EUROPEAN AI FOR FUNDAMENTAL PHYSICS CONFERENCE EuCAIFCon 2024

Contribution ID: **128** Type: **Flashtalk with Poster**

Boosted object reconstruction with Monte-Carlo truth supervised Graph Neural Networks

Tuesday, 30 April 2024 14:28 (3 minutes)

The High Luminosity upgrade for the Large Hadron Collider (HL-LHC) is due to come online in 2029. This will result in an unprecedented throughput of collision event data. Identifying and analysing meaningful signals within this information poses a formidable challenge in the search for new physics. The demand for automatic tools capable of physically-aware and data-driven inference, which can scale to meet the needs of HL-LHC, has never been higher.

In response to this, our research explores a data-driven approach, leveraging machine learning on Monte Carlo (MC) truth data. Event generators, including MadGraph5 and Pythia8, are used to simulate collision events. Low-level momentum information of the detector-level particles is extracted from these events, to form point cloud representations. These point clouds are clustered to form "jets", a low-energy representation of heavy particles produced during the high-energy collisions at the Large Hadron Collider. Traditional generalised-kT algorithms cluster particles by successively merging particle pairs based on their proximity and energy using a parameterised "distance function". In contrast, our approach assumes that more meaningful pair-wise relationships exist between cluster constituents. These relationships are modelled using an Infrared and Collinear (IRC) safe Graph Neural Network (GNN). Training our model directly on low-level data, with MC truth supervision, enables it to act as a bridge from the theoretical principles embedded in event generators, to analyse experimental data. Additionally, it eliminates the need for the customary jet grooming and pruning techniques typically following generalised-kT. We explore our IRC safe GNN's performance to reconstruct boosted Higgs and top-quark signals, and contrast this with traditional techniques.

Our existing body of work focuses on the analysis of boosted Higgs reconstructions. Results indicate our model offers improved mass peak reconstruction, in terms of width and location, when compared with generalised-kT algorithms. The application of our architecture to the more complex colour structure of events containing top-quarks is under active investigation.

Primary author: CHAPLAIS, Jacan (University of Southampton)

Presenter: CHAPLAIS, Jacan (University of Southampton)

Session Classification: 1.1 Pattern recognition & Image analysis

Track Classification: Session A