May 2008

VAC Views

Features:

Visual Analytics at Boeing The Boeing Company is partnering with universities to develop visual analytics solutions to highly complex industry problems (page 6)

Purdue Visual Analytics Center PURVAC performs visual analytics research applicable to numerous fields, including emergency response, health care, food production and network security (page 12)

An Imagination Toolbox Middle and high school students and teachers are using a graphical programming environment to create 3D games and simulations to solve real-world problems (page 20)

Dr. Matthew Clark *is Director of the Department of Homeland Security Science and Technology Directorate's Office of University Programs. Dr. Clark is responsible for developing, managing, integrating and delivering the results from a $50 million annual research and education program. Prior to joining DHS, Dr. Clark spent 11 years as an economist with the U.S. Environmental Protection Agency. He established and managed an Economics and Decision Sciences grant program that generated some of the most significant and widely used research results ever supported by EPA. He received his Ph.D. from the University of Washington, his master's degree from Washington State University and his bachelor's degree from the University of Massachusetts.*

DHS Office of University Programs

The Office of University Programs, in collaboration with Visualization and Analytics Centers and universities across the country, executes U.S. Department of Homeland Security mission-critical research to address current and future homeland security challenges. In keeping with this mission, University Programs focuses on research and education initiatives while cultivating the next generation of scientists and researchers.

In 2002, the Homeland Security Act established a coordinated, university-based system to enhance the nation's homeland security. The Centers of Excellence align with the missions of the S&T Directorate divisions and provide leverage to divisions and customers to take advantage of the universities' capabilities. Since the Department's creation in 2003, the Office of University Programs has established eight centers of excellence. Five additional centers were announced in March 2008. Further information on these centers can be found at www.sciencetosecurity.org.

Within the Education thrust, University Programs hosts various programs that enhance the development of students who wish to study in homeland-security-related Science, Technology, Engineering and Mathematics fields. These programs seek to promote DHS-related curriculum and programs to a wider community of academic institutions and research facilities. The following opportunities are available:

- Individual Scholarships and Fellowships
- Career Development (Training) Grants
- Naval Postgraduate School Ph.D. Program in Homeland Security
- American Association for the Advancement of Science Fellowships at DHS, Summer Internships
- International Science and Engineering Fair
- Homeland Security STEM Education Grants

University Programs also works closely with Minority Serving Institutions to ensure the development of a diverse and well-trained scientific and technical workforce for the homeland security community. Currently, Scientific Leadership Awards and Summer Research Teams are sponsored through this initiative.

As research and requirements change, so does the Office of University Programs—that's what makes us unique. We constantly think of ways to integrate with other communities, including the VACs, national laboratories, other federal, state and local agencies, and private sectors to challenge the universities' basic research outputs. We look forward to the challenges that lie ahead.

Dr. Matthew Clark, Director
University Programs
Department of Research
DHS Science and Technology Directorate

Current Happenings

A lot has been happening over the last few months, and *VAC Views* is the place to hear about it. To catch up on some of the changes in the VACs, check out the News Briefs (page 9), including the announcement of a new leader of the University of Washington RVAC.

This issue is full of firsts.

- The article on visual analytics at Boeing is the first of what will be many industry-led contributions. We have wanted to have industry partners provide highlights of their work since the first issue—and now we are. If your company is interested in contributing, let us know.
- In this issue, we have started reaching out to a broader set of DHS programs to keep you abreast of current happenings. The education report (page 20) on StarLogo TNG is from a DHS S&T Universities Program project developing Science, Technology, Engineering and Mathematics educational gaming material. Extremely cool stuff—especially if you live in a forest.
- Check out "What Is VAC?" (page 23) and the pages that follow. We wanted to make *VAC Views* something that you can hand out to others to explain what we are all about and what we're doing. Starting with this issue, we have added a VAC overview page and a list of projects in the VAC community. Contact information is provided for each of the centers so you know who to contact to find out more information.

Be sure to note the back cover because VisWeek is coming up. What is VisWeek, you ask? VisWeek is the premier forum for data and information visualization. It is three events in one (VIS, InfoVis, and VAST), plus a lot more. This is where you want to be if you are doing work in or around visual analytics. Want to get involved? Send a message to any of the contacts listed on the back cover or drop us a note. We will be happy to help.

We are always looking for input to make *VAC Views* more useful and of interest to the entire community. Please send us a note if you have thoughts or suggestions for future issues of *VAC Views*.

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Front cover photo courtesy of **Brittney Kluse**.

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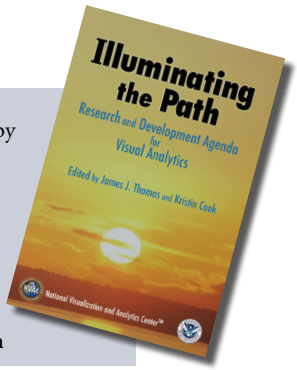
This edition of *VAC Views* is also available at **http://nvac.pnl.gov/vacviews**

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



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Visual Analytics in Canada

Canadian researchers from universities and industry have played a significant role in the visual analytics research effort from its inception. In recent months, their collaboration with the National Visualization and Analytics Center and several Regional Visualization and Analytics Centers has attracted the attention of the Canadian federal government. The result has been a new Cooperative Activity Arrangement between Canada and the United States for cooperation in science and technology for critical infrastructure protection and border security. This new agreement will enable Canadian and U.S. researchers to work together on projects that are of critical importance for both countries.

From left to right, John Dill, Simon Fraser University; Brian Fisher, Simon Fraser University; Jim Thomas, NVAC; and Andrew Vallerand, Public Security Technical Program at the February workshop at Simon Fraser University.

Building Momentum

This agreement was the product of a long collaboration between Canadian and NVAC researchers. The process began at the Fall 2006 Consortium meeting, when Simon Fraser University researchers John Dill and Brian Fisher were notified that their grant application "Visual Analytics for Safety and Security" had been funded by the Natural Sciences and Engineering Research Council of Canada. This provided the two researchers and collaborators Christopher Shaw and David Darvill at Simon Fraser University and Ronald Rensink at the University of British Columbia with funding to contribute their cognitive science perspective to collaborative work with NVAC and the Pacific Rim and Purdue RVACs. Application development was to take place in collaboration with U.S. partners and Canadian companies MacDonald Dettwiler, CAE, Oculus and Idelix. It also included funds for outreach to potential Canadian government and industry partners.

Drs. Dill and Fisher joined forces with John Pennant, a University of British Columbia Development Officer with extensive experience with government relations, and boarded a plane for the capital in Ottawa for discussions with officials in the Ministries of Defence and Public Security. Success was achieved when they gained the interest of Andrew Vallerand, a Director in the Public Security Technical Program, which is a joint defense/public safety agency that is, perhaps, the closest equivalent to the U.S. Department of Homeland Security in Canada.

Canadian Government Representatives at PNNL

Dr. Vallerand was intrigued enough to join with Julius Grodsky, a colleague from the Defence Research and Development Canada, for a visit to NVAC at PNNL. This visit cemented his belief that Canada should join with the United States in building a visual analytics capability to collaborate in key areas that are important to their shared commitment to assuring the safety of citizens and security of infrastructure while maintaining the free flow of people, goods, power and water across their common border.

Once a commitment to move toward collaboration was reached, work began in earnest. Many other meetings, and the efforts of many other people, were required to craft the agreement and the mechanisms by which it would be implemented in both countries. Jim Thomas, NVAC Director, and Joseph Kielman, DHS, traveled to Ottawa and worked with Dr. Vallerand, his Director General Anthony Ashley and the Assistant Deputy Minister Robert Walker on the specifics of the document, which received its final signature on April 7, 2008.

Building Visual Analytics Research in Canada

As the process of finalizing the agreement took place, Drs. Dill and Fisher and their collaborator Ronald Rensink worked to foster interest of researchers in academia and industry to build the capability to engage its research goals. A "Visual Analytics, Science and Applications" workshop was held February 2-5, 2008 with sessions at both Simon Fraser University and the University of British Columbia. This workshop included presentations from many RVAC leads as well as Jim Thomas, Joseph Kielman and Andrew Vallerand. Its goal was to initiate the development of CNVAC, the Canadian Network of Visual Analytics Centres. Presentations can be found online in the Visual Analytics Digital Library (http://vadl.cc.gatech.edu/; also see the February 2007 issue of *VAC Views*).

Andrew Vallerand, Director, Canada's Public Security Technical Program, speaks at the February "Visual Analytics, Science and Applications" workshop at Simon Fraser University.

While the focus of the Vancouver research group has been the cognitive and perceptual science that underlies visual analytics, the goal of CNVAC is to build the full spectrum of visual analytics from application-driven scientific research to application building in partnership with the stakeholder community. The Vancouver research group is currently building its own capacity for field studies to ensure that applications developed in their laboratories and in partnership with industry are engineered for the user community's capabilities, mental models, organizational structures and situations of use. New partnerships with Canadian and U.S. companies, in particular a major project with the Boeing Company (see page 6), will assure researchers that their scientific investigations have the necessary contact with the user community and that their applications are well grounded in both science and practice.

For more information about the research described here, see http://www.siat.sfu.ca/research/projects/18

Team Members

Simon Fraser University: David Darvill, John Dill, Brian Fisher
University of British Columbia: John Pennant, Ronald Rensink

Point of Contact

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Visual Analytics at the Boeing Company

The notion of intelligence can be hard to define. Intelligence analysts use visual analytics applications to identify security threats. First responders use similar applications to help make near-instantaneous decisions from real-time data streams.

Industrial users also face ever-mounting data volumes. With data volumes of hundreds of petabytes, industrial data characteristics are similar to the characteristics of data analyzed in government offices. Much of Boeing's data is graphical (2D and 3D). Like the intelligence community's data, Boeing's data sets contain erroneous, misleading and omitted values. Even when values are correct, many fields have values in which semantic interpretation is overloaded. In other words, the values are used as codes that may be meaningful in only one community. Data sets that seem to be related often do not share keys or have slightly different interpretations of shared keys. Finally, the data has been collected since the late 1950s and much of it is stored in archives or vaults. The archived data often is in formats that cannot be interpreted in modern applications.

Visual analytics offers an alternate way of gaining business intelligence from current and archived data stores. The questions companies like Boeing, Morgan Stanley, General Motors and others ask generally differ from those a government analyst might ask.

Boeing Problem Synopsis

Boeing's early assessment of visual analytics indicates that involving a user in the analysis loop, especially when the data has dubious provenance, is essential in complementing insight gained from more conventional statistical analysis and report-generation tools.

Boeing collects terabytes of data that, if better understood, could provide new insight into anomalies that can help the company

777 final assembly moving line in Everett, Washington.

- Assess unexpected risks
- Improve its aerospace products in specific areas (e.g., maintenance, reliability and quality)
- Understand and manage product costs
- Concurrently manage and improve employee services (e.g., pension, medical insurance).

