**151-PFlops Deep Learning for Electron Microscopy**Robert Patton, Travis Johnston, Steven Young, Catherine Schuman, Don March, Thomas Potok, Maxim Ziatdinov, and Sergei Kalinin

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**Abstract**

An artificial intelligence system called MENNDL, which used 18,000 NVIDIA Volta GPUs on Oak Ridge National Laboratory's Summit machine, automatically designed an optimal deep learning network in order to extract structural information from raw atomic-resolution microscopy data. In a few hours, MENNDL creates and evaluates millions of networks using a scalable, parallel, asynchronous genetic algorithm augmented with a support vector machine to automatically find a superior deep learning network topology and hyper-parameter set than a human expert can find in months. For the application of electron microscopy, the system furthers the goal of improving our understanding of the electron-beam-matter interactions and real-time image-based feedback, which enables a huge step beyond human capacity towards nanofabricating materials automatically. MENNDL has been scaled to the 3,000 available nodes of Summit achieving a measured 98.6 PFlops, with an estimated sustained performance of 151 PFlops when the entire machine is available.