Beamline Science – The Video Game: How Reinforcement Learning and Artificial Intelligence are Changing Operations at Large-Scale User Facilities

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Beamline experiments at neutron and X-ray central facilities are increasingly demanding of remote, high-throughput, and adaptive operation conditions. To accommodate such needs, new approaches must be developed that enable on-the-fly decision making for data intensive challenges. New methods powered by advances in Artificial Intelligence (AI) have demonstrated they can automate and expedite many of the analysis tasks required of these big-data sets, improving scientific outcomes and accelerating discovery. Reinforcement Learning (RL) is a domain of AI that holds the potential to enable autonomous operations in a feedback loop between beamline experiments and trained agents. Many of these RL methods have been demonstrated and benchmarked via application to board games and video games. By applying so-called 'gamification' logic to complex optimization processes, RL agents can be developed that can control beamlines with complex, optimized behaviors.

In this talk, we will present our work developing RL agents for optimized data collection strategies on the PDF beamline at NSLS-II, and how this has enhanced our ability to operate under remote operations. We will also highlight numerous other AI-enabled tools that have been developed at the NSLS-II, and discuss efforts to streamline and transition these techniques from being reliant on an expert practitioners to a modality where they can be adopted by the general user community.
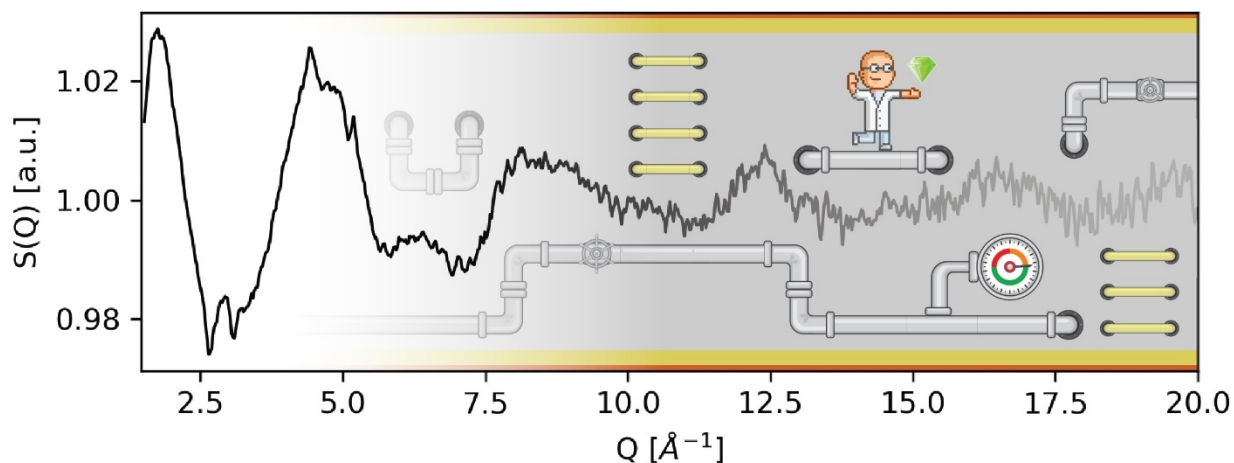

Figure 1