

Can Artificial Intelligence Transform the Power System?

By Chris Warren

Once a subject for science fiction writers, artificial intelligence (AI) has gone mainstream. Today it can be hard to get through a TV commercial break without seeing an ad about how AI is going to transform logistics, healthcare, or even the work of baseball statisticians. Name an industry or a pursuit, and there's a good chance that someone believes AI is set to revolutionize it.

Given significant interest in the electric power industry, EPRI is already pursuing more than 20 initiatives to explore AI's potential and limitations. Two projects are investigating how AI can support the use of drones for inspecting transmission and distribution infrastructure. Drones can capture far more images of conductors, insulators, and structures than a person on foot or traveling in a truck—especially across rough, roadless terrain. EPRI is evaluating and enabling AI algorithms that can be trained to recognize malfunctioning equipment and examine thousands of images to pinpoint problems requiring repairs—with limited human intervention.

EPRI collected 7,000 images of transmission and distribution assets and identified which were functioning properly and which were not. With technical support from EPRI staff, nine AI vendors used the data to write algorithms that could distinguish between the two.

“We used a new set of drone images that the vendors’ algorithms had not ‘seen’ before to test how well they could automatically identify defects,” said Andrew Phillips, EPRI vice president of transmission and distribution infrastructure. The algorithms performed better than random guessing but made many mistakes—a promising start given the relatively limited number of images on which the algorithms were based. “The data sets Google or Facebook use for their algorithms are in the millions,” said Phillips. “Ours was in the thousands.”



A drone collecting images of substation equipment during an EPRI field test.

This work provided important lessons that are guiding future EPRI collaboration with AI companies. “We learned how to ‘curate’ the data,” said Phillips. “This involves assessing the quality of the images and detailing what they mean—for example, this image shows a good insulator or conductor and this image shows a bad one. This enables us to train the algorithms properly. We also learned how important it is to collect a lot of images—the more data, the better.” Now, EPRI is working with power companies to collect and curate many more images so that vendors can train algorithms with larger data sets.

This and other AI projects have prompted EPRI to launch an initiative to improve collaboration between the AI and the electric power industries to meet the power system’s unique needs. EPRI technical staff will identify promising research areas and organize educational workshops for AI companies and researchers. They also will work with utilities to gather, curate, and secure data.

EPRI’s AI initiative broadly aims to support the power industry in providing safe, reliable, affordable, and clean energy. “AI has the potential to improve

the affordability of electricity,” said Neva Espinoza, EPRI director of cross-sector technologies and components. “It can improve reliability by identifying high-risk, malfunctioning assets. It also can enhance safety by providing utilities with information needed to replace or repair those assets before they fail.”

AI is poised to be critical in developing and operating the Integrated Grid and its combination of centralized power with distributed energy resources such as solar, battery storage, wind, and electric vehicles. For example, it offers the potential to forecast solar and wind generation more accurately based on weather, helping grid operators balance generation and demand.

More broadly, can AI help make an increasingly distributed, multi-directional, complex power system work seamlessly? “Real-time integration of all the diverse technologies in the power system relies on data and communications,” said Espinoza. “AI tools are vital because they can process data and react quickly. The old physics-based models we have relied on for the past century can’t do that.”

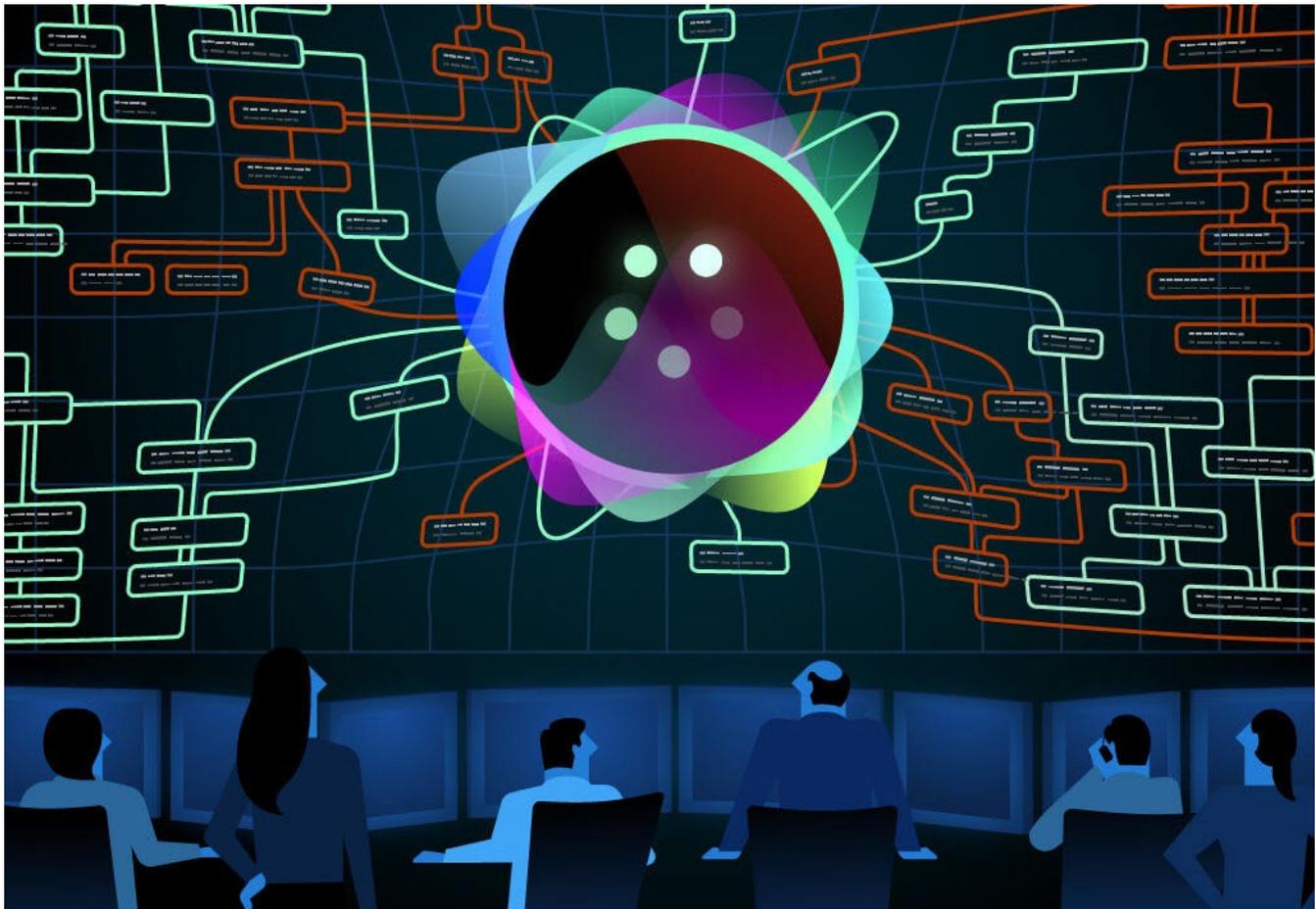
Increased reliance on AI comes with risks. As data, communications, and AI become more important in forecasting, planning, and operating power system assets, security becomes vital. EPRI will focus substantial research on addressing potential vulnerabilities that arise from increased use of AI.

