

Technosocial Predictive Analytics Initiative

Winter 2009

<http://predictiveanalytics.pnl.gov/>



QUARTERLY NEWSLETTER



Antonio's Notes

As we conclude our sixth quarter of operations, we wish to thank everyone who has continued to follow the activities of our Technosocial Predictive Analytics Initiative. The new quarter opened with a very successful two-day workshop on Analytic Gaming, with guests

Rachel Hanig and Mark Henshaw, who are the winners of the prestigious [2007 DNI Galileo Competition](#). We look forward to continue working with Rachel and Mark to leverage our work in support of their efforts to stand up a National Security Simulation Center.

We also received word from AAI that early registration for our Symposium is running high with strong participation by government agency representatives, and we anticipate a very engaging event. We hope that the symposium will foster interactions and partnerships leading to the creation of a new community of interest capable of delivering enduring outcomes for the creation of a new interdisciplinary paradigm of scientific research in proactive critical thinking.

Finally, I am very glad to announce that our Dynamic Scenarios for Organizations in Infrastructures team has recently received programmatic funding from two government clients. I invite you all to review the work carried out by this team in this issue's highlight.

AAAI SPRING SYMPOSIUM

The Association for the Advancement of Artificial Intelligence (AAAI) in cooperation with Stanford University's Department of Computer Science is hosting our 2009 Symposium on Technosocial Predictive Analytics March 23-25, 2009 at Stanford University. The symposium focuses on new methods for anticipatory analytical thinking and decision-making capable of addressing the global security challenges of our time. **(continued)**



PROJECT STATUS

Knowledge Encapsulation Framework (KEF): A Framework for Knowledge Inputs for Technosocial Predictive Analytics

The Knowledge Encapsulation Framework team has been working on integrating new structured data sources such as the Minorities at Risk database. They are continuing the effort to automate the discovery process and implement a team space through which the modeling team can access their information. The annotation pipeline has been significantly updated and additional tags are now being processed.

Development of Serious Gaming Technology for Cognitive Enhancement in Predictive Analytics

In the first quarter of FY2009, the project team employed their gaming framework architecture to construct a rough prototype of a "Biofuels" game to make use of the Food Security and Energy Infrastructures (FSEI) modeling project's outputs. As part of the 2nd quarter, they are refining that prototype into a playable demonstration and defining additional games to tie-in with additional Area 1 modeling teams.

Vulnerability of Food Security and Energy Infrastructures to Climate Change and Terrorism

Progress includes building on the systems prototype. The team is exploring ways to generalize the model design while keeping and expanding the bio-fuels prototype as part of the larger model. Important collaborations include active development of variables to be "fed" by the KEF and discussions about integrating the systems model with dynamic Bayesian nets (DBNs).

Predicting the Impact of Climate Change on U.S. Power Grids and Its Wider Implications on National Security

The project team identified datasets and methods to forecast future residential and commercial building stock, forecasted market penetration of technologies, and identified people at risk for heat wave analysis. The team continued their power load sensitivity study for the three California cities and addressed the random noise problems in our climate models.

Dynamic Scenarios for Organizations in Infrastructures

The project team identified areas to develop linkages among Model Types such as Bayes nets, Systems Dynamics, and Expert driven. They are working to validate their methodologies and studies to produce tangible products and outcomes such as papers, presentations, and continued engagement with the market.

Leadership Team

Antonio Sanfilippo, Initiative Lead and Knowledge Inputs Area Lead
Jim Thomas, Cognitive Enhancement Area Lead
Steve Unwin, Technosocial Modeling Lead

Operational Team

Janine Anderson, Communications
Amanda Cowell, Administrator
Gary Morgan, Strategy Advisor
Fran Stanley, Finance
Tim Strycker, Operations



Pacific Northwest
NATIONAL LABORATORY

DYNAMIC SCENARIOS FOR ORGANIZATIONS IN INFRASTRUCTURES

Project Lead: Paul Whitney

The ability to estimate the likelihood of future events based on current and historical data is paramount to the decision making process of many government agencies. Numerous predictive tasks, if successfully accomplished, have significant value to these agencies: notably predictive tasks related with deterrence of Weapons of Mass Destruction (WMD) events, countering terror events, characterizing the risks associated with terror events, and understanding the effects of options for resource deployment.

This project continues to develop models and methodologies addressing WMD and terrorism threats to infrastructures. Structuring and connecting technical process models (for WMD or terrorism activities, forensics, sociology, psychology) with social indicators (economic, political, cultural, and religious drivers) enables assessment, predication, and forensics within a repeatable, computationally sound framework.

The specific technical advances on which this project focuses are the integration of the 1) information from these two modeling approaches and 2) associated data and evidence. The models for the technical and for the social components will likely be known with differing certainties or accuracies – a critical challenge is linking across these model domains while respecting this fundamental difference in certainty level. In recognition of the rapidly evolving state of the area of computational, predictive social modeling, a major focus of this project is on methods for validating and understanding the information in the combined models and data.

This project will deliver mathematical modeling methodology to:

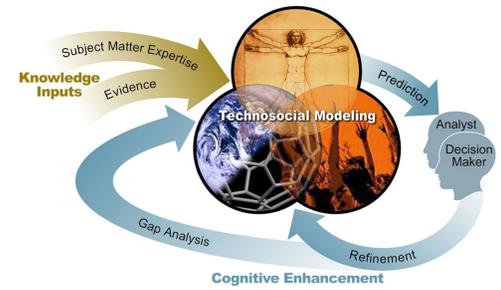
- » Demonstrate linkages between technical models and social models – where these linkages take account of the relative certainties associated with these models, and of the overlapping, but not coincident, focus of the models.
- » Combine information across expert driven models obtained via Judgmental Bootstrapping, dynamic stochastic models (in particular, dynamic Bayesian networks), data and evidence.
- » Provide clear and understandable diagnostics regarding the consistency, predictability and sensitivities across the models, data and evidence.

Approach

The team has adopted process models to represent the technical steps involved with WMD and terrorism threats to infrastructures. Such models include fault trees, material and information flows, and graphical models represented as Baynes nets. For behavior models, the approaches explored include graphical models and bootstrapping models. The technical and social aspects are naturally linked.

Examples include:

$$P(\text{Scenario}) = P(\text{Scenario} | \text{Attempt}) * P(\text{Attempt}) + P(\text{Scenario} | \text{no Attempt}) * P(\text{no Attempt})$$



Common forms of technical models in the domains the team is studying:

- » Fault trees – decomposition of causes of root event of interest
- » Event trees – begin with undesired initiator event and track outcomes thru sequence of events
- » Possibility tree – combinatorial representations of possible scenario outcomes
- » Process models – sequence of steps and actions to execute a scenario – (Demo – IED process model)
- » Bayes nets; Dynamic Bayes nets – probabilistic relationships among variables
 - Behavior models (demo)
 - General threat models (demo)

AAAI Spring Symposium (continued from p.1)

Events occur daily that challenge the security, health, and sustainable growth of our planet and often find the international community unprepared for the catastrophic outcomes. These events involve the interaction of complex factors such as climate change, energy reliability, terrorism, nuclear proliferation, natural and man-made disasters, and social, political, and economic vulnerabilities. If we are to help the international community to meet the challenges that emerge from these events, we must develop novel multi-perspective methods for predictive analysis that can support a concerted decision-making effort by relevant actors to anticipate and counter strategic surprise.

The symposium will further these objectives by providing a venue for discussion and scientific exploration that brings together scientists and government agency representatives interested in this emerging field. Please check the detailed Symposium program at http://predictiveanalytics.pnl.gov/aaai_symposium/.

