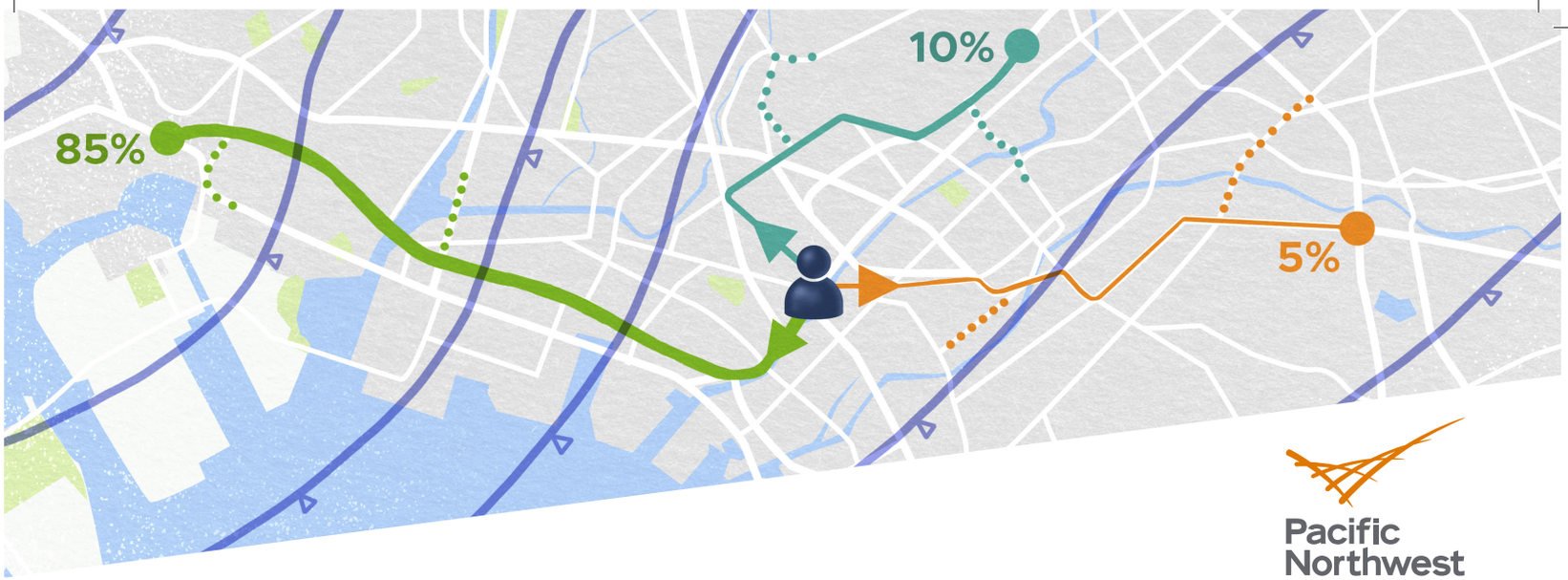


Pacific Northwest
NATIONAL LABORATORY

Predictive Situational Awareness

Combining machine learning and visualization to predict the future

THE CHALLENGE

Taking action always depends on knowing the current conditions in a given environment. Situational awareness is vital in order to take appropriate action, which sometimes involves protecting people and property. By coupling situational awareness with predictive models, we can forecast what the environment may look like to support future actions. This is especially true when it comes to protecting critical infrastructure, such as the power grid and industrial plant operations, military command and control, cybersecurity operations, transportation systems, and emergency management services. Situational awareness must be maintained 24/7 to identify problems, as they arise.

Situational awareness is the full view of a complex and changing environment that can be perceived and understood almost at a glance. It involves making sense of critical elements in the environment, various types of information, and their relationships and context across time and space. But the varied information is often in unstructured formats, which makes it hard to understand how the situation is unfolding and evolving at a glance.

APPROACH

Pacific Northwest National Laboratory's (PNNL) combination of advanced visual analytics techniques and machine learning seek to identify meaningful dynamic patterns in real-time, operational or observational data. Our capabilities fundamentally amplify and accelerate the analytical, predictive, and decision-making abilities of operators and analysts in interpreting the data spatially, temporally, and visually.