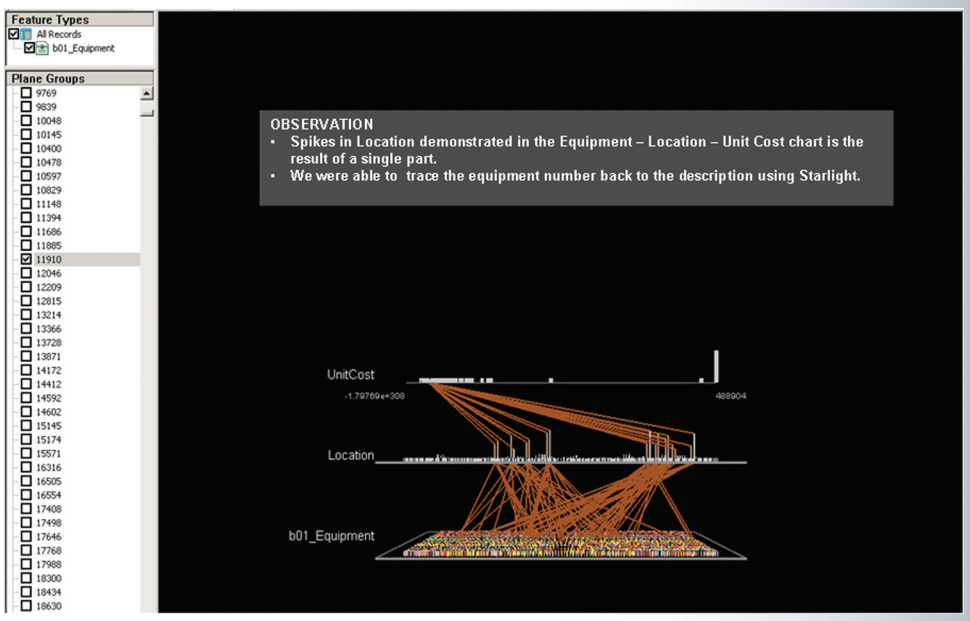
The basic problem is that different databases are populated independently from one another and often contain conflicting, contradictory and erroneous data. In many cases, Boeing's archived data is in a write-once, read-never state because Boeing lacks the tools to effectively analyze it.

Approach

Boeing's entry into visual analytics is built on joint company-university research. Boeing has formed partnerships with Pat Hanrahan (Stanford), Ron Rensink (University of British Columbia), Brian Fisher (Simon Fraser University) and John Dill (Simon Fraser University). These collaborative efforts build upon Boeing's subject matter and analysis expertise and the universities' expertise in new analytic approaches, existing tool assessments and graphical communication. The key to making such a program work is making real data available for experimentation and allowing access to Boeing subject matter experts to determine how they approach an analysis task today.

Boeing decided on the collaborative approach because the capabilities it needs are often unavailable in commercial off-the-shelf tools. Boeing's business varies significantly between the commercial and military business and among airplanes, satellites, laser systems, support contracts and thousands of other products and services. As a result, Boeing tends to add customization value to COTS software and continually challenges vendors with its scale problems.

Boeing's high-complexity problems require large-scale systems analysis across multiple components. Therefore, Boeing needs tools that are easily reconfigurable, flexible and usable by domain experts. A capability to explain the results to decision makers is essential. As Boeing personnel assessed the state of visual analytics, they realized that joint work with leaders like Stanford, SFU and UBC was critical for success.



Starlight visualization from the 2006 demonstration project in which Boeing learned the value of engaging domain experts early on.

A late 2006 demonstration project provided justification for collaboration with others. In this project, Boeing compared the insight gained into production maintenance records from conventional statistical analysis, a 3D visual analytics tool (PNNL's Starlight) and a 2D visual analytics tool (Tableau®). A sample Starlight-generated image is shown at right.

Boeing learned a lot from this effort. Boeing personnel impressed reliability and maintainability experts with some of their observations and learned about the relative immaturity of visual analytics as a discipline. Most importantly, Boeing learned that driving a visual analytics tool requires close interaction with domain experts. The expertise that leads to domain knowledge in aircraft engineering, manufacturing and maintenance takes years to develop. Boeing deliberately avoided involving domain experts in its first project to contrast the fidelity of results from the tools and to see just how far the tools could take analysts who were not specifically engaged in reliability and maintainability. Boeing concluded that getting subject matter experts engaged earlier in the process is a definite benefit.

In addition to providing research funding for its university collaborators, Boeing brings in real requirements from its large enterprise, experience from real users and a large volume of real data. Boeing is providing access to subject matter experts in multiple domains and large test data sets. Furthermore, Boeing contributes its expertise in 3D computer graphics, knowledge discovery, text analysis, statistical analysis and visual analytics.

Conclusion

Developing visual analytics in the context of Boeing's real-world users and applications helps focus university research and training programs. Boeing believes this collaborative effort will contribute directly to the methods Boeing uses internally and influence the capabilities and research direction in visual analytics tools for years to come.

Points of Contact

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Fall 2007 Consortium Meeting

Partnerships among NVAC, industry, RVACs, University Affiliate Centers and government agencies were highlighted during the November 14-15 VAC Consortium meeting at Pacific Northwest National Laboratory in Richland, Washington. Over 120 individuals attended from government, academia, U.S. and international industries and national laboratories. Comments received included "Outstanding networking opportunities"; "Overall content was broad and diverse"; and "Well run, information-rich event."

Meeting Highlights

Lieutenant Commander Jim Ford from the Office of Naval Intelligence provided the keynote address on "Visualization and Analytic Challenges in the Maritime Information Domain." Next up was a panel on Maritime Domain Awareness. This was followed by a panel from our Canadian colleagues, led by Dr. Andrew Vallerand, who described the recently announced Canadian partnership with NVAC. Always a favorite, the technology demonstrations from all partners spurred opportunities for increased collaboration. The day ended with a dinner where Larry Rosenblum of the National Science Foundation was recognized for his continued support of the field of visual analytics and the recent NSF partnership with NVAC.

On the second day, Joe Kielman's presentation set the vision for the VAC teams of the future. Other second-day headliners were Dr. Lee Schwartz, the Geographer from the Department of State; Dr. Maria Zemankova from the National Science Foundation; and Peter Kuper of Morgan Stanley.

Consortium meeting attendees networking and engaging in discussions.

Member Privileges

The two-day meeting concluded with a members-only class led by Dr. Bidisha Biswas of Western Washington University, with support from the National Consortium for the Study of Terrorism and Responses to Terrorism, on understanding the motivations of terrorist groups.

The level of energy throughout the sessions and in informal discussions clearly indicated that new emerging partnerships will bring even better technologies and solutions to DHS missions. Special thanks to Bruce Baicar and Joe Kielman for attending and representing the U.S. Department of Homeland Security.

To download presentations from the meeting, see http://nvac.pnl.gov/meeting_fall07

For more information about the Consortium, see http://nvac.pnl.gov/consortium.stm

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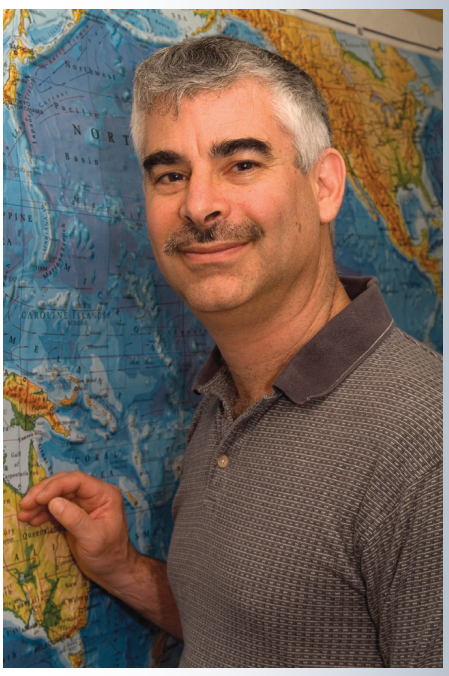
News Briefs

University of Washington RVAC Leadership

Dr. Mark Haselkorn assumed leadership of the University of Washington Regional Visualization and Analytics Center in January 2008. Mark has founded and led large, innovative, multi-disciplinary, research-based initiatives, working with organizations like the National Science Foundation and the National Academies. Dr. Haselkorn is founding chair of the Department of Technical Communication in the College of Engineering. Please join us in welcoming Mark to the VAC enterprise!

For more information, visit http://faculty.washington.edu/markh/



Dr. Mark Haselkorn, University of Washington Regional Visualization and Analytics Center.

A Visiting Scientist's Perspective

John Stasko, Professor at Georgia Tech, spent the second half of his sabbatical leave (January – May 2008) as a Visiting Scientist at NVAC and PNNL in Richland. During his time at NVAC, he worked on collaborative projects with interdisciplinary teams of NVAC researchers and practicing analysts at PNNL.

"I had a terrific experience visiting the lab for these four months and working on a variety of projects," Stasko said. "From a research point of view, I was able to get valuable feedback about my Jigsaw system from analysts-in-residence and other members of the NVAC team. I'm definitely departing with a huge to-do list and a bunch of new ideas to explore. Additionally, I had fun presenting a series of brown bag seminars about topics in visualization and analysis. The talks were well received and sparked a lot of stimulating discussions and ideas. I also enjoyed just sitting in on different group meetings to learn more about the ongoing projects and even offering up an idea or two from time to time. But I think the most valuable and enjoyable part of my stay has been getting to know the people here better. The warm hospitality they showed me these months has been tremendous and is really appreciated. I have made many new friends that I hope to stay in touch with for years to come."

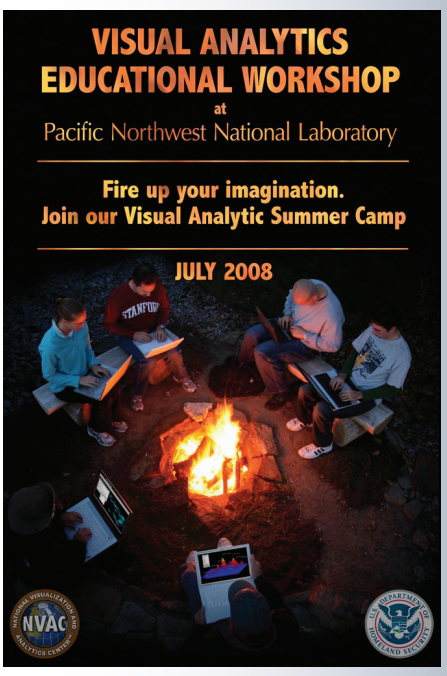
DHS Stakeholders Meeting

The Department of Homeland Security's Science and Technology Directorate held its Stakeholders meeting January 14-17, 2008 in Los Angeles. The meeting, titled "Putting First Responders First," focused on informing first responders, state and local governments, industry and academia of the direction, emphasis, scope and status of the research investments by DHS and on describing the business opportunities for private sector organizations and universities. The next Stakeholders meeting is scheduled for June 2-5, 2008.

Visual Analytics Summer Camp

NVAC is hosting a DHS-sponsored summer camp in July 2008. The two-week program is designed to bring together the next generation of researchers, developers and practitioners to facilitate the exchange of ideas and promote a shared understanding of visual analytics issues and solutions. The curriculum includes panels and presentations from professional information analysts and provides lots of hands-on training with the latest tools.

For more information, visit http://nvac.pnl.gov/summercamp.stm



Active Products: Composition and Dissemination of Smart Analytic Reports

One of the central challenges in visual analytics is helping analysts communicate the results of their work. Analysts need to be able to capture the discoveries they make using analysis tools and efficiently share those findings with colleagues and decision makers. This reporting phase of analysis often requires that products with different formats and content be customized for different audiences—yet such customization is typically a manual process that is separated from the act of analysis. Chapter 5 of the visual analytics R&D agenda, *Illuminating the Path*, describes this challenge in terms of production, presentation and dissemination. *Production* refers to the act of composing reports; *presentation* is the outward form these reports take, from graphics to written documents; and *dissemination* describes how the content of these reports is shared across an organization.

