergraduate and graduate education be fully integrated with the research elements. Models for developing sustainable education programs in higher education using existing and new curricula are critical to VACs' success. This includes professional skills development, internships, communication skills and cross-disciplinary training for advanced students.
- **Coordination and Integration**: Bring together the best and brightest researchers from government, academia, industry and national laboratories to create visual analytics tools to prevent terrorism.

VAC Partnerships

The unique partnerships created under VACs among national laboratories, university research centers, scholars and government agencies represent an ongoing commitment to collaboration in the discipline of visual analytics.

Regional Visualization and Analysis Centers

Each university-led RVAC conducts research in one or more of the areas described in the R&D agenda for visual analytics. This research focuses on problem domains of interest to the homeland security community. The RVACs produce research concepts and prototypes that are evaluated in the context of user needs and priorities, and the RVACs are developing the foundation for a curriculum in visual analytics.

Government Visualization and Analytics Centers

GVACs are led by non-DHS government agencies. The goal of the GVACs is to create the best possible visual analytics tools with profound utility in the homeland security and other government missions. The GVAC partnership can help achieve strong early results in critical, currently intractable problems and help ensure the sustained relevance of the NVAC effort.

Industrial Visualization and Analytics Centers

Industry is highly interested in partnering with VACs. The purpose of an IVAC is to support the research in elements of the R&D agenda or to fund an integrated technology demonstration that will bring together new capabilities to address a problem domain of interest.

National Laboratories

Appropriate projects are defined and executed with the Department of Energy national laboratories to contribute to this mission. Coordination of the national laboratory research with the VAC R&D activities maximizes the impact of the research results.

VAC Consortium

The VAC Consortium (see "Visualization and Analytics Center Consortium," p. 6) brings together all the partners to promote dialog, understanding and education among all parties. Meaningful collaboration will help ensure the success of the VACs by industry implementation of the best solutions from research with continual input from the user community.

Visualization and Analytics Center Consortium

The activities of the Consortium promote a high level of information exchange between NVAC/Regional Visualization and Analytics Centers and other suppliers of visual analytics technology solutions.

The Visualization and Analytics Centers Consortium provides a forum where industry leaders and government specialists collaborate to achieve the best solutions to protect the nation. Prior to formation, an advisory board crafted the framework for the VAC Consortium itself, including developing roles, responsibilities and benefits to its members. Formal launch of the VAC Consortium occurred in summer 2005.

The VAC Consortium comprises representatives from NVAC™; industry; academia; and local, state and federal government. The Consortium:

- Engages public and industry stakeholders to assess the impact of cutting-edge science and technologies
- Provides training and education through small group technical forums and workshops
- Provides members direct access to key government and technical leaders and end users to enable the technology deployment process.

Member Benefits

The Consortium provides a unique mechanism for participants to gain a better understanding of Department of Homeland Security challenges and needs. It also provides opportunities to collaborate in revolutionary analytical technology demonstrations. Education, strongly emphasized throughout the VAC approach, is extended to Consortium members through classes. Access to those knowledgeable in the analytical process also helps Consortium members gain a better appreciation for analysts' and first responders' problems and their approach to those problems. In the first Consortium meeting, two experts taught a 3-hour session about the analytical warning task. This class provided explanations of analysts' processes, terminology and challenges. Similar educational activities occurred at the second Consortium meeting and will be continued in future meetings.

Consortium members also gain access to those who are leading VAC-funded research and development. NVAC and Regional Visualization and Analytics Center leads provide updates on their research. A fundamental tenet of the Consortium is to promote communications among its members to advance technology development, the evaluation of new technology and the deployment of technology to the end users.

Stakeholder Benefits

Besides DHS, other government agencies and academic and industry stakeholders own aspects of the challenge to terrorism and benefit from the technologies and tools developed by NVAC. Coordination of related activities is the responsibility of the representatives from these organizations. The activities of the Consortium promote a high level of information exchange between NVAC/RVAC and other suppliers of visual analytics technology solutions.

Through meetings and discussions, the Consortium members gain unique insight into the activities of NVAC programs, including the RVACs. Participation in conferences, forums and workshops, plus connection to the community of users, influences the direction for both development and deployment of solutions and future generations of visual analytics. Over the course of the Consortium's first year, two meetings have been held: the first at the Pacific Northwest National Laboratory and the second hosted by the Stanford RVAC on the Stanford campus. Both meetings were attended by over 100 attendees representing a broad cross-section of interests including senior representatives from DHS, the intelligence community, National Science Foundation, Department of Defense, industry and academia.

Point of Contact

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Become a Member Today!

Join as either Providers of products or Consumers of solutions.

Key Benefits of Membership:

- Paid registration to Consortium meetings
- Participation in annual technical workshops
- Opportunities to engage DHS/other federal agency staff
- Interactions with technology providers and consumers
- Access to published reports of software evaluation and test datasets
- Awareness of key DHS programs and procurement opportunities.

A complete listing of benefits by type and level of membership can be found on the VAC Consortium website at:

http://nvac.pnl.gov/consortium.stm

Introducing the RVACs

RVACs are university-led teams with missions that encompass both research and education.

The research and development agenda for visual analytics articulates a grand challenge for the research community. NVAC™ is building a community of practice to help meet this grand challenge.

To be successful, this team must create the next generation of science—fundamentally new tools and techniques that allow people to gain insight and take action.

But the science alone is not enough. We must also prepare the next generation of scientists who can continue to invent new solutions to these difficult problems throughout their entire careers.

