Contribution ID: **49** Type: **Plenary**

Accelerated pixel detector tracklet finding with Graph Neural Networks on FPGAs

Track finding is a critical and computationally expensive step of object reconstruction in LHC detectors. The current method of track reconstruction is a physics-inspired Kalman Filter guided combinatorial search. This procedure is highly accurate but is sequential and thus scales poorly with increased luminosity like that planned for the HL-LHC. It is therefore necessary to consider new methods for representing and reconstructing tracks.

This work makes use of Graph Neural Networks (GNNs) to explore possible improvements to track finding efficiency in HL-LHC environment. A graph is constructed from each event by mapping hits in the pixel detector to graph nodes and constructing connecting edges using a physics-driven pre-processing. We then use an edge-classification GNN to assign physics-based probabilities to the connections. Finally, a simple, post-processing algorithm is applied to iterate through the GNN labeled edges to form final track candidates.

This work builds upon initial exploration of GNNs for particle tracking by the HEP.TrkX project and targets a specific HL-LHC use case: tracklet finding in the innermost pixel detector using the expected Phase 2 geometry. Both ATLAS and CMS utilize inside-out track reconstruction algorithms that are seeded from the pixel detector making this a critical computing problem for HL-LHC development. This study will provide insight into the impact these novel algorithms can have on compute-intensive and physics-critical reconstruction.

The GNN-based tracking can be further accelerated by implementing the inference network directly on FPGAs. This would improve the computational throughput of a critical reconstruction step and could allow the GNN algorithm to be used in the High-Level Trigger system.

This talk will describe the construction of the pixel detector graphs and reconstruction performance for a range of GNN architectures and attention mechanisms.

Consider for young scientist forum (Student or postdoc speaker)

Yes

Second most appropriate track (if necessary)

Primary authors: THAIS, Savannah Jennifer (Princeton University (US)); OJALVO, Isobel (Princeton University (US)); GRAY, Lindsey (Fermi National Accelerator Lab. (US)); NEUBAUER, Mark (Univ. Illinois at Urbana Champaign (US)); ATKINSON, Markus Julian (Univ. Illinois at Urbana Champaign (US))

Presenter: THAIS, Savannah Jennifer (Princeton University (US))

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