Creating New Reporting Models

"Active Products research is pioneering new forms of analytic 'products' that address many of the shortcomings of traditional reporting. Active Products are a new kind of smart report that can support both rapid authoring and new modes of presentation."

NVAC's Active Products research is pioneering new forms of analytic "products" that address many of the shortcomings of traditional reporting. Active Products are a new kind of smart report that can support both rapid authoring and new modes of presentation. These products are designed with four characteristics in mind. First, products must be auditable; they need to carry with them provenance information that reflects not just the origin of source data but also the analytic operations that were performed over it and the background knowledge that the analyst brought to the task. Second, products must be dynamic; as data, or analysts' confidence in it, changes, products should update automatically so that recipients of them are assured of working with the most up-to-date analysis. Third, products must be interactive; to support evaluation and re-use of analytic strategies, products should contain live visual components so that consumers "see what the analyst saw." Fourth, context-sensitivity should allow products to take different forms customized for their audiences, from actionable alerts for first responders to longer reports for policymakers that articulate the full reasoning behind hypotheses.

Collecting, Authoring and Disseminating Analytic Content

To create analytic reports with these characteristics, NVAC is developing new technology in three areas: collection, authoring and dissemination. For reports to become dynamic resources, analysis tools need to be their users' partners in the production of report content. The Active Products "collection widget" is a desktop sentinel that will connect to existing analysis tools and enable the capture of high-value analytic snippets. A *snippet* is a small piece of digital content that describes both an information unit (such as a piece of evidence) and the discovery processes that were used to find it. Snippets contain automatically generated provenance information about the analysis steps that the analyst took. An initial "snippet specification" is being developed that will allow any third-party tool to generate these snippets in a form that can be included in smart reports.

Once snippets have been collected from analysis tools, it's time to organize them into a report. The Active Products authoring environment lets the analyst focus on her story, crafting a message from the material she has produced along the way. Because the material has been collected automatically, it's a simple matter to organize and refine. A prototype online authoring environment is being produced that allows analysts to link written report content to the analysis snippets that underlie it. Using customizable taxonomies of analytic process variables, analysts can quickly record the relationship between their analytic processes and their ultimate findings.

Finally, products can be transformed into various presentation modes using style sheets. Typical formats might include text documents, web pages, slide sets and mobile messages. The Active Products team is currently working on MediaWiki extensions that support drill-down into the analysis and data behind statements recorded on wiki sites like Intellipedia. Access rules can be placed on these media, controlling the degree to which recipients will be able to interact with them and drill down to underlying data. Products can be transformed into new formats on the fly as they are disseminated, reducing the burden on the analyst to customize them manually.

Active Products research encompasses three areas: the collection of analytic content from analysis tools, authoring of dynamic, interactive reports and automated dissemination of customized reports for different audiences.

A Community Effort

VAC community involvement is required to make new reporting paradigms a reality. The Active Products project is initiating collaborations with academic and industrial VAC partners to identify and address the technology gaps that must be filled. For instance, an ecosystem of cooperating providers for Active Product content is needed; the larger the number of visual analytics tools that are "active product compatible," the more rich interactive content can be embedded in new reports. A significant research challenge, however, is in the representation of analytic reasoning strategies. How can visual analytics tools actively aid the detection and recording of analytic insight? How do active products describe reasoning processes such that they can be re-used? Over the coming months, the Active Products team will engage with VAC partners to build a research community around these problems.

Team Members

Pacific Northwest National Laboratory: Norm Carr, Wendy Cowley, Bill Pike, Rick Riensche, Ian Roberts, Marie Whyatt

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Purdue University Regional Visualization and Analytics Center

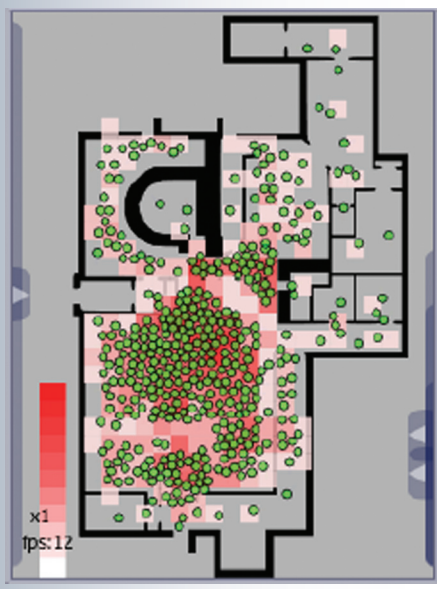
Mobile 3D visual analytic display of the simulation of the evacuation from The Station nightclub fire in Rhode Island.

PURVAC is an interdisciplinary research center with expertise in visual analytics, visualization, data integration and management, statistical analysis, image and video processing and analysis, mobile computing, data intensive computing, epidemiology, command and control, public health, veterinary health, medicine, homeland security and law enforcement. PURVAC's overall goal has been to develop visual analytic environments for the communication of information and insight from massive, disparate, incomplete and time-evolving homeland security data sets. These environments are comprehensive, providing analytic capabilities that enable the entire process from receiving massive, multisource and multimedia raw data, to the integration and extraction of relevant data necessary for the information analysis task, to the integrated visual presentation and analysis environment for evidence-based planning, decision making and response.

Mission-Oriented Research Goals

In order to have a direct impact on DHS missions in the near term, PURVAC is focused on mission-oriented research goals in two broad areas:

1. Integrated visual analytic and command and control environments for emergency planning, response and incident investigation:
   - Mobile analytics/sensor analytics
   - Emergency operations center/first responder visual analytic environments
   - Emergency response training
   - Video analytics
   - Network security analytics.
2. Novel, effective visual analytic tools for situational monitoring, event detection, planning and response for improved health and safety:
   - Healthcare monitoring
   - Pandemic and syndromic surveillance, management and interdiction planning
   - Biological sensing
   - Animal health and food production monitoring and management.



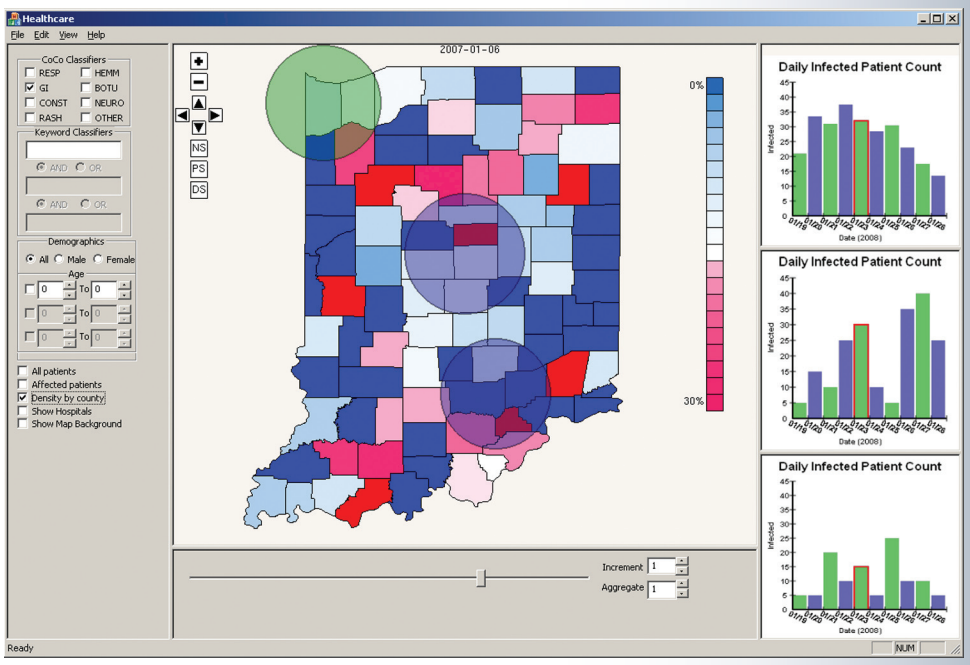
Congestion analysis display from the simulation of the evacuation from The Station nightclub fire in Rhode Island.

Mobile Analytics

Mobile devices bring computing power to personnel in any location. By leveraging their mobility factor, researchers can deliver visualization and data exploration solutions to problems that require on-site analysis where traditional desktop solutions are impractical. Typically, mobile visual analytic solutions are useful for in-field personnel, such as emergency responders and investigators. Emergency responders can take advantage of mobility coupled with wireless connectivity to be situationally aware. These devices can also be used to communicate and collaborate among field personnel. Real-time situational updates enable personnel to make critical decisions intelligently and rapidly in the wake of emergencies. Additionally, in-field investigators, such as network analysts and diagnostic personnel, can leverage the advantage of real-time connectivity and readily available computing power to interactively explore, analyze and diagnose situations directly in the field. The goal of this work is to explore the challenges in creating compact and interactive visualizations supported by limited mobile hardware on devices ranging from Tablet PCs to Pocket PCs, PDAs and cell phones. PURVAC is developing systems to address these issues.

Healthcare Analytics

The role of public health surveillance is to collect, analyze and interpret data about biological agents, diseases, risk factors and other health events in order to provide timely dissemination of collected information to decision makers. Unfortunately, data sources vary widely in accuracy and reliability, and frequently, unusual health trends, such as outbreaks or poisonings, have an incidence profile (signal) that is obscured by the statistical noise. To help investigators overcome these issues, PURVAC has developed a suite of statistical and visual analytical tools that couple novel data sources with human health data and enable more effective, advanced and timely analysis and investigation of unusual health events. Primary data sources include emergency room data from the Indiana State Department of Health, general visits of pets to Banfield, The Pet Hospital® locations, Indiana Board of Animal Health data and data from public health news feeds, such as ProMed. These analytical tools and data sets are brought together in a visual analytics environment called Linked Animal-Human Health Visual Analytics. The LAHVA application provides investigators with the ability to visually search the data for clusters in both a statistical model view and a spatio-temporal view. By providing linked graphical and statistical analysis views for public health officials, PURVAC will improve event detection and response, while reducing false positives.



Public health monitoring, investigation, analysis and response planning visual analytic display for the state of Indiana. This example shows inquiry and visual analysis for gastrointestinal case totals for the time period per county along with detailed statistical analysis plots for advanced analysis of three specific regions of interest, indicated by the circles in the main window.

For more information about the Purdue University Regional Visualization and Analytics Center, see http://www.purvac.org

Team Members

Purdue Universtity: Sandra Amas, William Cleveland, Chris Clifton, Timothy Collins, Edward Delp, David S. Ebert, Ahmed Elmagarmid, Mourad Ouzzani

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Foreign Animal and Zoonotic Diseases: An Information Analysis Framework

The November 2007 issue of *VAC Views* described the DHS Foreign Animal and Zoonotic Diseases Center of Excellence and its need for visual analytics technology. This follow-up article introduces a draft information framework to map levels of information abstractions from a real-world FAZD event through the resulting actions. The challenge of implementing such a framework will be maintaining a conceptual connection to how events unfold in the familiar space-time of the "real world" and the familiar two-dimensional decision space of "IF THIS, THEN THAT," while navigating through new multiple dimensions of informational space. A block diagram of the framework is shown below.

Why does Space-Time matter in the world of FAZD? Animals (humans and otherwise) are distributed in space. A disease moves through the animal populations that are distributed in space. The magnitude of a disease can be determined by how quickly it spreads or by how long it persists. If a disease is spread based on close physical proximity between animals, the important characteristics may be density and proximity in time, not simply relative proximity in space. Therefore, space and time bound FAZD events.