Partnering with Universities

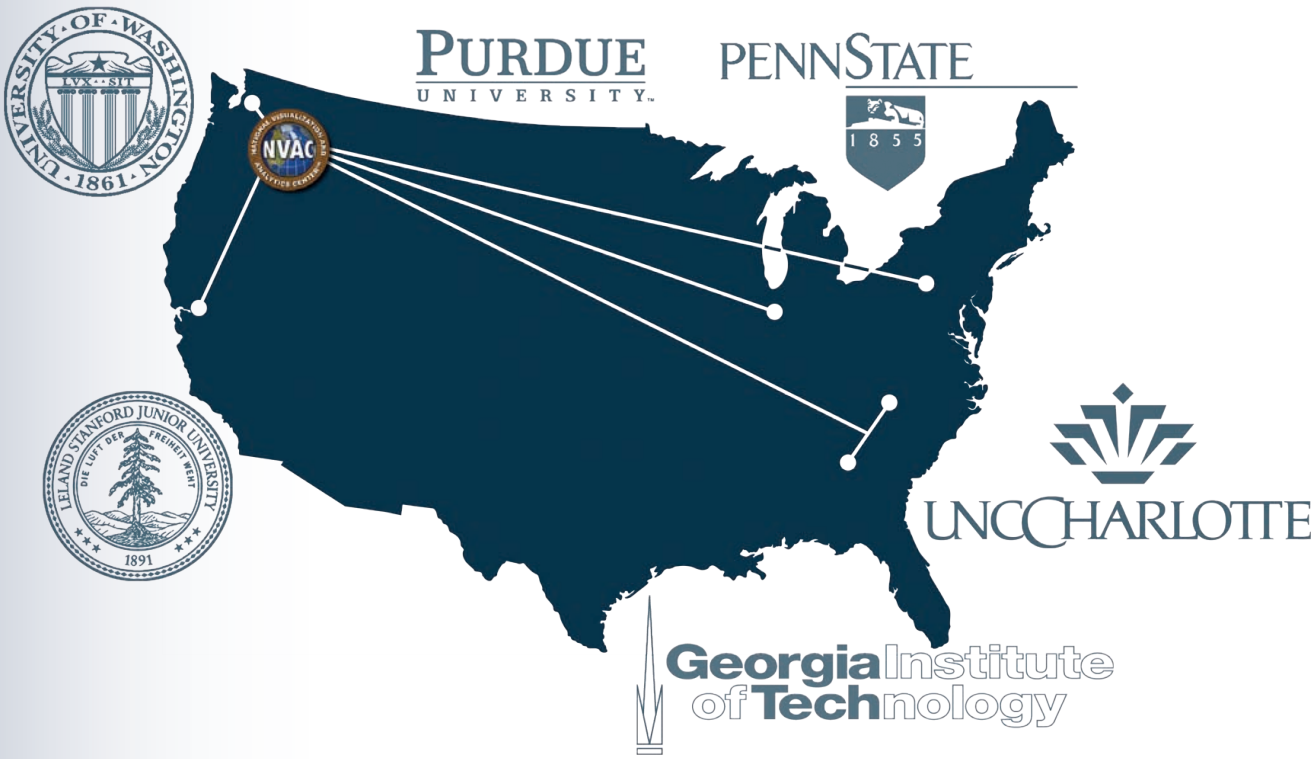
Universities are outstanding team members in accomplishing the visual analytics research agenda. Not only are they able to bring together multi-disciplinary research teams to advance the science of visual analytics, but they also offer the ideal environment for training new students in the challenges and foundations of visual analytics.

To harness the strengths of the academic community, NVAC has established five Regional Visualization and Analytics Centers. These RVACs are university-led teams with missions that encompass both research and education.

The initial RVAC was established at Stanford University in early 2005. Four additional RVACs were selected through a competitive proposal process in late 2005, and these new RVACs began operation in early 2006.

The RVACs are:

Pennsylvania State University. Penn State and partner Drexel University are conducting research to help analysts understand the spatial ("where") and temporal ("when") aspects of data. These elements are essential to helping analysts anticipate, prevent and respond to major events. Researchers are developing new methods to integrate data and visualization tools to uncover and interpret emergent patterns.



Purdue University and Indiana University School of Medicine. Purdue and IUSM are performing research that will allow homeland security personnel at all levels to quickly and effectively extract, visually analyze and synthesize information so that they can make quick and accurate decisions. The team is focusing on three homeland security areas: analysis; emergency planning and response; and healthcare monitoring and management.

Stanford University. Stanford is developing new approaches for analyzing huge volumes of transaction data, which describe individual events such as border crossings or telephone calls. Stanford is also developing novel visualizations and new approaches for analyzing image data.

University of North Carolina at Charlotte and Georgia Institute of Technology. UNC Charlotte and Georgia Tech are developing techniques and tools to assist in the analytical reasoning process. They are creating new approaches for analysis of enormous multimedia databases, such as the data generated by the web in the forms of text, imagery, video and webcast.

University of Washington. UW is establishing a Pacific Rim regional center, which includes experts from UW, British Columbia, Australia, New Zealand and Hawaii. Industrial partners include the Boeing Company and ChangeTools, Inc. The team is conducting research in "collaborative visual analytics," which will enable teams of people in different locations to work together to conduct analysis.

We must... prepare the next generation of scientists... to invent new solutions to these difficult problems throughout their entire careers.

Teaming Up for Education

The RVACs are working together with NVAC to define new college courses in visual analytics. The RVACs also are planning activities ranging from educational seminars for faculty and students to educating middle school and high school teachers about the fundamentals of visual analytics.

Off to a Great Start

Our collective goal is to build fundamentally new approaches for helping people get the greatest possible insights from their data while protecting privacy. Establishing the RVACs is a major milestone on the path to this goal. The RVACs are gearing up for enthusiastic collaboration as we tackle the research challenges ahead.

Point of Contact

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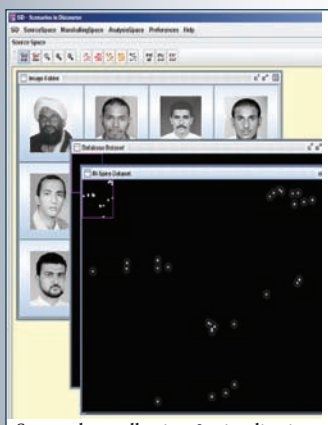
Pacific Northwest National Laboratory, kris.cook.@pnl.gov

RVACs provide both research expertise and training and education programs.

