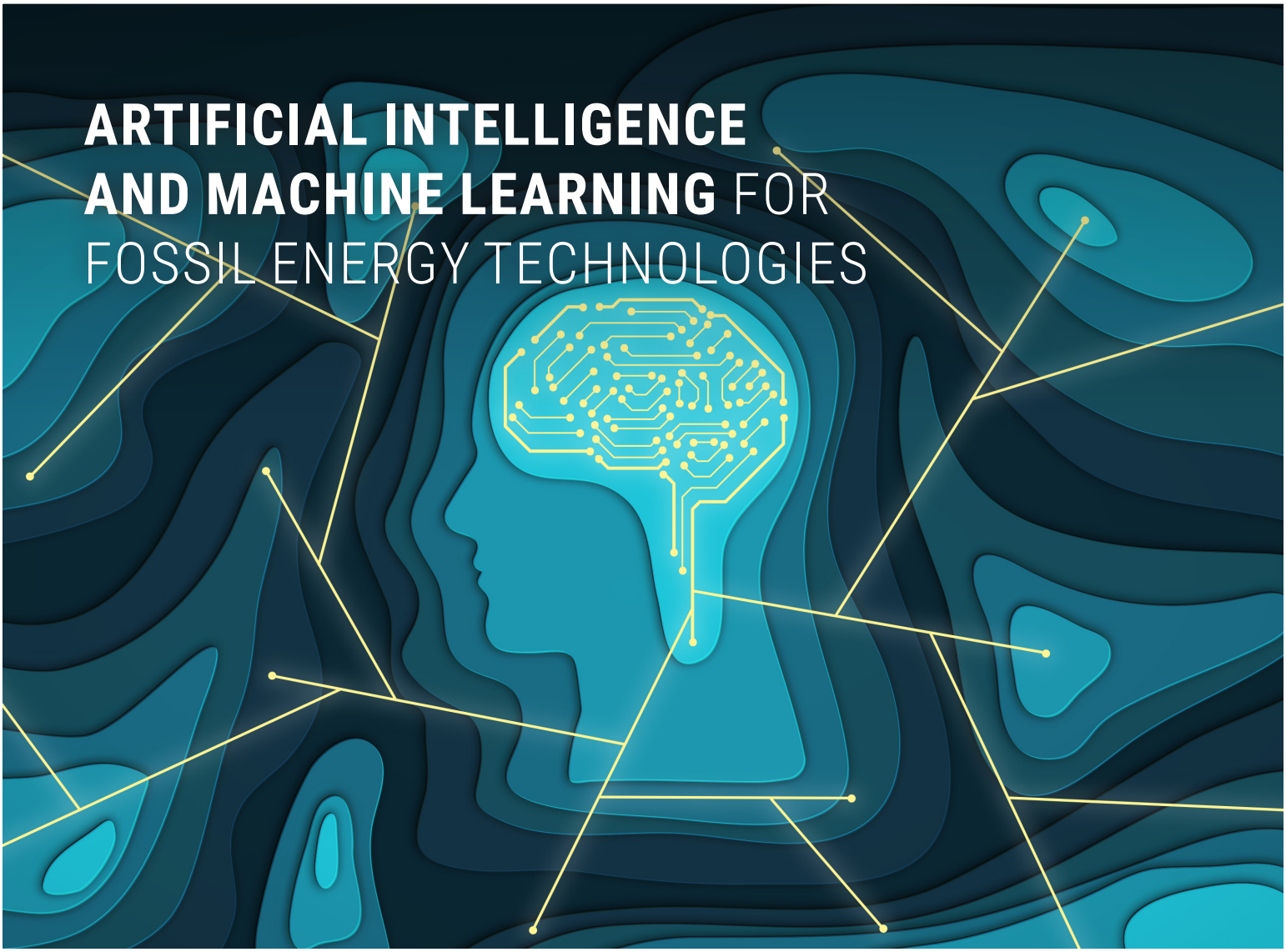
ARTIFICIAL INTELLIGENCE AND MACHINE LEARNING FOR FOSSIL ENERGY TECHNOLOGIES



NETL

NATIONAL ENERGY TECHNOLOGY LABORATORY

Since the days of the Manhattan Project, the U.S. Department of Energy (DOE) has been the nation's leader in high-performance computing. Supercomputers and associated cutting-edge computational tools offer the potential to accelerate the pace of energy discovery through artificial intelligence (AI) and machine learning (ML).

AI is a branch of computer science focused on creation of intelligent machines to increase accuracy and efficiency in decision-making, reduce human errors, and cut costs, while ML is the confluence of science-based prediction, data collection from novel sensors and data analytics.

As part of its mission to discover, integrate and mature technology solutions to enhance the nation's energy foundation and protect the environment for future generations, NETL is pursuing AI and ML approaches for advancing fossil energy technologies.

ARTIFICIAL INTELLIGENCE AND MACHINE LEARNING

RESOURCES

NETL is home to the Joule 2.0, which is among the fastest, largest and most energy-efficient supercomputers in the world. The powerful 4-petaflop system allows researchers to model energy technologies, simulate challenging phenomena and solve sophisticated problems using computational tools that save time and money to ensure that technology development ultimately proves successful.

NETL has also created a Center for Data Analytics and Machine Learning that allows researchers to explore problems using AI, ML, data mining and data analytics techniques. The center features a petascale machine designed to house, transport and process up to 37 petabytes of data using cutting-edge algorithms developed in-house and with external collaborators. Partners for this initiative include Carnegie Mellon University, West Virginia University, Battelle, Leidos, industry and other national labs.

APPLICATIONS

FOSSIL ENERGY UTILIZATION TECHNOLOGIES

NETL is using AI and ML tools to enhance research focused on fault detection, materials discovery, catalytic activity prediction and process synthesis, optimization and intensification. Among the Lab's achievements:

- NETL researchers recently developed and used a high-throughput computational methodology to rapidly screen more than 1 million possible mixed matrix membranes for carbon capture, identifying several that decrease the cost of carbon capture from $63 to $48 per metric ton of CO2 removed.
- NETL is leading a multi-lab initiative called eXtremeMAT, which uses data analytics to develop and deploy new alloy materials that are affordable and perform reliably under the harsh environments encountered in power plants.
- NETL is using computational fluid dynamics and ML to develop a tool that power plant engineers and operators can use to optimize part-load operations of a large coal-fired power plant.

NETL also supports external projects developing or using AI and ML to advance fossil energy technologies. For instance:

- SparkCognition is applying AI techniques to understand power plant conditions and flag anomalies so that corrective action can be taken.
- Colorado School of Mines is developing AI-enabled robots for automated nondestructive evaluation and repair of power plant boilers.
- Siemens Corp. is developing methods for live monitoring of power plant components to enable condition-based maintenance and prediction of the remaining useful life of components.

SUBSURFACE ACTIVITIES

NETL is using ML to develop real-time analytical capabilities with the potential to transform subsurface operations, significantly increase recovery of oil and gas, and reduce environmental impacts. This emerging initiative builds upon recent investments by DOE's Office of Fossil Energy (FE) to develop rapid predictive modeling capabilities using ML algorithms, reduced-order models and more.

For example, NETL established an agreement with an oil and gas operator in the Permian Basin to acquire large data sets that can be augmented with public and synthetic data. Managing these large data sets will be the basis for developing new workflows to combine multiple data streams that can be used within the lab and more broadly.

NETL is also taking advantage of several field laboratories funded by FE and the FE Oil and Gas Program to identify opportunities to apply ML approaches and validate their application in the field. Validation of these approaches will be key to demonstrating the value of this initiative.

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