Event ST	FAZD ST	FAZD Information ST		Action ST
		SIMM ST	Decision ST	
Occurrence Detection	Biology Epidemiology Geography	Parameter Identification Statistical Sampling Stochastic Representation	Parameter Abstraction Relation Discovery	Response

Space-Time Framework: Levels of abstraction.

Event Space-Time

Disease events occur in space and time (Event ST). They start in a place or places; the disease spreads and subsides over time. Intervention can prevent, reduce or mitigate the amount of the disease and its consequences.

FAZD Space-Time

Geographic Information Systems are used to map the spread of a disease or related factors in space. The current FAZD GIS models represent the first level of abstraction beyond Event ST. Here, we try to understand what is happening in Event ST. We combine biology, epidemiology and geography to try to provide a visual representation that helps us better perceive what is happening as well as where and when it is occurring.

For instance, Rift Valley Fever (RVF) is naturally occurring in Africa and the Middle East. The disease primarily affects livestock but does affect humans that work in close proximity to the animals. The disease is vector borne; it is transmitted by mosquitoes. When the temperatures are favorable and there is a lot of rain in an otherwise arid climate, the mosquito population rapidly increases; RVF disease transmission accelerates; and disease outbreak occurs. To consider how RVF might spread in the United States, one can look at the parameters that govern the manifestation of the disease, temperature, moisture, mosquitoes and cattle in GIS visualizations.

FAZD Information Space Time

While GIS is a valuable and necessary first step, it is only a first step. GIS presentations themselves need to be made more visually useful to convey FAZD information. To truly accomplish this, researchers need to be able to build on GIS and move to another level of abstraction and visualization to better show the actual and potential magnitude of the consequences of a disease outbreak. Researchers also need to be able to identify critical junctures where and when the pathway of a disease event can be shaped and then integrate the insights from diverse disciplines. There must be a way to present the flow of information so that it is meaningful to different audiences, including the general public, relevant private sector industries, scientists from diverse disciplines, security planners and state and federal event managers.

The creation of simulated environments, or SIMM STs, for FAZD analysis is critical in developing a large population of events that can be created, manipulated, studied and evaluated, allowing for statistical tools to have a place in the analysis. To develop SIMM STs, the critical environmental parameters need to be identified, such as temperature and rainfall. Different physical parameters might need to be considered given the nature of a particular disease. These parameters might include vegetation, topography, water drainage systems and transportation infrastructure. Once the critical physical parameters are selected, a SIMM space representing a geographic space can be created: SIMM Counties, SIMM States, SIMM Regions, even a SIMM Nation. Whatever the scale, a statically representative sampling of the chosen parameters can be selected to create a SIMM Space.

To connect to and use the vast flows of information made available through VAC technologies and to organize that information in a way helpful for making decisions (Decision ST), the "essential nature" of critical FAZD parameters and variables needs to be abstracted from what is known about FAZD. It is necessary to sort out what is most important and why it is important in order to isolate and successfully visualize critical information for determining appropriate responses from the flood of potentially relevant data.

A first list of some of FAZD concepts and consequences that are governed by space-time:

- *Magnitude*
- *Concentration*
- *Proximity*
- *Connectivity*
- *Isolatableness*
- *Vulnerability*
- *Persistence*
- *Duration*

The relation of these concepts and consequences to space-time will also govern how "quickly" an event occurs and will determine which response goals, like containment, are feasible.

Action ST

Users return out of the simulations and models of Information ST having decided to do something. Traditional space and time relations matter again because the actions may have to be implemented in specific places and times in order to have the desired effects.

For more information about the research described here, see http://fazd.tamu.edu and the previous issue of *VAC Views* (http://nvac.pnl.gov/vacviews/VacViews_nov07.pdf).

Team Members

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Point of Contact

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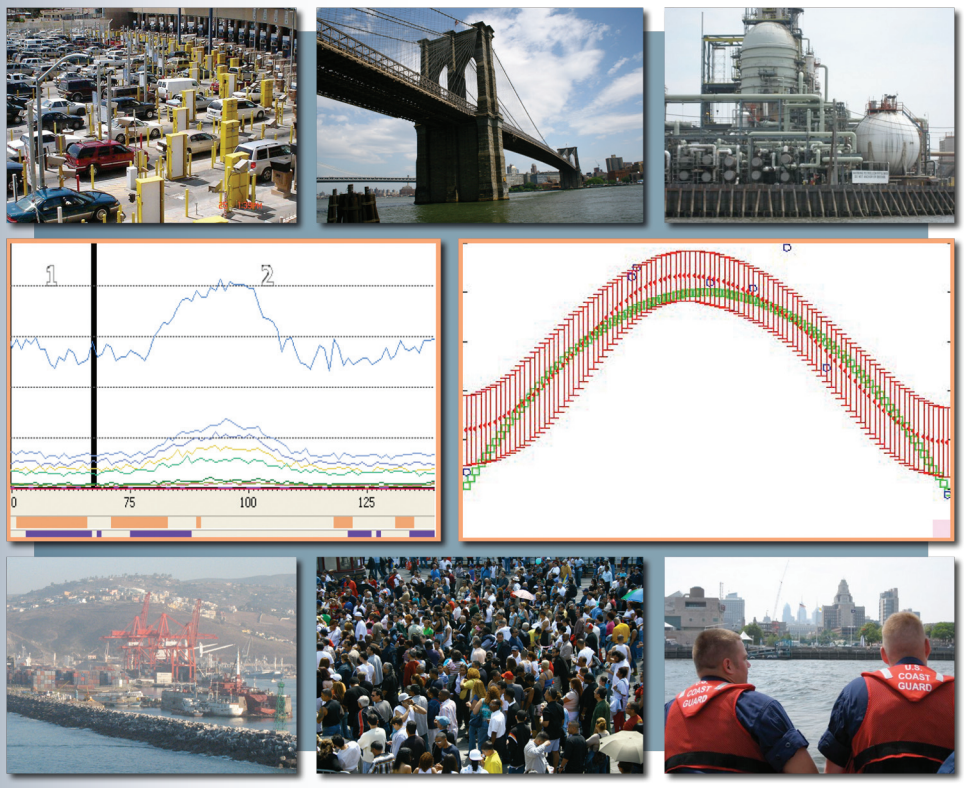
Enhancing Law Enforcement Using Data and Visual Analytics

The Center for Dynamic Data Analysis, or DyDAn, is one of four U.S. Department of Homeland Security Centers of Excellence performing research on advanced methods for information analysis. DyDAn, led by Rutgers University, coordinates the four centers, which are based at Rutgers University, the University of Pittsburgh, the University of Illinois at Urbana-Champaign and the Information Sciences Institute of the University of Southern California.

These centers are part of a larger nationwide collaboration, called the Institute for Discrete Sciences, that includes DHS and Lawrence Livermore National Laboratory. Methods of discrete science have become important tools for homeland security, especially when combined with powerful, modern computer methods for analysis and simulation.



Methods of the discrete sciences offer benefits to many areas of national importance, providing enhanced capabilities to secure our nation's borders, ports, industries, infrastructure and population. Potential benefits, however, lie not only in national security but also in applications from other fields that must reconcile large amounts of data from a variety of sources. These fields include medical informatics/healthcare, environmental protection and natural hazard prediction.

Applying Visual Analytics to Law Enforcement Challenges

DyDAn is joining with the Port Authority of New York and New Jersey, Pacific Northwest National Laboratory, Intuidex, and the National Consortium for the Study of Terrorism and Responses to Terrorism to develop cutting-edge data analytic and visualization tools to be immediately and effectively used by Port Authority law enforcement personnel. (See the November 2007 issue of *VAC Views* for more information about START.) The goal is to marry law enforcement and counter-terrorism initiatives to find emerging trends and changes in the nature and location of crimes and to enable more proactive force deployment by the Port Authority NY/NJ police.

As much as 75% of a law enforcement organization's data is unstructured—not stored in a database—making it one of the most valuable untapped resources available to law enforcement and counter-terrorism experts today. This project aims to organize and analyze Port Authority crime data to aid in crime prevention.

Phase One: CompStat

The project's first phase, CompStat, involves compiling comprehensive crime statistics from the Port Authority NY/NJ bus terminal. Much of the preliminary work creating a basic infrastructure is already complete. This includes downloading historical data from the Port Authority NY/NJ police server, setting up a network for automatic daily updates from the server and developing an interim database with crime analysis software.

This system enables a weekly CompStat recap for each facility, including statistics for seven major crimes, targeted crimes and quality of life issues.

The new crime analysis software sorts crime statistics by date, location, time of day and day of week to provide weekly CompStat summaries to support more efficient and effective force deployment.

Phase Two: Creating a Data Warehouse

The project's second phase involves creating a data warehouse aimed at providing easier access to under-utilized everyday data by enabling automatic information gathering and intelligence generation. These capabilities will support suspect identification and discovery of trends that aid in counter-terrorism and crime prevention efforts.

Phase Three: Visual Analytics Integration

The third phase is adopting the work being developed at the Automated Regional Justice Information System (see the November 2007 issue of *VAC Views*) and incorporating it with phase I and II outcomes. In this phase, techniques are also being created to identify and analyze valuable links between entities in order to enable the Port Authority NY/NJ police command staff to quickly visualize crime and other trends. Port Authority NY/NJ Executive Director Tony Shorris describes this system as a "national model" for counter-terrorism and crime prevention and analysis.

For more information about DyDAn, see http://www.dydan.rutgers.edu/

Team Members

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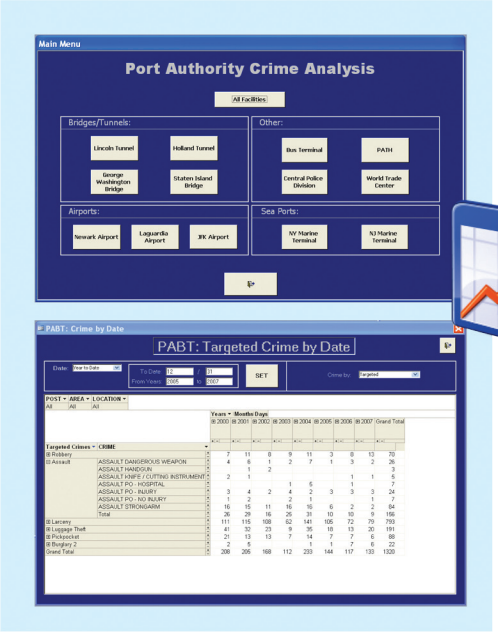
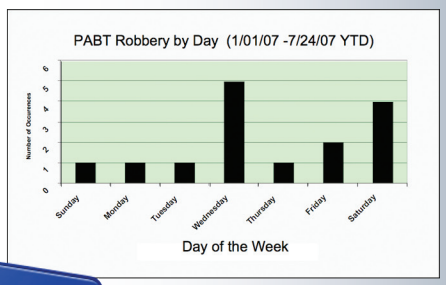
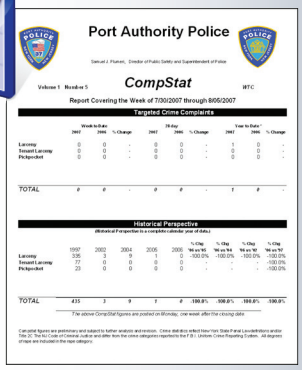
From Data...Discovery







The new Port Authority crime analysis software provides weekly CompStat Summaries to support more efficient and effective force deployment.