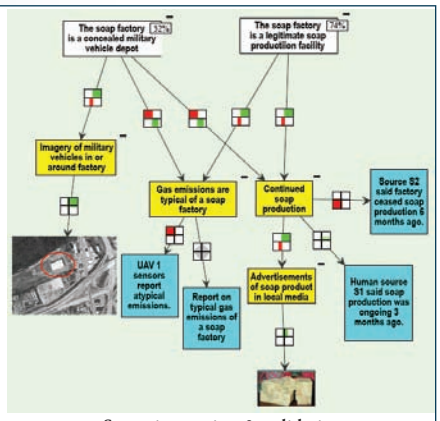
Scenario Analysis: Human Information Discourse for Hypothesis Construction and Validation

The ability to support simultaneous creation and validation of competing scenarios is a great challenge for today's information analysis systems. Parallel Analysis of Competing Scenarios is needed to prevent analysts from prematurely committing to a single conclusion and neglecting evidence supporting other plausible conclusions (Heuer 1999). Because of memory limitations on human cognition (Miller 1956), most people cannot retain several hypotheses and relevant supporting evidence in working memory. Moreover, supporting evidence for competing scenario analysis needs to be distilled from huge data repositories. Without the help of computer-aided information extraction and analysis processes, such a task would require extravagant expenditure of human resources and would thus deter timely actions.

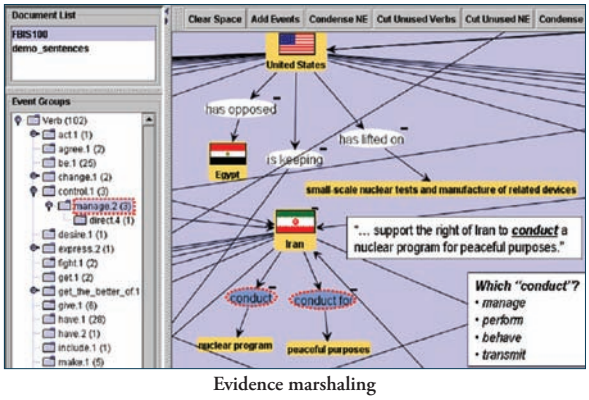
Current tools for Scenario Construction and Validation address some aspects of the problem but fail to provide an end-to-end solution. Also, the tools' interfaces are often designed for specialists familiar with the inner workings of the system. Such interfaces are typically not intuitive enough for a user who has no knowledge about the theoretical assumptions underlying the system.



Source data collection & visualization



Scenario creation & validation



Evidence marshaling

Our Human Information Discourse Interface environment

Approach

Our goal is to develop a Human Information Discourse Interface that provides a user-friendly platform integrating document classification, text mining, semantic search and navigation and assisted hypothesis creation and validation capabilities (Sanfilippo et al. 2005). Our HIDI provides an environment in which analysts work within three interoperable panels:

1. *Source Data Space* for initial analysis of document collections (including text, images, media objects, databases) and selection of relevant data
2. *Evidence Marshaling Space* for in-depth exploration of document content selected through the automated recognition of entities of interest such as people and places; events in which the entities participate; and relationships across these events to examine causal patterns, opposing views and relate tacitly connected information to specific scenarios
3. *Scenario Creation and Validation Space* for analysis of competing hypotheses.

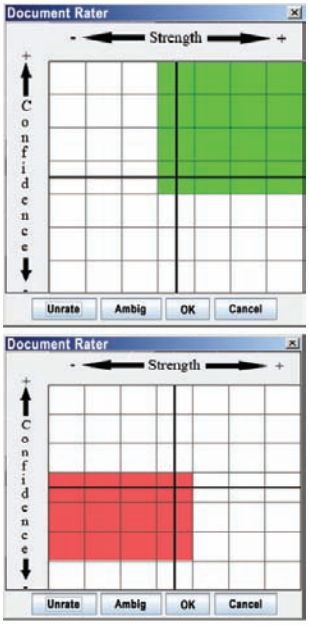
We apply the Prospective Analysis approach developed by Turner et al. (2005) to develop a scenario construction and validation interface based on three node types: hypothesis, indicator and evidence. A hypothesis node represents a specific outcome (e.g., "the soap factory is a concealed military vehicle depot") we wish to validate or refute using the evidence selected in the Source Data and Marshaling Evidence Spaces. Hypotheses are linked to evidence via indicators (yellow boxes in Our HIDI Environment figure, top right) that represent classes of evidence (e.g., field intelligence reports, gas emission reports, satellite images). Evidence nodes (turquoise boxes) represent actual pieces of evidence (e.g., a picture of the alleged soap factory) and contain references to the original source material.

Hypothesis, indicator and evidence nodes are related via ranking parameters, which are controlled through mouse-driven visual interactions. The relationship between a piece of evidence and an indicator is rated in terms of relevance of the evidence to the indicator (strength) and the degree of trust ascribed to the source of the evidence (confidence). The relationship between two indicators or an indicator and a hypothesis is encoded in terms of supported or refuted influence, as determined by the input evidence.

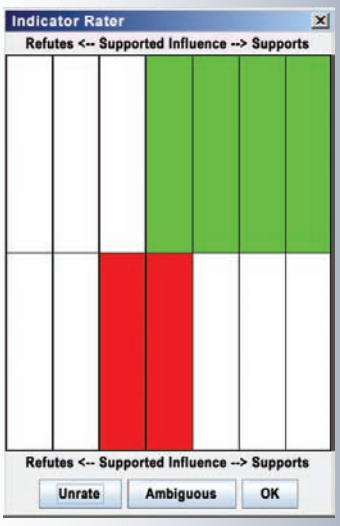
Our HIDI environment provides users with visually interactive capabilities to create graph queries. The evidence gathered through graph queries or other evidence identification operations can be dragged and dropped into the scenario graph, while maintaining references to source documents.

