# Artificial Intelligence for Science and National Security

Oak Ridge National Laboratory (ORNL) has a rich tradition of AI research, which dates back more than 40 years and has garnered more than 10 patents. The laboratory's AI Initiative is dedicated to ensuring safe, trustworthy, and energy efficient AI in the service of scientific research and national security.

Through this internal research investment, subject matter experts at ORNL leverage the laboratory's computing infrastructure and software capabilities to expedite time-to-solution and realize the potential of AI in projects of national and strategic importance.

For example, the Initiative has helped multidisciplinary teams demonstrate that machine learning algorithms can be used to extract information from signals with low signal-to-noise ratios, develop algorithms capable of accelerating modeling and simulation with very little training data, and design novel biomimetic neuromorphic devices that can detect epileptic seizures.



Frontier was the world's first exascale system when it came online for early users in 2022.

# <text>

2023

Frontier moves to

full operations



"Oak Ridge National Laboratory uniquely has the expertise and facilities to advance the state of the art in AI and apply it to DOE's most pressing scientific challenges."

-Al Program Director, Prasanna Balaprakash

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## Safe, Trustworthy, and Energy Efficient

The Al initiative is underpinned by two cornerstone elements: application-centric endeavors and cross-disciplinary foundational frameworks. The application-centric component is designed to leverage Al in three domains: scientific discovery, experimental facilities, and national security. The cross-disciplinary foundational framework seeks to ensure that Al systems are secure, trustworthy, and energy-efficient. The security dimension covers aspects such as alignment with scientific goals, cybersecurity measures, and robustness against failures. Trustworthiness is ensured through rigorous validation and verification processes, uncertainty quantification, and causal reasoning methodologies. And energy efficiency is achieved through scalable solutions, edge computing, and a co-design approach that optimizes both software and hardware resources.

## **Expertise and Outreach**

ORNL's foundations in computing and data science enable researchers to accelerate data analytics, create novel workflows, and expedite outcomes via modeling and simulation. The laboratory, a recognized leader in algorithm and application development, has research groups dedicated to machine learning, AI, and neuromorphic computing as well as several groups dedicated to high-performance computing. A series of strategic hires is further expanding this expertise. ORNL shares numerous faculty with the University of Tennessee, Knoxville, and the two institutions launched the Bredesen Center's Data Science and Engineering PhD program to educate future data scientists working to solve a range of problems that stand to benefit from the advancement of AI. ORNL also maintains key partnerships with industry leaders, including NVIDIA, IBM, and Google.

### Data and Infrastructure

ORNL is home to state-of-the art instruments within some of the world's most advanced scientific facilities, including the National Transportation Research Center and the Spallation Neutron Source. These facilities generate large, unique scientific datasets perfectly suited for the AI analysis conducted with the help of Frontier—the world's first exascale supercomputer—and other computing resources located at the laboratory's Oak Ridge Leadership Computing Facility. ORNL also offers data resources and analytics for AI applications through the Compute and Data Environment for Science.



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