Jet tagging with ML Analysis

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Related works

- Several ATLAS/CMS groups have been working on jet tagging by ML (classification task) and report state-of-the-art models:
  - Particle Transformer for Jet Tagging
  - How Much Information is in a Jet?
  - N-Jettiness: An Inclusive Event Shape to Veto Jets
  - Identifying Boosted Objects with N-subjettiness
  - Maximizing Boosted Top Identification by Minimizing N-subjettiness
- In addition to kinematics (energy and momentum), other variables such as charges, trajectory displacement and N-Jettiness are good options to be fed as the inputs for ML training.
- All papers used more than 10M signal+bkg events with CUDA cores to speed up the training and surpass the previous state-of-the-art.

Jet representations and ML models

- In any machine learning problem, how we represent the data often has a large impact on the performance of the models we train. For jet tagging, the most common approaches one finds in the literature include:

- **Jets as images:** A jet image is a pixelated grayscale image, where the pixel intensity represents the energy (or transverse momentum) of all particles that deposited in a particular location in the detector plane (*CNN*).

- **Jets as sequences.** Here the idea is to order the particles in a jet (usually by p_T) and use sequence-based architectures like *recurrent neural networks (RNNs)*.

- **Jets as graphs.** This approach treats each jet as a generic graph of nodes and edges. Graph neural networks (which we'll also encounter later in the course) excel on this type of data.