Impact and Outcomes

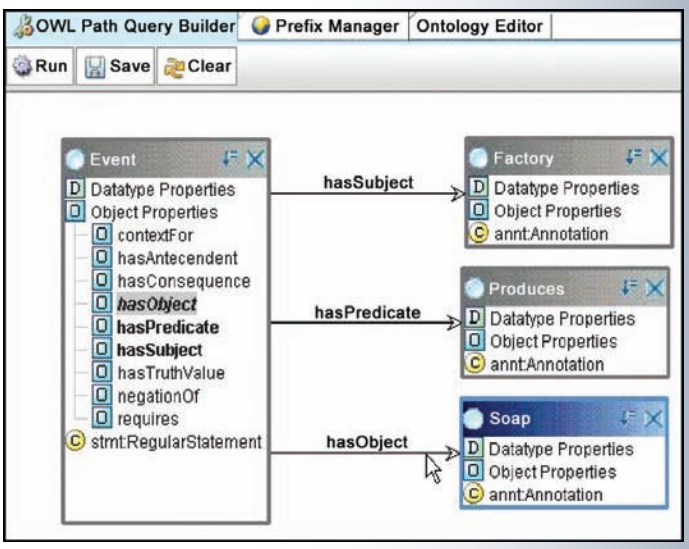
HIDI provides an interactive visual environment that supports scenario construction and validation processes in a user-friendly manner. The approach developed merges insights from a variety of existing solutions for structured reasoning with multimodal document clustering, text mining and semantic-based search techniques. The resulting application provides a platform that can be integrated with various mathematical models in support of structured reasoning (e.g., Bayesian Networks, Dempster-Schaefer theory, Neural Networks). We are currently specifying such integrations and evaluating the capabilities provided to users.



Evidence ranking



Indicator ranking



Graph query sample in HIDI

References

Hetzler E. and A. Turner. "Analysis Experiences Using Information Visualization," *IEEE Computer Graphics and Applications*, 24:5, 2004.

Heuer R.J. Jr. *Psychology of Intelligence Analysis*. Center for the Study of Intelligence, Central Intelligence Agency, Washington, DC, 1999.

Miller G. "The Magical Number Seven, Plus or Minus Two: Some Limits on Our Capacity for Processing Information," *The Psychological Review*, 63: 81-9, 1956.

Sanfilippo A., B. Baddeley, A.J. Cowell, M.L. Gregory, R. Hohimer and S. Tratz. "Building a Human Information Discourse Interface to Uncover Scenario Content," *Proceedings of the 2005 International Conference on Intelligence Analysis* (McLean, VA), 2005.

Turner A., E. Hetzler, B. Cheney, L. Williams, S. Zabriskie. "Method for Prospective Analysis of Alternative Futures," *Proceedings of the 2005 International Conference on Intelligence Analysis* (McLean, VA), 2005.

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Moving to Mobile

Current analytical tools are primarily developed for traditional single-user desktop systems. However, the state of technology continues to advance, and mobile appliances are getting more powerful and capable with every new generation. At the same time, the infrastructure for wireless and cell communications is becoming more ubiquitous and reliable. No longer do we only access electronic information on our desktops. Today we use devices such as personal digital assistants, cell phones, hand-held games, MP3 players and a growing array of palm computers to communicate and to view and transmit information at anytime from anywhere.

The Challenges

Our motivation is to exploit these technologies and create the next generation of mobile visual analysis techniques and technologies for a wide range of user environments and applications. Examples range from response teams and investigators responding to a disaster to analysts and business professionals on the move. We are working to facilitate providing true analytical capabilities no matter where we are.

NVAC is developing analytical tools for mobile devices to someday allow users to reason about complex data in the field.

Even with all the advances in technology, the range of information quantity and complexity that can be displayed on a PDA is still limited when compared to a multi-screen desktop computer. Also, because a mobile appliance can be used anywhere, environmental considerations must be taken into account. Consider for example the operational differences between working on a PDA sitting in a café versus riding in a vehicle down a bumpy dirt road with sunshine streaming through the windows. To help us get a better handle on how to best use mobile appliances, we have deployed a mobile-based application to provide real-time information for attendees of the Supercomputing Conferences in 2004 and 2005 with an application called InfoStar (Sanfilippo 2005).

InfoStar Approach

The goal of InfoStar was to provide Supercomputing attendees real-time data on all aspects of the conference. This included information not available through other means, such as exhibitor presentation schedules, and capabilities such as full-text queries of all conference information that only existed on InfoStar. Characteristics of the application environment required that InfoStar be easy to load and run on as many mobile devices as possible. There was no feasible way to distribute software or train users due to both their number and limited prior access.

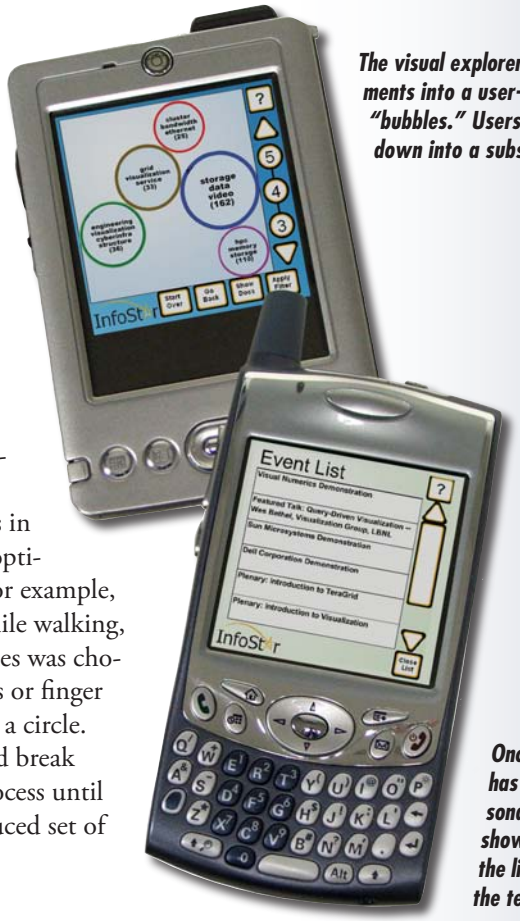
For these reasons, InfoStar was developed with common web protocols and Macromedia's Flash™ for the interactive graphics. The web pages were designed to provide several ways to access any piece of information. Users could search for events by type (papers, posters, panels, exhibitors, Birds-of-a-Feather sessions and more), a keyword query, or date and receive a list of relevant events. Each event listed could then be expanded to see details or the event's location on a map. From any event listing, further lists could be generated. Given an event, a list could be generated based on several common attributes like showing all events that took place on the same day, in the same room, or of the same type. This provided the capability to rapidly access a class of events from different starting points, minimizing the need to move through numerous web pages.