A BRIDGE BETWEEN AI ORGANIZATIONS AND THE POWER INDUSTRY

Along with the exponential increases in computing power and data collection, the power industry is focused on widespread AI deployment. “Many industries, including ours, have been collecting and storing large quantities of data for a significant amount of time,” said Phillips. “Now, AI tools are becoming available to work with this data, with the potential to provide solutions in many areas.”

EPRI is also working to create a common understanding of power systems’ unique characteristics. “AI companies have math and computer science expertise, but they often lack the physics background to understand why power system assets degrade and fail,” said EPRI Technical Leader Lea Boche. “As EPRI engages them, one of our first objectives is making them aware of the challenges utilities face and the related physics.”

Educating the AI industry—which encompasses large companies such as IBM and Google as well as startups and university researchers—also involves conveying a broader understanding of how regulations and business models can affect the development of AI solutions. For example, cloud applications are often central to AI solutions, but most utilities face regulatory restrictions on their use. “This is beginning to change as the benefits of cloud applications grow more apparent,” said Boche. “We want to help streamline the work that AI vendors do by helping them to understand the utility industry better.”



One technical expert in each of EPRI's four sectors will serve as a facilitator, understanding each sector's main challenges and identifying AI companies with potential to contribute solutions. "This person will facilitate collaboration among AI stakeholders and EPRI experts," said Espinoza.

Through ongoing workshops and newsletters, EPRI will communicate each sector's priorities to AI companies. "We're going to identify data sets with potential AI applications and publish white papers to outline an AI vision for the power industry," said Espinoza.

DATA, DATA, AND MORE DATA

Because AI solutions are built on extensive, quality data, EPRI is preparing to collect such bodies of data from utilities. "Power companies want to work together and share data because they know they will benefit from it," said Boche.

EPRI is uniquely positioned for this as a result of close collaboration among its subject matter experts and its utility members. "This effort requires many companies to submit data, which needs to be curated. This in turn requires subject matter experts—EPRI's strength," said Phillips. "EPRI can provide additional value by taking the responsibility of collecting and curating the data."

Data from a single utility may be insufficient for such tasks. Drawing on its engineering expertise, EPRI can collect and curate data for the power industry and provide the large, high-quality data sets needed for AI solutions.

To prioritize and focus AI research, EPRI will identify the 10 data sets most valuable for power system AI applications, drawing on input from utility executives. Each data set in the "EPRI10" may represent hundreds of different applications.

"The 10 data sets will span the power sector from end use to distribution to transmission to generation," said Phillips. "We are working with utility executives to make sure the applications can give us the biggest bang for the buck."

The data collected and analyzed as part of this effort can inform all of EPRI's research priorities, not just those for AI. "It can provide a solid foundation for our day-to-day R&D moving forward," said Espinoza.

EPRI's Data Analytics Initiative

AI research can draw on insights from EPRI's Data Analytics Initiative, which examines the complex policy, legal, and IT issues with respect to data security, governance, use, and ownership.

"When we collect data from a utility, we need to have in place all the things that touch that data including legal contracts and terms and conditions of use," said Neva Espinoza, EPRI director of cross-sector technologies and components.

In this initiative, EPRI has defined its approach to cleansing, cataloging, security, privacy, management, control, and access. These will be audited as AI research proceeds. A secure, flexible data analytics platform can help enable the collaboration needed to develop AI solutions while protecting EPRI data sets.

KEY EPRI TECHNICAL EXPERTS

Andrew Phillips, Neva Espinoza, Lea Boche