

ORNL develops, deploys AI capabilities across research portfolio

24 September 2019, by Elizabeth Rosenthal

Processes like manufacturing aircraft parts, analyzing data from doctors' notes and identifying national security threats may seem unrelated, but at the U.S. Department of Energy's Oak Ridge National Laboratory, artificial intelligence is improving all of these tasks. To accelerate promising AI applications in diverse research fields, ORNL has established a labwide AI Initiative, and its success will help to ensure U.S. economic competitiveness and national security.

Led by ORNL AI Program Director David Womble, this internal investment brings the lab's AI expertise, computing resources and user facilities together to facilitate analyses of massive datasets that would otherwise be unmanageable. Multidisciplinary research teams are advancing AI and high-performance computing to tackle increasingly [complex problems](#), including designing novel materials, diagnosing and treating diseases and enhancing the cybersecurity of U.S. infrastructure.

"AI has the potential to revolutionize science and engineering, and it is exciting to be part of this," Womble said. "With its world-class scientists and facilities, ORNL will make significant contributions."

Across the lab, experts in [data science](#) are applying AI tools known as [machine learning](#) algorithms (which allow computers to learn from data and predict outcomes) and [deep learning algorithms](#) (which use [neural networks](#) inspired by the human brain to uncover patterns of interest in datasets) to accelerate breakthroughs across the scientific spectrum. As part of the initiative, ORNL researchers are developing new technologies to complement and expand these capabilities, establishing AI as a force for improving both fundamental and applied science applications.

Home to the world's most powerful and smartest supercomputer, Summit, ORNL is particularly well-suited for AI research. The IBM system debuted in

June 2018 and resides at the Oak Ridge Leadership Computing Facility, a DOE Office of Science User Facility located at ORNL. With hardware optimized for AI applications, Summit provides an ideal platform for applying machine learning and deep learning to groundbreaking research. The system's increased memory bandwidth allows AI algorithms to run at faster speeds and obtain more accurate results.

Other AI-enabled machines include the NVIDIA DGX-2 systems located at ORNL's Compute and Data Environment for Science. These appliances allow researchers to tackle data-intensive problems using unique AI strategies and to run smaller-scale simulations in preparation for later work on Summit.

"AI is rapidly changing the way computational scientists do research, and ORNL's history of leadership in computing and data makes it the perfect setting in which to advance the state of the art," said Associate Laboratory Director for Computing and Computational Sciences Jeff Nichols. "While Summit's rapid training of AI networks is already assisting researchers across the scientific spectrum in realizing the potential of AI, we have begun preparing for the post-Summit world via Frontier, a second-generation AI system that will provide new capabilities for machine learning, deep learning and data analytics."

Although ORNL researchers are applying the lab's unique combination of AI expertise and powerful computing resources to address a range of scientific challenges, three areas in particular are poised to deliver major early results: additive manufacturing, [health care](#) and cyber-physical security.

Additive manufacturing, or 3-D printing, enables researchers at the Manufacturing Demonstration Facility, a DOE Office of Energy Efficiency and Renewable Energy User Facility located at ORNL, to develop reliable, energy-efficient plastic and

metal parts at low cost. Using AI, they can consistently create high-quality, specialized aerospace components. AI can instantly locate cracks and other defects before they become problems, thereby reducing costs and time to market.

Additionally, AI makes it possible for the machines to detect and repair errors in real time during the process of binder jetting, in which a liquid binding agent fuses together layers of powder particles.

Researchers at ORNL are also optimizing AI techniques to analyze patient data from medical tests, doctors' notes and other health records. These techniques use language processing to identify patterns among notes from different doctors, extracting previously inaccessible insights from mountains of data. When combined with results from x-rays and other relevant tests, these results could improve health care providers' ability to diagnose and treat problems ranging from post-traumatic stress disorder to cancer.

For example, ORNL Health Data Sciences Institute Director Gina Tourassi uses AI to automatically compile and analyze data and determine which factors are responsible for the development of certain diseases. Her team is running machine learning algorithms on Summit to scan millions of medical documents in pursuit of these types of insights.

Cybersecurity platforms such as "Situ" monitor thousands of events per second to detect anomalies that human analysts would not be able to find. Situ sorts through massive amounts of raw network data, freeing up network operators to focus on small, manageable amounts of activity to investigate potential threats and make more informed decisions.

And through partnerships with power companies, ORNL has also used AI to improve the security of power grids by monitoring data streams and identifying suspicious activity.

To date, ORNL researchers have earned two R&D 100 Awards and 10 patents for work related to AI research and algorithm development. The lab plans

to recruit additional AI experts to continue building on this foundation.

To ensure that U.S. researchers maintain leadership in R&D innovation and continue revolutionizing science with AI, ORNL also provides professional development opportunities including the Artificial Intelligence Summer Institute, which pairs students with ORNL researchers to solve science problems using AI, and the Data Learning Users Group, which allows OLCF users and ORNL staff to practice using deep learning techniques.

ORNL also collaborates with the University of Tennessee, Knoxville, to support the Bredesen Center Ph.D. program in data science and engineering, a curriculum that combines data science with scientific specialties ranging from materials science to national security.

Provided by Oak Ridge National Laboratory

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