To further help users access and understand the relationship between various events at the conference, we used the IN-SPIRE™ (Hetzler 2004) engine to analyze syntactical relationships between the events. This allowed attendees to look for related events regardless

of the event type, time or track it was assigned. For example, say a user was interested in a certain paper. All he or she had to do was select that event and then ask to see "similar events." Events were then returned in order based on their syntactical relationship to the initial event. This functionality provides a rapid way to see that an exhibitor presentation and an education panel cover a similar topic even though the program would provide no such indication. Access to this functionality was provided by a text list and by a visual exploration interface.

The visual exploration tool provided a simplified view of the IN-SPIRE Galaxy visualization. Because the mobile devices have limited screen real estate, representing documents individually in a single view was not reasonable.

The technique provided by InfoStar displayed groups of similar documents, based on the IN-SPIRE clustering, as circles with key terms to represent the topics of each group along with the number of documents in each group displayed in each circle. Users could dynamically select the optimal number of circles to display based on the device they were using. For example, if the device had a small, low-resolution screen and it was being read while walking, users could set the display to a small number of clusters. The use of circles was chosen to maximize the size, which allowed easier selection by using a stylus or finger on touch-sensitive screens. Users drilled down into the data by selecting a circle. This would sub-select only the documents associated with that circle and break them into a new set of circles (clusters). Users repeated this selection process until they had drilled down to a sufficiently small set of documents. This reduced set of documents could then be viewed as a list and displayed.



The visual explorer screen groups documents into a user-defined number of "bubbles." Users click a bubble to drill down into a subset.

Once the number of events has been reduced to a reasonable number, they can be shown as a list. Any event on the list can be selected and the text displayed.

References

Hetzler, E. and A. Turner. "Analysis Experiences Using Information Visualization," *IEEE Computer Graphics and Applications*, 24:5, 2004.

Sanfilippo, A., R. May, G. Danielson, B. Baddeley, R. Riensche, S. Kirby, S. Collins, S. Thornton, K. Washington, M. Schrager, J.V. Randwyk, B. Borchers, D. Catchell. "InfoStar: An Adaptive Visual Analytics Platform for Mobile Devices," *First International Workshop on Managing Context Information in Mobile and Pervasive Environments*, May 9, 2005. Ayia Napa, Cyprus, 2005.

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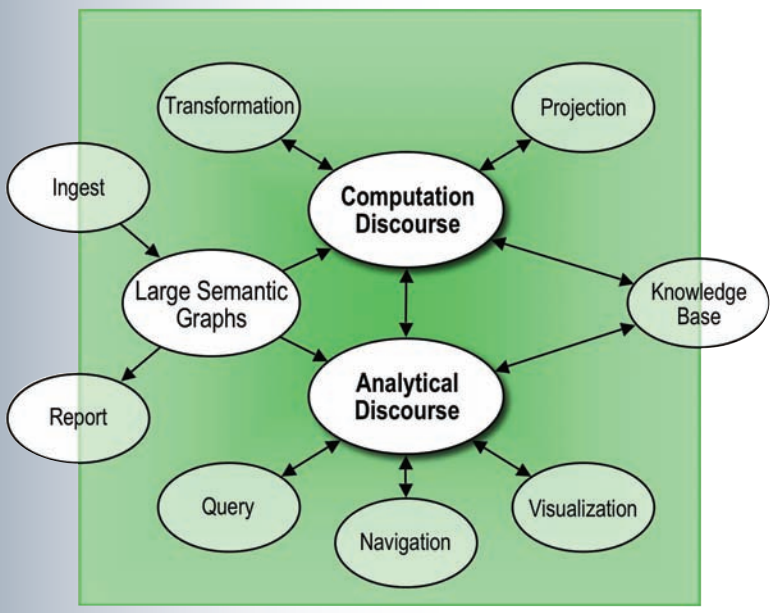
Visualizing Semantic Graphs

Introduction

A semantic graph is a network of heterogeneous nodes and links annotated with a domain ontology. In information analysis, semantic graphs are generated and applied in a visual analysis approach known as link analysis (Kolda et al. 2004). Through link analysis, investigators draw, lay out and link people, facts, locations, events, objects and data in hopes of discovering key trends, patterns and insights. In today's analysis environment, however, users are bombarded by massive amounts of information from a multitude of sources. The vast amounts of information being fed into semantic graphs may easily overwhelm an analyst's cognitive capacity.

The Pacific Northwest National Laboratory is developing a new visual analytics capability that interactively analyzes semantic graphs with up to one million nodes. Our objective is to develop graph-based tools and environments that will enhance analysts' natural analytical capabilities to create, comprehend and analyze large semantic graphs—allowing analysts to effectively and efficiently perform in an information world that grows more complex daily.



A framework overview of Have Green

Approach

Have Green is a suite of visual analytics technologies developed at PNNL to support analysis of large semantic graphs.

Once a semantic graph is ingested, it enters one of two cycles: 1) the cycle of analytical discourse of query, navigation and visualization if the graph is ready in terms of size and format or 2) the cycle of computation discourse if the graph needs further processing. Have Green also has a knowledge base component to supplement information that is lacking in the graphs.

The design requirement of Have Green is enormous but manageable. We champion software reusability and practice modular design throughout the development stage. After the architecture is established, individual components are implemented separately so that we can pinpoint design weaknesses in the earliest stage. Each component undergoes multiple usability studies. Results collected from the studies and post-study interviews are used to further revise our designs. These individual components eventually become the foundation of Have Green.

Impact and Outcomes

To date, we have developed four major system prototypes to support Have Green components.