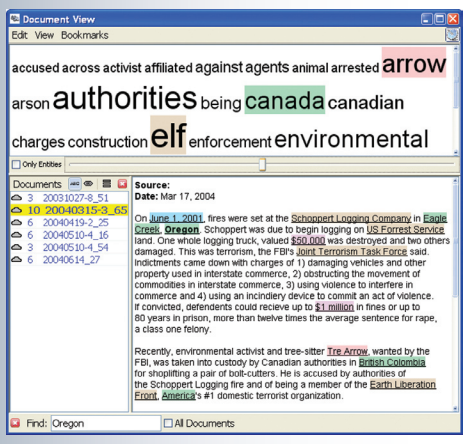
Jigsaw: Visualization for Investigative Analysis

Suppose that you are given a big box full of the pieces from many different jigsaw puzzles and you are asked to put the pieces together from one or two of the most "interesting" puzzles and describe what you see. Oh, by the way, not all the pieces of those "interesting" puzzles are in the box.

Investigative analysts, particularly those in fields such as law enforcement or intelligence, frequently confront this kind of challenge in their work. They are given large collections of seemingly unconnected documents and are tasked with identifying a plot or threat that is hinted at, but not clearly communicated, by a small subset of the documents in the collection.

Researchers at Georgia Tech and the SouthEast RVAC believe that clever visual analytic technologies can provide significant assistance to investigators faced with such challenges. They have developed a system called Jigsaw to do just that. Jigsaw provides visualizations of documents and the entities within them to help analysts explore the document contents and develop hypotheses about plots and stories suggested therein.

Investigative Focus



Document View showing a report with identified entities. The tag cloud summarizes key terms from a subset of documents.

Systems such as PNNL's IN-SPIRE™ provide investigative analysts with rapid overviews of large document collections, highlighting themes across the collection and sets of documents that cluster together. Jigsaw, instead, focuses on the individual entities within the documents: the people, places, organizations, etc., that are the actors and events in narratives to be discovered. Jigsaw allows the analyst to search for a particular entity, and then the system visually communicates the context of that entity, such as the documents in which it appears and the other entities to which it is connected.

Jigsaw provides a suite of visualizations that depict different perspectives on the documents and their entities. Each visualization (called a "view" in Jigsaw) communicates a different aspect of the documents and how the different entities relate to each other.

The figure to the left shows the most basic view within the system, the Document View. This visualization presents a subset of documents from the collection (listed in the left-hand panel) and shows one selected document in the main window. Entities of varying types, indicated by the words with different background colors, are shown in the context of the document's source text. The tag cloud above highlights some of the key terms from subsets of the documents.

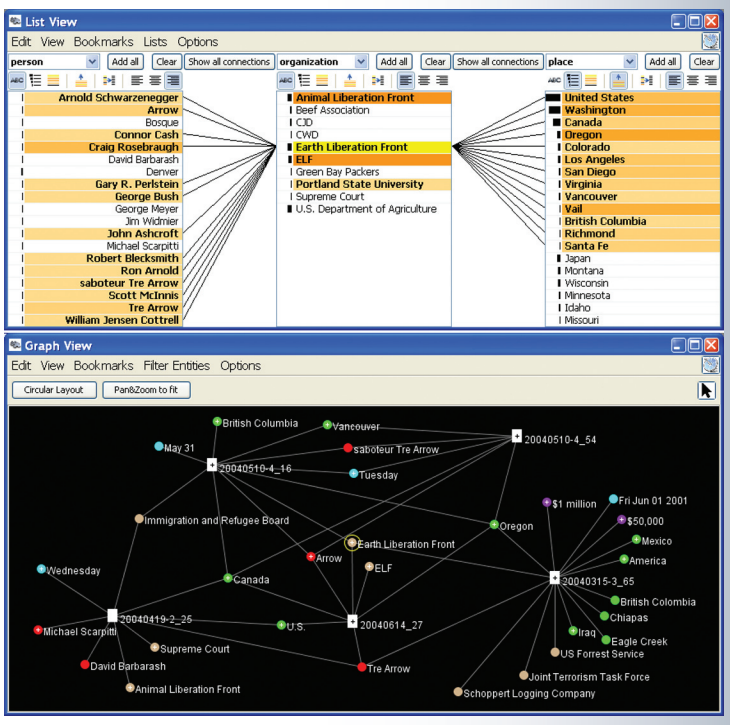
The first figure on the next page illustrates the List and Graph Views in Jigsaw. The List View presents lists of entities organized by entity type. Selected entities are drawn with a yellow background; entities logically connected to them are shown in orange, with darker shades indicating stronger connections. Entity lists can be sorted by frequency of occurrence across the document collection, connection strength, or alphabetical order on the entity names. Thus, the List View provides rapid exploration of the connections between sets of entities in the documents.

The Graph View provides a node-link representation of the documents and entities. Documents are white rectangles and entities are small colored circles connected by lines to the documents in which they appear. Jigsaw allows an analyst to display a particular document or entity and then interactively expand that item to show connected entities and documents, repeating the process to explore more of the "interesting" aspects of the collection. Jigsaw provides layout assistance when the view becomes cluttered so that the analyst can focus on the entities and documents of most interest to her/him.

This notion of interactive exploration is a key part of Jigsaw's design. The system's user interface provides a simple-to-learn model: a single mouse click selects an item and a double-click expands the item. Analysts can always query items through the system's search capability, but most investigation and analysis occurs by exploring the different representations in the system views.

Jigsaw includes a number of other views as well, including calendar-based temporal perspectives of the documents and entities and cluster-based collections of documents. Further, Jigsaw includes a Shoebox window to help analysts develop hypotheses, identify supporting evidence and organize their thoughts in general.

Because the system provides many different views of the document collection, researchers have found it fruitful to run Jigsaw on a multiple monitor computer that allows many views to be shown concurrently without overlap. The figure below shows a computer with four monitors in the Georgia Tech lab used to run the system.



List and Graph Views illustrating documents, entities and the connections.

Jigsaw in Action

Using Jigsaw as an analytic aid, Georgia Tech entered the 2007 IEEE Visual Analytics Science and Technology Symposium Contest and won the university division. The team is presently incorporating feedback from practicing analysts to refine Jigsaw's capabilities and views. Future planned research will explore collaborative versions of the system and support for reflection on the investigative process. Additionally, the Jigsaw team is actively seeking organizations that would like to explore the use of Jigsaw in their investigations.

For more information about the Jigsaw project, see http://www.gvu.gatech.edu/ii/jigsaw

Team Members

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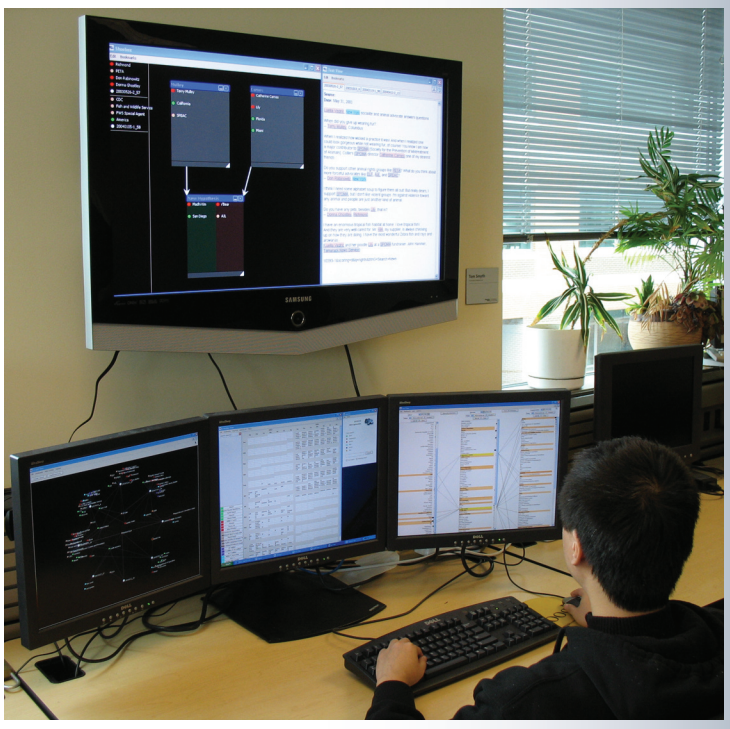


Jigsaw running on a multiple-monitor computer.

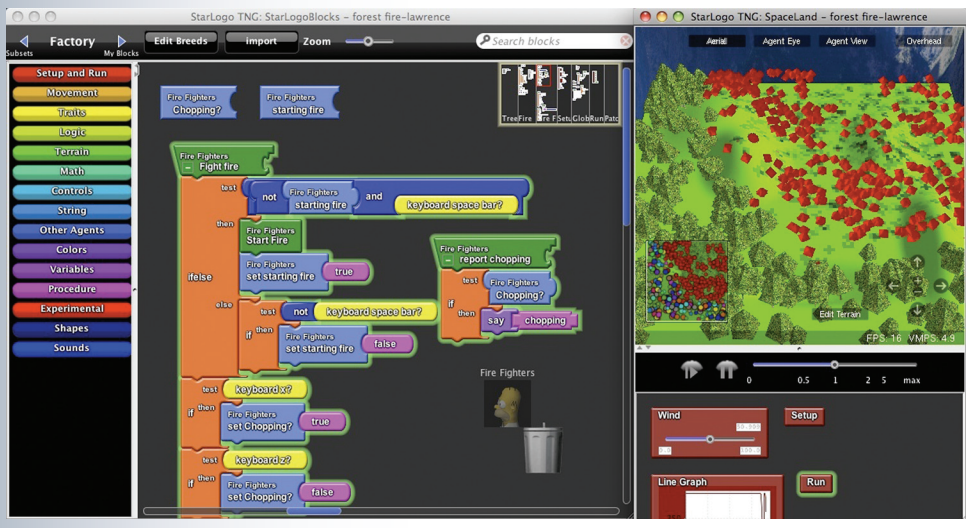
StarLogo TNG: An Imagination Toolbox to Explore Our World

The Office of University Programs from the Science and Technology Directorate of the Department of Homeland Security is partnering with the Massachusetts Institute of Technology Scheller Teacher Education Program (STEP) to develop curriculum units, inspired by research from the Homeland Security Centers of Excellence, that excite students and raise their interest in science, technology, engineering and mathematics careers. Topics ranging from the prevention of epidemics to increasing preparedness for natural disasters will be explored using an educational software tool called StarLogo TNG, also developed by STEP.

A Programming Environment for Students and Teachers

StarLogo TNG is graphical programming environment designed for middle and high school students and teachers to study and create 3D games and simulations. Unlike other programming environments, StarLogo TNG only requires users to connect puzzle-piece shapes called blocks to build their programs. Blocks are labeled with the program's commands, and users can only connect blocks of complementary shapes. Thus, the syntax of this language is visually apparent and encoded in the shapes of the blocks, relieving the work and stress of learning and recalling confusing syntax.

By connecting blocks, users program the behaviors of agents (characters and objects) in a 3D world. The 3D world enables students to immerse themselves in the games and simulations that they create, even allowing them to take on the perspective of agents and see firsthand the outcomes of the behaviors they programmed.



