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Autonomous experiments in scanning probe microscopy: opportunities for rapid inference and decision making

The rise of robotics, automation and the creation of various levels of abstraction have by now enabled automated experiments on a range of scientific instruments ranging from chemical robots for molecular synthesis, to electron and scanning probe microscopes that can be programmed to enable automated and autonomous experiments with a view towards physics discovery.

In this talk, I will briefly outline automated and autonomous experiments as it pertains to scanning probe microscopy, here at the Center for Nanophase Materials Sciences. It will be shown that microscopy in general is an ideal playground for the development, testing and deployment of machine learning methods, form both a hardware and algorithmic viewpoint. Typical automated setups and needs for Fast ML will be discussed in the context of problems such as using reinforcement learning inline on the microscope for tuning domain wall functionality in ferroelectrics. We posit that the correct deployment of algorithms and simulations at the edge, on HPC and at the cluster level, with workflow tools and connectivity, will be critical in realizing truly autonomous microscopy platforms for physics discovery. This work was supported by the Center for Nanophase Materials Sciences (CNMS), which is a US Department of Energy, Office of Science User Facility at Oak Ridge National Laboratory.

Author: Dr VASUDEVAN, Rama (Oak Ridge National Laboratory)

Co-authors: Prof. KALININ, Sergei (University of Tennessee); Dr LIU, Yongtao (Oak Ridge National Laboratory); Dr ZIATDINOV, Maxim (Oak Ridge National Laboratory); Mr VALLETI, Sai Mani; Dr JESSE, Stephen (Oak Ridge National Laboratory); Prof. YANG, Jan-Chi (National Cheng Kung University)

Presenter: Dr VASUDEVAN, Rama (Oak Ridge National Laboratory)