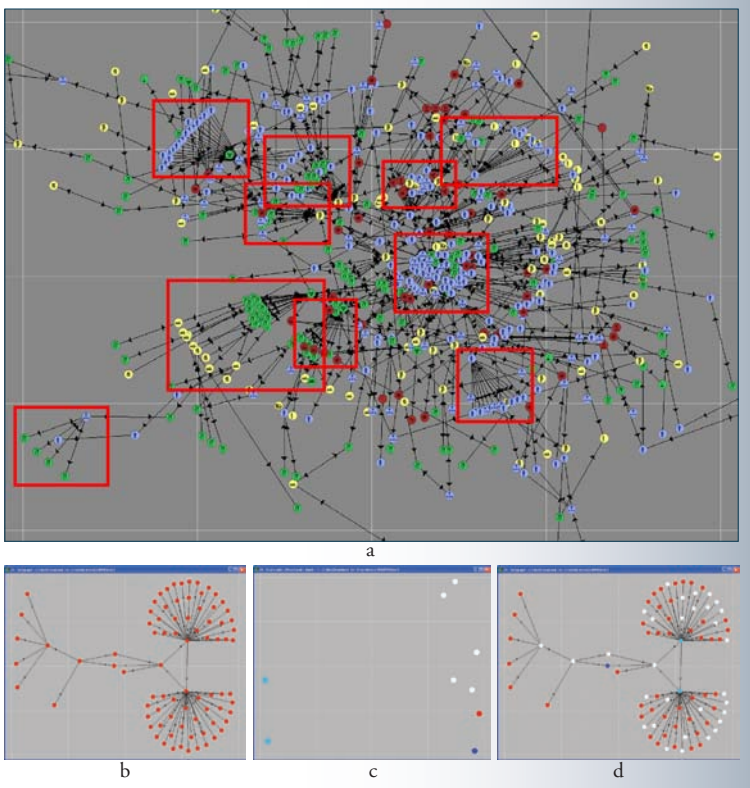
Greenland (Wong et al. 2006b) is our first prototype designed to support the Have Green *navigation* component. Signature vectors extracted from a graph are projected onto a low-dimensional scatterplot through the use of scaling. Brushing, linking and clustering are used extensively to cross-examine different visualizations created by different signatures.

While Greenland provides a way to browse a large graph and look for clues, GreenSketch (Wong et al. 2006a) provides a graphical interface for users to *query* graphs. A preliminary case study using Greenland and GreenSketch together is reported in (Wong et al. 2006a); more elaborate implementation is under development to support more complicated queries.

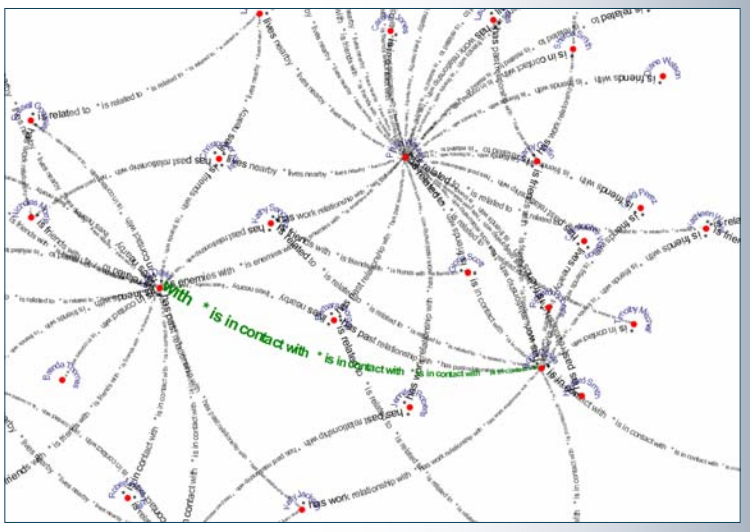
A hallmark signature of a semantic graph is the rich semantics of its individual nodes and links. This graph metadata ranges from a short phrase to a full sentence to an entire paragraph and beyond. We develop a practical *visualization* prototype, known as GreenArrow (Wong et al. 2005a), which allows users to browse the metadata interactively.

GreenMonster is our latest Have Green addition that addresses the scalability issue of our large semantic graphs. The requirement is to provide a capability to visualize semantic graphs with up to one million nodes adaptively and interactively on both desktop computers and PDAs. While GreenMonster belongs to the *projection* component, it also supports the *visualization* component that is under our design's analytical discourse hierarchy. GreenMonster is currently undergoing evaluation.

The design of individual Have Green prototypes has been carefully studied and system usability has been thoroughly investigated and reported in (Wong et al. 2006a; Wong et al. 2006b; Wong et al. 2005a). While these prototypes are designed to eventually become part of the Have Green system, some have been used independently for different applications. For example, GreenArrow has been used to support a storytelling case study that involves a crime scene investigation (Wong et al. 2005b). Greenland has been used to support a PNNL study on threaded dialogs. Together these components form an innovative graph analytical platform that allows developers to uniquely customize graph analytical tools for different applications.



a) Greenland visualizes a small world network with major hierarchies highlighted by the red rectangles. b) A portion of the graph in a). c) A scatterplot generated by scaling the signatures in b). d) Brushing and linking between the scatterplot and the graph.



A screenshot of the GreenArrow visualization

References

Kolda, T., D. Brown, J. Corones, T. Critchlow, T. Eliassi-Rad, L. Getoor, B. Hendrickson, V. Kumar, D. Lambert, C. Matarazzo, K. McCurley, M. Merrill, N. Samatova, D. Speck, R. Srikant, J. Thomas, M. Wertheimer, and P.C. Wong. *Data Sciences Technology for Homeland Security Information Management and Knowledge Discovery, Report of the DHS Workshop on Data Sciences*, Alexandria, VA, Sep 22–23, 2004.

Wong, P.C., H. Foote, P. Mackey, K. Perrine, and G. Chin Jr. "Generating Graphs for Visual Analytics through Interactive Sketching," *IEEE Transaction on Visualization and Computer Graphics*, 2006a. To appear.

Wong, P.C., H. Foote, G. Chin Jr., P. Mackey, and K. Perrine. "Graph Signatures for Visual Analytics," *IEEE Transaction on Visualization and Computer Graphics,* 2006b. To appear.

Wong, P.C., P. Mackey, K. Perrine, J. Eagan, H. Foote, and J. Thomas. "Dynamic Visualization of Graphs with Extended Labels," *Proceedings IEEE Symposium on Information Visualization 2005*, pp. 73-80, Oct 2005a.

Wong, P.C., K. Perrine, P. Mackey, H. Foote, and J. Thomas. "Visual Analytics and Storytelling through Video," *IEEE Symposium on Information Visualization 2005 Proceedings Compendium*, pp. 79–80, Oct 2005b.

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Educating the Next Generation

The VACs have an active education program carried out through a wide range of activities.