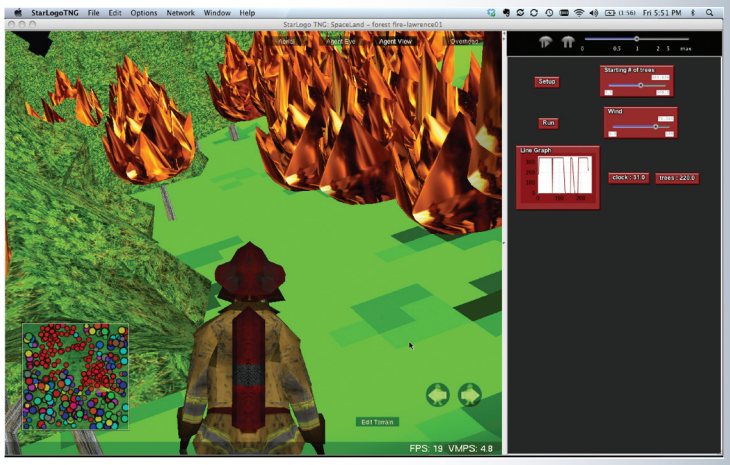
Users program by connecting puzzle-piece-shaped blocks, each labeled with a command. The block code, on the left side, defines a forest fire simulation in the 3D world called Spaceland, shown on the right side.

StarLogo TNG is already being used in a variety of classrooms and after-school programs. "Watching students collaborate as they use StarLogo TNG to create games that accurately reflect laws of physics reminds me why I feel so passionate about technology as a learning tool," says Aaron Mandel, a school technology coordinator at the Governor's Academy in Byfield, Massachusetts. "The students are fully engaged with material that is relevant to them, have creative control and are ferociously motivated to find creative solutions to complex problems."

Sample Curriculum Unit: Forest Fires

With the help of advanced teaching tools like StarLogo TNG and user-centered curricular units, the basic math and sciences behind the Centers of Excellence research can be integrated into existing school curricula. The Centers are investigating problems that are relevant and important to all of us, such as optimizing emergency responses to natural disasters or understanding the spread of epidemics. Educating students to understand the complex nature of these problems and appreciate the actions planned to reduce their likelihood and damage is essential. StarLogo TNG modeling and simulation enables young people to engage and apply what they are learning in a real and meaningful way. The knowledge students gain from both the content and the role of models and simulations in modern science is critical and empowering for emerging scientists and well-informed citizens alike.

Currently, MIT STEP is piloting a curriculum unit about forest fires with 7th and 8th graders in Lawrence, Massachusetts. In this unit, the role of simulations in modern fire prevention and containment is introduced along with the basic math and science concepts required to understand and modify these simulations. In the initial activity, students vary tree density and wind speed in a StarLogo TNG forest fire simulation developed for the unit. Then they ignite a fire in their simulated forest. They watch and measure the effect of their changes on fire spread and forest destruction. In follow-up activities, students may develop an emergency response plan by programming the behavior of a firefighter and other firefighting interventions or focus on prevention by designing a forest less susceptible to large-scale damage by removing brush, creating firebreaks or planting fire-resistant species. Teachers challenge the students to formulate informed, evidence-based recommendations to policymakers, who make decisions on fire management.



Users can easily immerse themselves in the 3D world called Spaceland by taking on the perspective of a single agent and seeing firsthand the behaviors they have programmed.

Upon receiving the challenge from teachers in a recent workshop at Lawrence, students became immediately absorbed, running their simulations through multiple iterations and collecting and analyzing their data. Some students even modified their provided worksheet and added columns to collect more data. "They're really engaged in deep, meaningful conversations about problem solving. If you listen to what they're talking about, they're figuring out problems," said one teacher at the workshop.

Integrating Real World Problems and Technology into the Classroom

By studying and building scientific models of complex systems with StarLogo TNG, students can develop valuable research and problem-solving skills while gaining a rich understanding of the complex and critical topics they are investigating.

To help advance DHS goals of wide distribution of these units, STEP will be conducting teacher workshops in the summer of 2008 to introduce teachers to the programming environment and to deepen their understanding of the simulation and game development capabilities of StarLogo TNG. The curriculum units and support materials generated from this joint project with DHS will be posted at a StarLogo TNG community website for national dissemination and to foster a community of teachers who integrate these units into their classrooms.

For more information about the research described here and to download StarLogo TNG and curriculum materials for free, see http://imaginationtoolbox.com

Seventh and eighth graders used the StarLogo TNG forest fire simulation to formulate recommendations that would help decrease the catastrophic damage of forest fires.

Team Members

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U.S. Department of Homeland Security: Matthew Clark, Tom Kowalczyk, Desiree Linson

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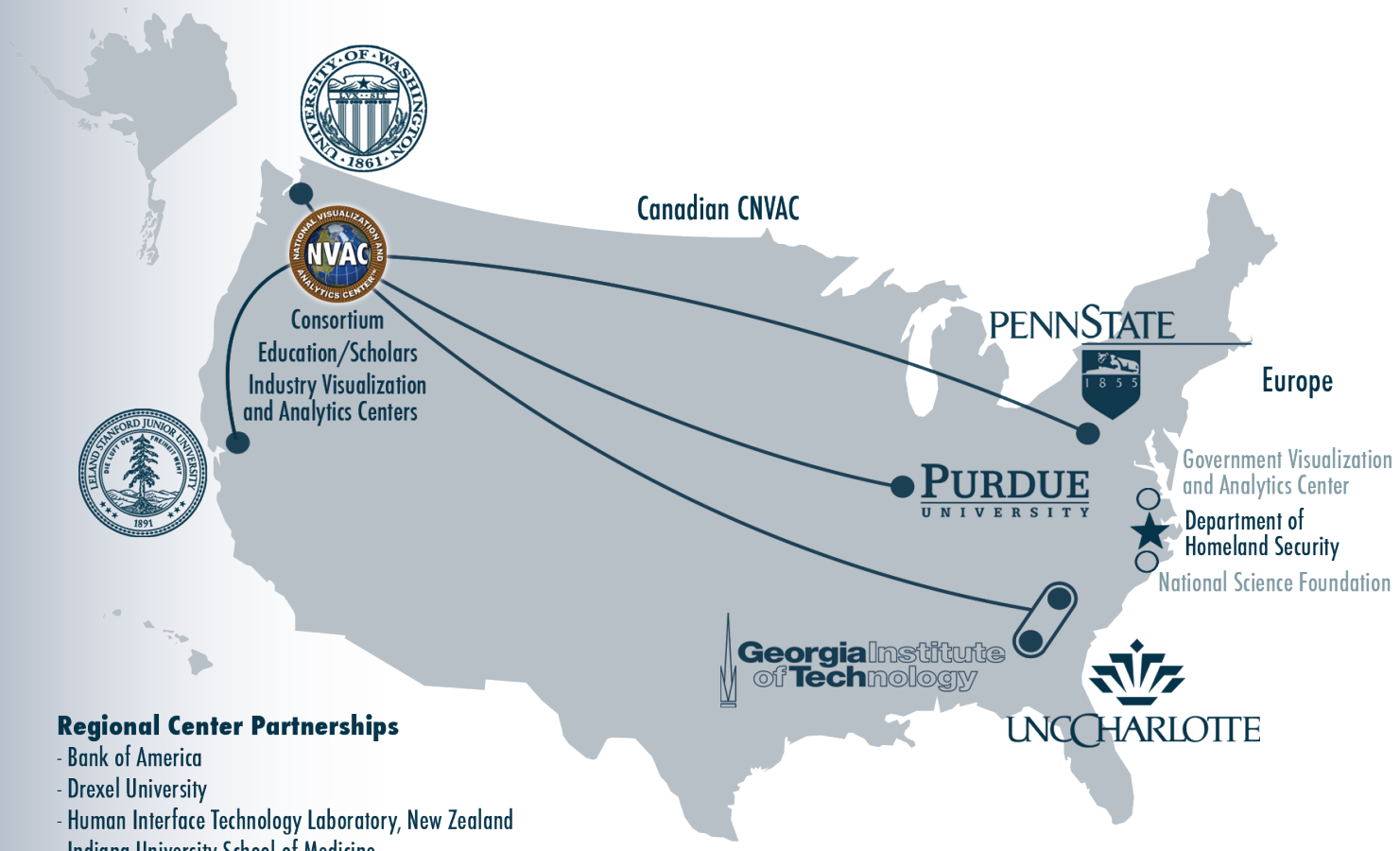
A Partnership with Academia, Industry and Government



Regional Center Partnerships
- Bank of America
- Drexel University
- Human Interface Technology Laboratory, New Zealand
- Indiana University School of Medicine
- NY/NJ Port Authority

Consortium Members – Provider Level

Microsoft Research
BOEING
tableau SOFTWARE
FUTURE POINT Systems, Inc.
Quantum4D®

Program Representatives

Joseph K. Kielman
Department of Homeland Security

John Hoyt
Department of Homeland Security

James J. Thomas
National Visualization and Analytics Center

What Is VAC?

The Visualization and Analytics Centers are a national and international resource, fulfilling a fundamental need to provide advanced analytical tools to address the U.S. government's critical challenges in identifying and preventing attacks on U.S. soil.

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 VACs through academic, government and industrial partnerships.

Vision

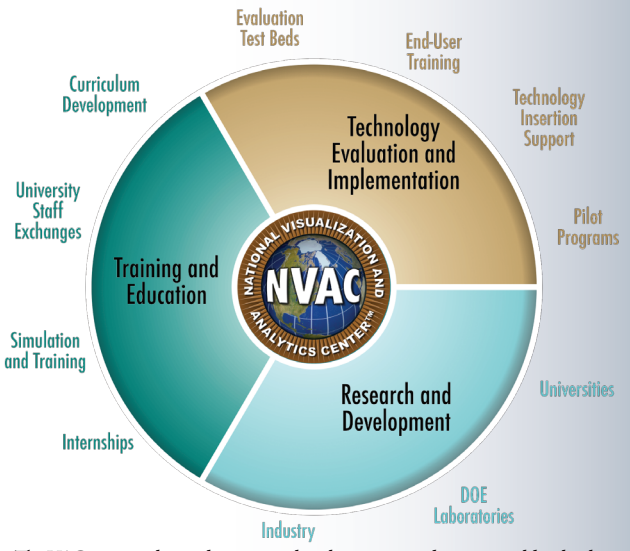
VACs will provide high throughput, accessible visual analytics, enabling anticipation and prediction of, preparedness for, and response to man-made and natural disasters and terrorist incidents and ensuring the security and resilience of our nation's infrastructures and citizenry.

VAC Approach

VACs are more than research and development. They foster a culture that brings together the resources necessary to advance the state of visual analytics.

The VAC charter includes four major missions:

- **Research and Development Leadership:** Provide stewardship for the visual analytics R&D agenda, ensuring that a continual stream of advanced analytical tools 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.
- **Coordination and Integration:** Bring together the best researchers from government, academia, industry and national laboratories to create visual analytics tools.



The VAC approach involves research, education, evaluation and leadership.

VAC Partnerships

The unique partnerships created under VACs among universities, industry and government agencies represent an ongoing commitment to collaboration in the discipline of visual analytics.

Regional Visualization and Analytics Centers

Each university-led RVAC conducts research in one or more of the areas described in the R&D agenda for visual analytics. The RVACs' research concepts and prototypes are evaluated in the context of user needs and priorities. RVACs also develop curricula in visual analytics.

Government Visualization and Analytics Centers

GVACs, which are led by non-DHS government agencies, aim to create the best possible visual analytics tools for government missions.

Industrial Visualization and Analytics Centers

IVACs support the research in elements of the R&D agenda or fund integrated technology demonstrations that join new capabilities to address an important problem.

Other Partnerships

Other less formal partnerships have been formed (for example, through University Affiliate Centers), and NVAC has a year-round internship program for both students and professors. The twice-yearly VAC Consortium meeting brings together all the partners to promote dialog, understanding and education. Meaningful collaboration helps 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 Centers

Visualization and Analytics Centers are a national and international resource, fulfilling a fundamental need to provide advanced analytical tools to make progress in understanding and addressing critical challenges in identifying and preventing terrorist attacks in the United States and around the globe. The following listing provides brief descriptions of the Centers, the Centers' individual projects, and related and jointly funded projects. The primary points of contact for each Center are also provided for further information.