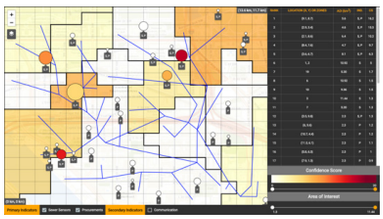
We use machine learning to enhance predictive analytics. Machine learning models are trained on historical data to automatically find correlations in it to forecast future situations based on those trends. The electricity sector, for example, needs reliable forecasting a day ahead for power production at dams and a week ahead for electricity on the power grid.

Deep learning techniques and Bayesian network models are also part of the approach at PNNL for forecasting/predicting for situational awareness in forms that are easily interpretable and intuitive. Glyphs, icons, and graph-based visualizations are also effective ways of representing the who, what, when, and where of a particular situation and confirming indicators across various information channels.

The Building Operations Control Center at PNNL provides situational awareness for campus facilities. Situational awareness is key to protecting critical infrastructure and predicting future conditions.

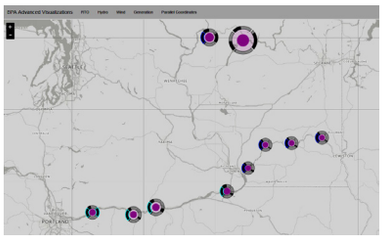
EXAMPLE PROJECTS

SIGMA



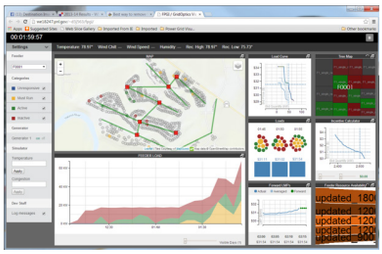
PNNL is supporting large Defense Advanced Research Projects Agency (DARPA) research programs on early detection systems for weapons of mass destruction (WMD) threats. One of these programs, DARPA's SIGMA+, is developing highly sensitive detectors and advanced intelligence analytics to detect traces of various substances related to chemical, biological, radiological, nuclear, and explosives threats. PNNL is conducting data modeling and developing visual displays to identify potential locations where there is a combination of events and interactions that indicate WMD threat activity. Different activities, such as travel and communications, mapped to specific areas are assigned probabilities, in order to predict and rank threats. These models help inform strategies for interdiction, as well as deploying additional sensors.

Visual Analytics Platform for Hydropower Operations



Various visual analytics tools to monitor hydropower and wind production have been combined into a renewable energy analytics platform. The platform conveys to dam and wind farm operators how much energy is being produced at different units, at different times. Such critical multidimensional data improves system awareness. For instance, to convey water flow conditions, we created a four-quadrant glyph representing water behind the dam, in front of the dam, spilling over the dam, and through the dam. These intuitive visual representations show operators the data needed to optimize power production or highlight areas with anomalous conditions.

Visual Steering and Modeling Environment



The Visual Steering and Modeling Environment (VSME) enables the visual control and steering of smart grid simulations. Users can define environmental and power grid behaviors and conditions and visually interact with what-if scenarios. VSME provides a rich suite of visualization tools that can display data in different orientations and perspectives, including spatial, geospatial, temporal, hierarchical, logical, and categorical.

If a generator goes down, what will happen to the grid? Using the VSME tool, operators can forecast future events and plan accordingly. They can model plausible events and predict how the system will respond.

About PNNL

PNNL advances the frontiers of knowledge, taking on some of the world's greatest science and technology challenges. Distinctive strengths in chemistry, earth sciences, and data analytics are the heart of our science mission, laying a foundation for innovations that improve America's energy resiliency and enhance our national security. PNNL's computing research encompasses data and computational engineering, high-performance computing, applied mathematics, and semantic and human language technologies.

Collaborate with us | Tap into our capabilities to meet your needs | Explore technology transfer opportunities | Join our team to grow your career

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BATTELLE

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