Education plays a vital role in creating an enduring science and technology research program for visual analytics. The education project led by NVAC™ is responsible for working with the national and regional centers to create educational programs with other universities and industry to help develop highly interdisciplinary skills that are essential to visual analytics research and development. With this in mind, the VACs have an active education program carried out through a wide range of activities.

Internships and Fellowships

By teaming with NVAC through internships and fellowships to develop, integrate and evaluate new technologies, faculty and students will become more effective contributors to the visual analytics research agenda. We sponsor a year-round intern/fellowship program and take pride in creating an enjoyable educational experience. This program lets students and faculty see how research is conducted outside of the university environment, broadens their experience and provides them with new inspirations to draw on. NVAC researchers benefit as well. The researchers at NVAC get the chance to work with creative, fresh minds, bringing different points of view to ongoing research.

We believe in helping interns and fellows achieve a strong sense of accomplishment. Where possible, they work on distinct tasks that have a defined outcome at the end of their time at NVAC. Internships and fellowships provide opportunities besides project work. Everyone is encouraged to attend presentations given by other researchers and distinguished visitors. Special activities are set up just for interns, including workshops on resume writing, tours of facilities, and tutorials on how to conduct research. There are also ample opportunities for interns to get to know one another in social activities outside of work. The wrap-up process for interns and fellows includes a final presentation and, in some cases, a written report. For interns, these are done with close supervision by the mentor who works with them throughout their time here.

2005 intern/fellowship program

Visual Analytics Curriculum

Understanding where visual analytics fits in university class offerings and helping to define what could be included in a visual analytics curriculum is of key interest to NVAC. The university-led RVACs are developing course material for university curricula in visual analytics. The goal is that this material will be made available to everyone with the intent of making it easier to provide visual analytics related offerings. Along with full class offerings, we plan to provide presentation material for short courses and online classes. Our intention is that this will become a community-wide effort that will draw on the talents of many university programs in numerous domains. The expected results are not only a repository of visual analytics course material but also guidelines and recommendations for how to implement a visual analytics curriculum.

Technical Community Support

To provide additional forums for discussions on visual analytics educational topics, we will be promoting events at technical conferences. Our first endeavor is to help develop an educational forum at this year's IEEE Visualization conference, which is co-located with the IEEE Symposium on Information Visualization and the IEEE Symposium on Visual Analytics Science and Technology.

The forum will showcase the quality and breadth of scholarly research in visualization and visual analytics through the graduate students who are advancing the fields. The forum will allow students to discuss their research directions in a supportive atmosphere with a panel of distinguished leaders in these fields and with their peers. Participants can expect helpful feedback and fresh perspectives on their research topics and possible career paths, and they will have the opportunity to interact closely with expert researchers. The forum will support community-building by connecting beginning and advanced researchers. For more information about the education forum at IEEE Visualization, check out the website at http://conferences.computer.org/vast/vast2006/forum.html.

This education column will be a standard feature in *VAC Views*. Our goal is to keep the community up to date on visual analytics educational happenings and to provide a venue for those involved in the program to talk about their experiences. Stay tuned for future articles with more reports from interns, updates on our visual analytics curriculum efforts and reports from conference events.

The [VAST education] forum will showcase the quality and breadth of scholarly research in... visual analytics...

Point of Contact

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Joe Bruce
2005 summer intern

"Mathematics has always been my passion. Computer science is more of a hobby. During my internship with NVAC, I found myself in an environment that offered an intriguing blend of mathematics and computer science. More than that, there was room to branch out or to move back and forth along the spectrum from mathematical theory to computer engineering. Of greatest benefit to me was the exposure: exposure to different minds and different styles, exposure to a freeing environment, exposure to projects with direction and purpose."

"The internship was an opportunity for me to discover the real world of work. It was a great transition from college to career because it was a combination of the freedom and exploration typical of university study and the timing and atmosphere of a work environment. I learned to write software in a way completely different from class. I was assigned complex and challenging tasks that required me to meet with my mentor frequently, but at the same time I was also given the chance to explore and suggest directions for the research. I would recommend this kind of internship to anyone who is looking for direction in their interests or a smooth transition from education to career. This internship opened doors for me."

Bob Baddeley
2004 summer intern

Partnerships

Advisors

VAC Consortium Members – Provider Level

BOEING
inxight
Objectivity
Intelligent Results
Microsoft
i2
A ChoicePoint® Company
TABLEAU SOFTWARE
OSIsoft
GCS research

Regional Visualization and Analytics Centers

Georgia Institute of Technology
UNC CHARLOTTE
PENNSTATE
PURDUE UNIVERSITY

Resources

The following publications are related to visual analytics. This list is by no means inclusive, nor is it meant as an endorsement of those mentioned here versus those that are not. Please send us resources you have found valuable, and we may include them in a future edition of *VAC Views*.

Adams JL. 1990. *Conceptual Blockbusting: A Guide to Better Ideas*, 3rd edition. Perseus Books, Cambridge, MA.
Identifies the key blocks that prevent us from fully using our minds and provides exercises to overcome those blocks.

Heuer R. 1999. *Psychology of Intelligence Analysis*. U.S. Government Printing Office, Washington, D.C. Available online at http://www.cia.gov/csi/books/19104/
Discusses how subconscious cognitive processes can limit our reasoning abilities and how we can try to understand and negate these effects.