NVAC – Contact: Jim Thomas, jim.thomas@pnl.gov

The National Visualization and Analytics Center provides leadership and coordination among the academic community, industry and government to create and deploy visual analytics technologies to ensure the security and resilience of our nation's infrastructure.

Leadership & Coordination

Visualization and Analytics Center Consortium

The VAC Consortium provides a forum where industry and university leaders and government specialists collaborate to achieve the best solutions to protect the nation.

VAC Participation in Conferences and Workshops

Participation and collaboration through conferences, workshops and other forums ensures that VAC-developed technology is deployable and has real-world impact.

National Science Foundation: Partnering to Advance Visual Analytics

A formal partnership between DHS and the National Science Foundation results in the establishment of the NSFVAC.

Educating the Next Generation

Internships for students and professors at NVAC, visual analytics curricula at universities, and workshops at conferences and other venues are just a few of the ways the VACs are educating the next generation of researchers.

Research

Scalable Reasoning System: Lightweight Visual Analysis and Dissemination

SRS is a prototype suite of analytical capabilities that can be deployed over the web. Its visual interfaces offer intuitive ways to explore information collections.

Visual Analytics for Law Enforcement

The Scalable Reasoning System links mobile and office law enforcement personnel with real-time information analysis and notification tools. Web-based and PDA interfaces enable investigators to find patterns in data and disseminate findings to colleagues.

Threat Stream Generator

TSG creates realistic data sets that are becoming the test data sets of choice by commercial tool developers, government analysts, and university technology developers.

Evaluation of Visual Analysis Environments

This project is helping RVACs develop their own evaluation metrics based on their needs and working with potential end users to develop task descriptions, work environment constraints and metrics.

Visualizing Semantic Graphs

Have Green is a suite of visual analytics technologies that supports analysis of large semantic graphs.

Analyzing the U.S. Electric Power Grids

GreenGrid, a visual analytics prototype, identifies vulnerabilities in U.S. power grids.

The Assessment Wall: Usable Visualization for Streaming Data

The Assessment Wall has linked visualizations for streaming text documents on a high-resolution touch-screen interface to help users find the latest on topics of interest and to discover unexpected and emergent themes.

Text/Data Analytics Integration

This effort explores approaches that will leverage analysis techniques used for both unstructured text analysis and structured data analysis.

Active Products: Composition and Dissemination of Smart Analytic Reports

Active Products are a new kind of "smart report" that support both rapid authoring and new modes of presentation.

Information Synthesis and Fusion

This research intends to develop mathematical models and methodologies that merge information with different conceptual representations into a common semantic space.

Rapid User-Guided Analytics: Reducing the Time to Productive Analysis

RUGA is developing ways for users to rapidly assess an entire information space in a personalized context.

ProSPECT: Proactive Scenario Production, Evidence Collection and Testing

ProSPECT is a visual interactive environment for event, entity, and relationship analytics that integrate knowledge discovery, discourse analysis and visualization capabilities to scenario manipulation and generation.

Audio Categorization

This project is developing the capability to compare audio and text features based on the linguistic and emotional content of a conversation recording and combining the analytical results into one coherent, comprehensive analysis.

IN-SPIRE

IN-SPIRE is text analysis and visualization software that can quickly reveal important information from large collections of unformatted text documents and accelerate subsequent investigation and discovery.

Universal Parsing Agent

UPA, an R&D 100 award winner, accepts multiple data sets or streams of information, discovers and extracts information needed by users and delivers results in their most useful form.

The Pennsylvania State University –
Contact: Alan MacEachren, maceachren@psu.edu

The North-East Visualization and Analytics Center, operated by Penn State, is one of five regional centers coordinated by the National Visualization and Analytics Center and supported by the U.S. Department of Homeland Security. NEVAC is developing knowledge-enabled, geographically aware visual analytics.

Thrust 1: Information Retrieval, Extraction and Contextualization

A fundamental challenge for homeland security is to quickly find among massive volumes of data the information essential for threat and situation assessment and decision making. This thrust addresses the challenge through fundamental research linked to development, implementation, testing and deployment of visual analytics tools.

FactXtractor: Automated Named Entities and Entity Relationship Extraction from Text Documents

FactXtractor is an information extraction web service that provides core technologies to support textual data analysis.

FEMARepViz: Automatic Information Extraction for Geo-temporal Visualization

FEMARepViz supports nationwide and regional crisis situation assessment by visualizing FEMA situation updates geographically. It automatically extracts place and event information from reports and plots them on web-based maps that make it easy to see the distribution of events and to drill down to relevant details.

Context Discovery Application

CDA supports knowledge-enabled retrieval of news stories and other documents relevant to user-specified issues and places.

TexPlorer: An Integrated System for Text Analysis and Visualization

TexPlorer enables information analysts to find entities and connections in text documents.

Geographic Information Retrieval

Geographic Information Retrieval methods and tools address the challenge of retrieving documents that are relevant to a task in terms of both document theme and geographic focus.

Health GeoJunction

Health GeoJunction is an interactive visual analytic web portal for tracking the science and public health indicators of infectious disease threats.

Thrust 2: Visual-Computational Methods

NEVAC is developing new visual and computational methods that support rapid sifting and analysis of complex information sources. The approach combines modular tool architectures that support interconnection of independently developed components with general visual analytics strategies that adapt easily to many problem contexts and support complex querying of realistically large data sets.

Improvise Application: KEDS

The Kansas Event Data System tool provides analysts, policy advisors, journalists, and social scientists with a highly interactive visual interface for probing geographic and temporal patterns in political relationships between groups of international actors.

Improvise: Highly Coordinated Multiple View Visualization

Improvise provides tool developers with an environment for rapidly prototyping and implementing applications that support highly interactive visual exploration and analysis of high-dimensional, multi-source information.

The GeoViz Toolkit: Insight into Spatial Data

The GeoViz Toolkit supports systematic analysis of spatial, temporal and attribute data sets and allows analysts to discover previously hidden patterns in data.

CiteSpace: Detecting and Tracking Trends and Transformative Changes

CiteSpace facilitates visual analysis of trends, patterns and critical changes in a volatile information environment.

Semantic Network Structure Analysis

SemanticNetSA will help analysts assess the evidentiary value of data stored in graph or network form.

Thrust 3: Knowledge Representation and Management

In this thrust area, NEVAC's focus is on integrating technologies from three areas: concept mapping and knowledge visualization; ontology management; and text browsing and analyzing.

ConceptVista: A Visual Environment for Ontology Development and Analysis

ConceptVISTA supports the representation, management, and exploration of knowledge and the connection of knowledge with data. It enables analysts to quickly encode tacit knowledge and link artifacts to existing knowledge structures that support computational reasoning.

Thrust 4: Supporting Analysis and Decision-Making in Group Work

NEVAC research in group work is identifying impediments to successful distributed and collaborative, visually enabled work in the domains of crisis management and threat assessment and developing specific geo-visual analytics technologies to support collaborative tasks in these domains.

NeoCITIES Geo-Tools

NeoCITIES Geo-tools is an update and extension of the NeoCITIES scaled-world simulation developed based on knowledge elicited from crisis management experts. NeoCITIES is a resource allocation problem involving police, fire and hazardous materials teams designed to mimic emergent situations that comprise real-life emergencies and to measure decision-related outputs.

Purdue University – Contact: David Ebert, ebertd@purdue.edu

Purdue University Regional Visualization and Analytics Center is dedicated to supporting the National Visualization and Analytics Center and the U.S. Department of Homeland Security in confronting the challenges of safeguarding our nation against natural and human-induced catastrophic events.

Data Integration

PURVAC is taking a multipronged approach to solve challenges inherent to the critical problem of data integration.

Privacy and Visual Analytics: Effective Analysis of Anonymized Data

PURVAC is evaluating and comparing privacy protection methodologies and their impact on analytical methods and plans to analyze the performance of de-identified data relative to original data to see when privacy and utility coexist.

Visual Analytics for the Disaster Response Life Cycle

The visual analytics disaster response life cycle defines the key challenges facing first responders. By implementing systems based on this framework, tools for improved coordination, delivery, detection and response in large-scale disaster management will be greatly enhanced.

Mobile Analytics for Command & Control in Real-World Testbeds

PURVAC is exploring the potential of mobile analytic techniques using several applications as test beds: wireless network/sensor mobile analytics for the eStadium project; first responder mobile analytics using the Muscatatuck Urban Training Center; and first responder mobile analytics using a decommissioned elementary school.

Integrating Personnel Tracking and Video Capture For Emergency Response

This research focuses on creating an affordable, mobile, state-of-the-art emergency response training capability and real-world testbed through the integration of low-cost, commercially available products.

In-field Visual Analytics

PURVAC has developed three systems that address the challenges in creating compact, interactive visualizations supported by limited mobile hardware on devices ranging from TabletPCs to cell phones.

Mobile Analytics for Emergency Response and Training

PURVAC's mobile visual analytics system provides a flexible, interactive prototype for emergency response and training by allowing first responders to better carry out rapid and actionable on-site analysis and decision making.

Sensor-Driven Video Analytics: Next Generation Surveillance System

PURVAC is investigating a new approach to the development of sensor-driven surveillance systems that monitor security conditions, identify events of interest and coordinate emergency response operations.

Smart Video Surveillance

Object-tracking tools have been tested on video sequences with moving objects including humans and vehicles. These tools can be deployed in many applications such as visual surveillance, road traffic control, human-computer interface and video compression.

Social Networks: Applications to First Responder Scenarios

PURVAC is examining social networks in the context of first responders. The main issue is how to coordinate resources and first responders in an emergency. To answer this question, PURVAC is harnessing key ideas drawn from social networks: presence and status, messaging and coordination.

Visual Analytics for Analysis, Management and Containment of Zoonotic Disease Spread

PURVAC has developed a suite of analytic tools aimed at improving disease control on local farms, as well as providing analysis of larger scale zoonotic disease occurrences.

LAHVA: Linked Animal-Human Health Visual Analytics

LAHVA technology provides public health officials with a suite of visual analytic tools for spatio-temporal exploration of multivariate healthcare data sets in linked statistical and geospatial-temporal views.

Time-Space Modeling and Analysis for Disease Surveillance

Advanced statistical models provide healthcare professionals with tools for measuring and predicting disease spread, allowing for rapid detection and response to outbreaks.

Network Security: Flow Monitoring and Forensics

PURVAC is collaborating with the Stanford RVAC to develop novel techniques to analyze traffic flows on computer networks to distinguish normal user activity from attacks to prevent humans and machines from gaining illegal entries.

K-12 Education Initiative

PURVAC and the Purdue Homeland Security Institute are working on educational outreach initiatives to inform PK-12 students and teachers about the broad range of topics related to visual analytics and homeland security.

Stanford University – Contact: Pat Hanrahan, hanrahan@cs.stanford.edu

The Stanford RVAC performs basic research on the technology behind visual analytics with an emphasis on applications drawn from transactional analytics.

Scalable Visual Analysis for Temporal Databases

The goal of this research is to develop technologies that enable scalable and interactive visual analysis over large temporal data sets.

Isis: Visual Analytics for Network Security Investigations

This project contributes new interactive visualization techniques for analyzing, organizing and presenting network event data at multiple levels of detail for the purpose of forensic analysis—tracking down causal sequences of importance.

