Technosocial Predictive Analytics Initiative

Spring 2010 http://predictiveanalytics.pnl.gov/ QUARTERLY NEWSLETTER

Antonio's Notes

As the second half of our research program unfolds, we would like to thank you for your continued interest in the Technosocial Predictive Analytics Initiative. Our active list of subscribers to this newsletter is now close to 1000, and in the last year alone our website received over 2000 visits from 68 countries, (see Figure 1).

Figure 1: 2,033 visitors to http://predictiveanalytics.pnl.gov, from 19 May 2009 to 12 May 2010.

Overall, two themes have emerged with renewed strength:

- Our commitment to address complex problems in the domains of security, energy, and the environment
- The pursuit of model integration as a key enabler for anticipatory analysis and decision making.

Our current efforts in addressing national security are focused on the illicit trafficking of nuclear materials. Our goal is to help analysts and policymakers anticipate the formation and purpose of illicit nuclear trafficking networks to influence the function of such networks, disrupt or destroy them, and interdict network processes at specific times and places. Security remains our primary focus and accounts for the largest part of our resources. Our energy and the environment research this year targets the integrated assessment of energy consumption for smart grid design and analysis. Our overall approach takes into account a variety of perspectives: data and models of energy consumption; technical feedback effects; social and psychological factors; structural demand; energy supply systems; data and models of climate change and carbon emission models. I invite you all to review the ongoing work carried out in these two areas in this issue's highlight. **(continued)**

Our IEEE Workshop *(see back…)*

PROJECT FOCUS

Knowledge Inputs

Knowledge Encapsulation Framework (KEF)

This project enables subject matter experts to discover, gather, and arrange evidence and other material in support of modeling and simulation projects, as well as other domains that require collaborative workspaces for knowledge work.

Cognitive Enhancement

Serious Gaming Technology

This project develops techniques and a systematic framework to enable the creation of games that provide a means for users to explore the outputs of technosocial predictive models. We seek to provide an environment in which the computational power of these models can be seamlessly paired with the creativity of human players, facilitating a more robust decision-making process.

Technosocial Modeling

Illicit Nuclear Trafficking

This project includes mathematics and computational collaborative methodology to forecast organization behavior using models, empirical data and experts' opinions. Our technical approach to integrate predictive information has three unique and significant aspects: rigorous model validation, formal modeling of experts' assessments and automatic support for model integration.

Energy Efficiency/Conservation and Grid Vulnerability

The purpose of this project is to better define the characteristics of energy feedback so as to achieve optimal effectiveness in reducing energy consumption and improving efficiency, and assessing the ensuing impact on grid security and infrastructure integrity in combination with climate change factors.

Leadership Team
Antonio Sanfilippo, Initiative Lead
Scott Butner, Initiative Co-Lead
Steve Gajewski, Initiative Co-Lead
Jim Thomas, Initiative Co-Lead

Operational Team
Carrie Almquist, Operations
Keri Schneirla, Communications
Wendy Andres, Administrator
Fran Stanley, Finance

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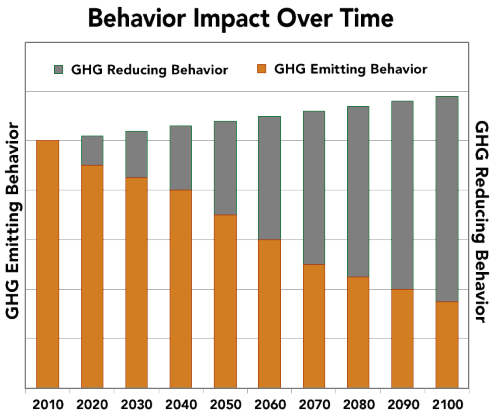
BEHAVIOR AND ENERGY EFFICIENCY

The relationship of human end-use energy consumption to smart grid efficiencies involves numerous technical and social-behavioral variables. On the technical side, there are issues related to supply and generating capacity, the emissions characteristics of various types of power plants, variations in supply continuity due to the intermittent nature of wind and solar power, and the relative cost of generating power during peak demand periods.

Social-behavioral variables include factors such as attitudes, information, incentives, comfort, and convenience. While these social-behavioral factors have been shown to reduce energy consumption under specific circumstances, there is little understanding of how behavior and technology may combine on a large scale to transform the existing energy system.

By developing a behavioral-economic-technical model, this roject permits evaluation of alternative smart gridmplementation approaches, and provides key criteria for the design and assessment of diverse demonstration projects throughout the nation.



ILLICIT TRAFFICKING

Illicit nuclear trafficking networks are a national security challenge. These networks can directly lead to nuclear proliferation, as states or non-state groups attempt to identify and acquire nuclear-weapons-related expertise, technologies, components, and materials. The ability to characterize these networks and improve our ability to anticipate the key nodes, and transit mechanisms associated with them, is essential to influencing, disrupting, destroying, or interdicting the function of the network and its processes.

Our contribution to addressing this challenge includes mathematics and computational collaborative methodology to forecast organization behavior using models, empirical data, and experts' opinions. Our technical approach to integrate predictive information has three unique and significant aspects: rigorous model validation, formal modeling of experts' assessments, and automatic support for model integration. Each is an essential step to improving the forecasting of organizational behaviors. We take an "engineering" approach to validating the integrated forecasting model—executing a detailed quantitative comparison of dynamic behavior models to observations. We incorporate experts' assessments through a mathematical structure linking experts' input and the computational model. Our approach treats experts as "sensors", incorporating their opinions through sensor model component. Finally, the diverse concepts and expertise to address these challenges drives developing automatic support for model integration. These three aspects involve significant traditional science and technology expertise, combined with detailed knowledge of extant social systems (e.g., banking, energy distribution, insurance…) and technical systems. Enabling and supporting integration of models, experts' opinions and data is a critical step forward to address the challenge of illicit trafficking.

WORKSHOP ON CURRENT ISSUES IN PREDICTIVE APPROACHES TO INTELLIGENCE AND SECURITY ANALYTICS

Vancouver, BC, May 26, 2010, held under the auspices of the EEE Intelligence and Security Informatics Conference.

To build further awareness about model integration as a main stumbling block in the successful use of anticipatory reasoning techniques, we are holding a workshop on model integration and evaluation in Vancouver, BC, on May 26, 2010. Our intent is to facilitate the creation of a community of interest capable of advancing the state of the art by

- Bridging diverse mathematical modeling techniques
- Extracting, relating, and calibrating model evidence from massive data sources
- Achieving coherence across diverging temporal and social scales
- Verifying model function and validating model output.

The workshop features eleven presentations and an invited talk covering three topics:

- Model interoperability and meta-modeling
- Collection, analysis and coalescence of evidence
- Model diagnostics and evaluation.

Details at http://predictiveanalytics.pnl.gov/isi2010_conference/-

Antonio's Notes (continued from p. 1)

Our approach to model integration targets two specific challenges:

- The combination of heterogeneous elements of knowledge (e.g., social and physical factors)
- The interoperability across diverse modeling algorithms (e.g., Bayesian Nets, System Dynamics, Agent-Based Modeling).

Model integration is required to address complex modeling problems. The combination of diverse elements of knowledge promotes the fidelity and reliability of the model. The ability to link across different modeling algorithms enables us to use the right tool for the right job. For example, linking Bayesian nets and System Dynamics models enables the integration of probabilistic evidentiary reasoning methods with the ability to model behavior of complex systems over time.