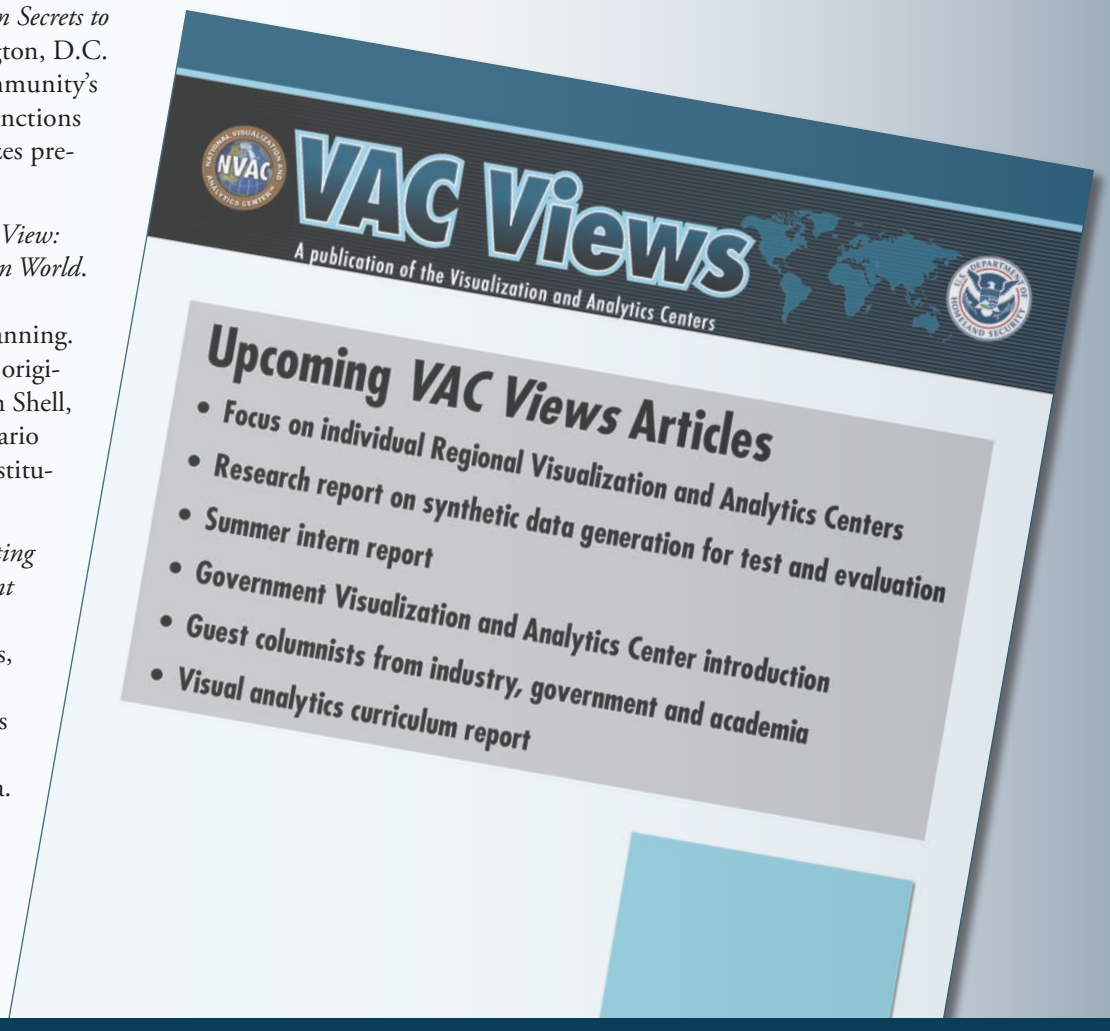
Johnston R. 2005. *Analytic Culture in the U.S. Intelligence Community*. Central Intelligence Agency, Washington, D.C.
An inside look, from an anthropological perspective, at the analytical culture in the intelligence community.

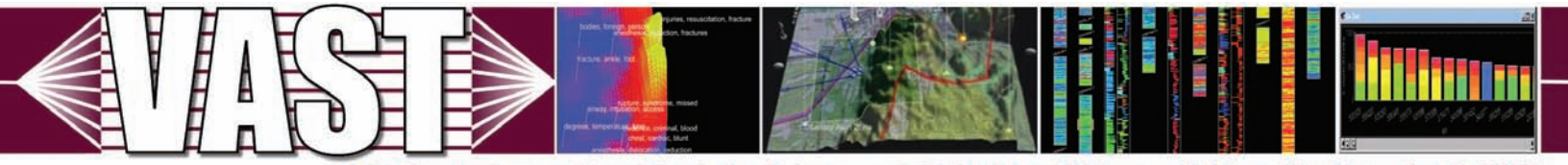
Jones M. 1995. *The Thinker's Toolkit: Fourteen Skills for Making Smarter Decisions in Business and in Life*. Crown Business, New York.
Provides practical methods for simplifying problems and making faster, better decisions.

Lowenthal M. 2005. *Intelligence: From Secrets to Policy*. 3rd edition. CQ Press, Washington, D.C.
Describes how the intelligence community's history, structure, processes, and functions affect policy. This 3rd edition analyzes pre- and post-9/11 issues and events.

Schwartz P. 1996. *The Art of the Long View: Planning for the Future in an Uncertain World*. Currency, New York.
Outlines a scenario approach for planning. Schwartz describes new techniques, originally developed within Royal/Dutch Shell, based on many of his firsthand scenario exercises with the world's leading institutions and companies.

Thomas JJ, KA Cook (Eds). *Illuminating the Path: The Research and Development Agenda for Visual Analytics*. IEEE Computer Society Press, Los Alamitos, CA, 2005.
Describes the field of visual analytics and outlines the visual analytics science and technology research agenda.





IEEE Symposium on Visual Analytics Science and Technology 2006 • October 31 - November 2, 2006

IEEE VAST 2006 is the first international symposium dedicated to the advances in visual analytics science and technology. The scope of the symposium, co-located with the annual **IEEE Visualization 2006 Conference** and the **IEEE InfoVis Symposium**, is based on the research agenda that has been recently published in *Illuminating the Path: The Research and Development Agenda for Visual Analytics*.

Keynote Speaker: Dr. Joe Kielman, Department of Homeland Security

Special Features:

- **Doctoral Colloquium** – This colloquium will showcase the quality and breadth of scholarly research in visual analytics through the Ph.D. students who are advancing this new field. This colloquium will use a panel-moderated presentation of the students' research overviews to show how the future of visual analytics is taking shape. The panel comprises established researchers from academia, industry and government.

- **Contest** – The purpose of the IEEE VAST Contest is to promote the development of benchmarks for visual analytics and establish a forum to advance evaluation methods. Selected entrants will present at the conference, and some teams will be invited to participate in a special workshop before the conference during which professional analysts will interact with the systems and provide feedback. Submissions accepted until July 15, 2006.

Please join us in Baltimore, Maryland, October 31 - November 2, 2006.

More information can be found at
http://conferences.computer.org/vast/

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P.O. Box 999, MSIN: K7-10
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PNNL-SA-50343