Joint WK#7: Real-time Analysis of Synchrotron Light Source and Nanoscale Research Center Data using AI/ML for APS-U First Experiments

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The APS and CNM are in the position to help solve some of the most challenging and novel scientific questions facing the energy needs of the nation. The design of new materials to manipulate classical and quantum information with high fidelity and ultralow power consumption, enabling systems for efficient energy storage, transportation, and conversion that will drive the emerging economy based on renewable energy are just a few examples. Addressing these scientific opportunities will be aided by the intrinsic capabilities of APS-U era facilities along with technological advances in detectors and new measurement techniques in x-ray and electron microscopies.

These advances in sources and detectors (x-ray & electron) will result in orders of magnitude higher data rates, and increased complexity from multi-modal data streams. Conventional data processing and analysis methodologies become infeasible in the face of such large and varied data streams. The use of AI/ML methods is becoming indispensable for real-time analysis, data abstraction, and decision making at advanced synchrotron light sources and nanoscale centers. AI/ML will play a key role in the realization of real-time data analysis capabilities for APS-U first experiments.

This workshop is organized to discuss the state-of-the art and potential applications of AI/ML for APS-U first experiments. It provides an opportunity for academics, laboratory and facility staff, researchers, and students from x-ray & electron characterization, hardware design, and computer science communities to exchange ideas and think creatively about new approaches to edge AI/ML applied to next-generation AI-driven experiments at synchrotrons and nanoscale centers.

Topics include, but are not limited to:

- Real-time, on-the-fly processing and analysis
- Smart *in-situ* and *operando* experiments (electron and x-ray)
- Ultrafast phenomena and dynamics
- AI/ML-assisted workflows
- Digital Twins for electron and x-ray characterization
- Data infrastructure for synchrotron and nanoscale user facilities
- AI-accelerators for fast training and inference