Contribution ID: **763** Type: **Contributed talk**

Integrating ML-Based Segmentation Into Tomography Beamtime Experiments with MLExchange

Friday 30 August 2024 14:20 (15 minutes)

The historical limitations with data collection at synchrotron facilities have been, by and large, solved. Today, imaging beamlines can acquire 100s of tomograms per hour at a sustained rate. Similarly, high-quality 3D reconstruction of the 2D raw data is now completed within a few minutes of the last radiograph hitting the disk. Resultingly, users leave a typical tomography beamtime session with 100s of reconstructed datasets. However, much of this collected data is not analysed and therefore remains unpublished. This is because post-processing and segmentation remain a significant challenge for experienced and inexperienced users. Specialised and costly hardware and software are required to handle 3D datasets. Still, more fundamentally, traditional computer vision algorithms are not robust against cross-sample changes in image quality that the instrument or sample preparation can introduce. As a result, many users must process each dataset uniquely. Artificial intelligence (AI) and Machine learning (ML) tools have been shown to better cope with image quality variation; however, they require a high level of technical know-how to utilise successfully.

MLExchange, a cross-facility project developed by LBNL, ANL, BNL and ORNL, has been developed to address the challenges of making AI tools readily available to users during their sessions at tomography beamlines. The framework is designed to be user-friendly and intuitive, with graphical user interfaces (GUIs) that simplify the process of using ML tools. MLExchange ties together browser-based user interfaces, workflow management, data services and machine learning packages in an integrated platform. Multiple scientific workflows are targeted, including tomographic image segmentation. For this use case, the High-Resolution Image-Segmentation application provides an intuitive browser-based interface for easily defining segment classes on slices of reconstructed images, kicking off training and segmentation jobs, and reviewing results. The system uses the DLSIA framework, which provides multiple machine-learning network implementations targeting image segmentation with an intuitive API for tuning network architectures. Data is read from and written to the Tiled data service, providing a consistent interface for image and mask data. During a beamtime, the full system was installed at the DIAD beamline and integrated into the beamline's scan and reconstruction workflow, seamlessly allowing the user to begin the annotation and segmentation process as soon as their scans are reconstructed. By leveraging the high-performance hardware already available at synchrotron facilities, users can seamlessly integrate ML tools into their research workflow, eliminating the obstacles that previously impeded their research progress.

I plan to submit also conference proceedings

Yes

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Session Classification: Mikrosymposium 3/4: Data, Automation and the Use of AI

Track Classification: 3. Data, Automation and the Use of AI