Visualizing Heterogeneous Information Spaces

The Stanford RVAC is developing techniques for automatically creating visualizations from heterogeneous graphs of relations. The system automatically searches for and ranks paths from objects to the attributes needed to visualize the objects.

The Perceptual Efficiency of Information Visualization

This project is conducting basic research in visual analytics using eye tracking. The purpose is to improve the understanding of established visualization display and interaction techniques by analyzing interaction at the level of moment-to-moment visual attention and cognitive load.

University of North Carolina-Charlotte and Georgia Tech – Contacts: William Ribarsky, ribarsky@uncc.edu; John Stasko, stasko@cc.gatech@edu.com

The SouthEast Regional Visualization & Analytics Center (SRVAC) is a closely integrated collaboration between the University of North Carolina at Charlotte and the Georgia Institute of Technology. The main objective of SRVAC is to attack challenging problems in evidence gathering, investigative analysis, hypothesis building and testing, and decision making using analytical reasoning capabilities within the visual analytics context.

RESIN: Resource-bounded Decision Making

RESIN is a mixed-initiative reasoning agent that helps investigative analysts perform multi-view point predictive analysis.

Global Terrorism Data Visualization

GTD contains a broad range of visual analytic tools to support the exploration and investigation of patterns in international terrorist activity.

Automated Intelligent Multimedia Analysis

These tools provide investigators a complete, annotated organization of very large collections of images, broadcast video, multimedia web pages and more.

Image and Video Visual Analysis

Semantic Image Browser integrates automatic semantic image classification techniques with novel visualization techniques to let analysts browse and search large image databases. Broadcast News Video Browser integrates automatic news video analysis and temporal analysis techniques with visualization techniques to help analysts detect major news events, access related stories and retrieve stories from large video streams.

Jigsaw: Visualization for Investigative Analysis

Jigsaw provides investigative analysts with a "visual index" onto a document collection and helps them track down connections between entities, thus facilitating the discovery of embedded plots and threats.

Financial Visual Analysis

WireVis facilitates the marriage between the art of analysis with the science of visualization and allows the analyst to systematically discover suspicious financial activities in a reproducible manner.

ResultMaps: Understanding Search Spaces and Search Results

ResultMaps use existing hierarchical structures (e.g., subject classifications) to provide a visual representation of how search results are distributed over a data set.

Visual Analytics Digital Library

VADL provides an organized and readily accessible collection of educational material designed to help teachers develop VA courses and to help students more quickly develop competence as VA practitioners and developers.

University of Washington – Contact: Mark Haselkorn, markh@u.washington.edu

The University of Washington manages the Pacific Rim Visualization and Analytics Center. PARVAC's mission is to advance distributed cognition and visual analytics to enhance decision making for public safety and security around and across the Pacific Rim. PARVAC also serves as a resource for regional research on communication and collaboration among public safety and security agencies in Puget Sound.

RimSim

RimSim is designed to integrate relevant critical infrastructure data and interaction methods into a role-playing testbed for synchronous and asynchronous collaboration during simulated emergency scenarios.

Just-In-Time C3

The JITC3 visualization system uses GIS data to generate a cohesive geo-spatial representation of an urban environment that can be navigated and manipulated using Augmented Reality. JITC3 has an intuitive, tangible interface to navigate and view location-specific perspectives.

Geospatial Optimization of Strategic Resources

The GOSR project develops optimization models for the location and allocation of medical supplies to be used in emergencies in the Seattle region, an area vulnerable to critical infrastructure damage due to earthquakes. These optimization models are an important component of the "analytics" in visual analytics systems.

Moving Visual Analytics Research into Practice

This project aims to improve the way new technology for enhanced visual analytics is developed, introduced and maintained within the environments of regional safety and security communities.

University of Illinois at Urbana-Champaign – Contact: Dan Roth or Robin B. King, contact@mias.uiuc.edu

The Multimodel Information Access and Synthesis Center

The MIAS Center is part of a nationwide network of Department of Homeland Security Centers of Excellence that perform research on advanced methods for information analysis and decision science.

New Search Paradigms for Meaning-based Information Retrieval

The goal of this project is to develop natural-language processing capabilities and associated search protocols that improve search capabilities.

Cornerstone Technologies for Automated Text Analysis (part one)

MIAS is developing a suite of efficient, precise and domain-adaptable tools that improve information extraction, synthesis and visualization by making relevant concepts in natural-language text easily accessible to analysts.

Cornerstone Technologies for Automated Text Analysis (part two)

MIAS is developing general probabilistic models and new algorithms for discovering and analyzing various contextual patterns from text.

Contextual Text Analysis with Probabilistic Topic Models

This project is developing general probabilistic models and new algorithms for discovering and analyzing various contextual patterns from text.

MetaQuerier: Exploring and Integrating the Deep Web

This research aims to enable effective access to structured information sources on the internet.

Complex Data Analysis: Knowledge Discovery from Massive Data Sets

This effort reveals hidden correlations or structural events; analyzing such hidden networks will have a strong impact on identifying hidden themes as well as analysis of social (and anti-social) networks and other sub-communities.

Learning the Meaning of Pictures

Words that appear next to images are correlated. We use this information to train correlated word predictors and discover scene types, improving analysts' ability to derive useful information from images and text.

Cimple: Monitoring People and Events for Online Communities

The Cimple Project is developing a software platform that can be rapidly deployed and customized to manage data-rich online communities.

Data Science Summer Institute

The MIAS Center has a unique summer program that teaches information analytics and retrieval methods from a vast number of potential sources.

University of Pittsburgh – Contact: Jan Wiebe, wiebe@cs.pitt.edu

CERATOPS: Center for Extraction and Summarization of Events and Opinions in Text

CERATOPS is developing new capabilities for information extraction from unstructured text that will allow information analysts to automatically identify entities, facts, and relations from text-based information sources. The emphasis of this work is on accuracy, robustness and rapidly re-trainable deployment.

Detecting Opinion and Sentiment Types to Improve Question Answering and Information Extraction

Expressions of opinion are ubiquitous on message boards, discussion forums, blogs etc. Being able to automatically extract these opinions in a timely manner enables one to take the pulse of public opinion.

Extraction and Summarization of Fine-grained Opinion Frames

This project tackles the problem of automating fine-grained interpretation of opinion expressions at the phrase-level or clause-level.

Exploiting Semantics in Information Extraction

This project has developed several new methods for extracting factual information from unstructured text. These techniques have achieved good results in the domains of Latin American terrorism and infectious disease outbreaks.

Rutgers University – Contact: Fred Roberts, froberts@diamacs.rutgers.edu

DyDAn Is a University Affiliate Center of the Institute for Discrete Sciences

The Center for Dynamic Data Analysis (DyDAn) is one of four Department of Homeland Security Centers of Excellence performing research on advanced methods for information analysis.

Analysis of Large, Dynamic Virtual Communities

This project is developing methods for understanding and analyzing large dynamic multi-graphs arising in virtual communities.

Universal Information Graphs

Universal Information Graphs are a tool for analysts that are the result of fusing a collection of graphs on separate vertex sets. This project is developing the algorithmic and computational infrastructure to support analysis of dynamic, and sometimes massive, networks.

Optimization and Learning for Decision-making under Uncertainty

This project is developing logic for optimally collecting information and for detecting fundamental changes in streams of data. These methods are applicable to a broad range of detection problems, such as determining when a nuclear detector has failed or when a new pattern of activity emerges.

Enhancing Law Enforcement Using Data and Visual Analytics

DyDAn is joining with the Port Authority of New York and New Jersey, Pacific Northwest National Laboratory, Intuidex and the National Consortium for the Study of Terrorism and Responses to Terrorism to develop cutting-edge data analytic and visualization tools for immediate use by Port Authority law enforcement personnel.

Laboratory for Port Security

The Laboratory for Port Security is building systems to help understand and mitigate the impact of events at ports.

Optimizing Port of Entry Inspection

This project is providing strategies for inspecting cargo containers at sea ports, balancing costs of inspection with detection rate to achieve the best possible detection rate given practical limitations.

Sensor Management Problems of Nuclear Detection

This project is addressing sensor management for nuclear threat detection by formulating the related problems using precise mathematical language and then developing tools of the mathematical sciences to solve them.

Privacy-Preserving Model Selection

This project studies privacy-preserving model selection. Initial work assumes a kind of vertical partitioning in which one party holds all the data except the class label and a second party holds all the class labels. The project demonstrates how to perform model selection using cross validation in a privacy-preserving manner without revealing the parties' data to each other.

Using Entropy for Biosurveillance

This project, initiated as part of the DHS Summer Research Team Program for Minority Serving Institutions, examines the potential for using information theoretic measures of entropy in biosurveillance.

Adding Semantics to and Interconnecting Semantic Graphs

This project is investigating augmenting shallow representations of information in semantic graphs or networks with richer information, expressed as ontologies in formal representation languages (such as OWL).

Outreach Across New Jersey

DyDAn members are joining with state and local agencies to help keep New Jersey safe.

DyDAn K-12 Education Programs

DyDAn is committed to building pioneering educational programs that nurture the homeland security workforce of the future. Aware that individuals can help develop homeland security solutions well before college, DyDAn is developing K-12 programs to help teachers introduce homeland security topics in their classrooms.

DyDAn Research Experiences for Undergraduates

The intensive 8-week DyDAn Research Experiences for Undergraduates summer program pairs undergraduates with DyDAn faculty mentors to conduct research on important problems in homeland security.

Summer Reconnect Conference

Annual DyDAn Summer Reconnect Conferences allow faculty and government and industry professionals to explore research questions in a new area of the mathematical sciences relevant to homeland security. This program seeks to "reconnect" to the research enterprise faculty and researchers who don't have the time to keep up with research developments or who would like an immersive introduction to a new research area.

Promoting Homeland Security Research

DyDAn is building awareness of the importance of data analysis in homeland security. DyDAn hosts research workshops, seminars and tutorials to help connect the research community with the homeland security enterprise.

University of Southern California – Contact: Eduard Hovy, hovy@isi.edu

CKID: The Center for Large-Scale Strategic Knowledge Integration and Discovery from Multiple Media

To contextualize and visualize various media in the most appropriate form and discover trends and patterns, CKID is building technology to extract and save the data into a standardized form for each medium.

Geospatial Visualization of Multiple Media for Large-Scale Strategic Knowledge Discovery

This research is building a comprehensive geospatial knowledge base by exploiting a variety geospatial sources and using the knowledge base to search the various media to link them to specific locations.

Large-Scale Discovery of Patterns from Textual Information

This project is developing algorithms to allow automated discovery of trends and patterns over large amounts of textual information.

A Federated Store for Extracted Information and Semantic Graphs

This project provides a store for extracted and ontological information to facilitate effective retrieval by analysts and provide the basis for analysis methods and learning techniques to be applied to a massive amount of source information.

Context-Based Information Trust Analysis for Threat Detection

CONITA filters and presents the most relevant information for the analyst to enhance threat detection. The Content Relevance of the information (e.g., documents) presented to a user in response to an information request is measured based on the semantics of the request and the interests of the analyst.

Learning about Organization Structure and Personnel from Email

This project investigates what can be learned about individuals in an organization from their email messages.

KOJAK Link Discovery Tools

KOJAK UNICORN uses anomaly detection to find anomalous entities in large, complex data sets that are best represented by semantic graphs. KOJAK Simplifier applies normalization and abstraction operators to simplify large semantic graphs, allowing analysts to focus on and visualize only the important parts of the data.

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