Introduction

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Project: Conditional Generation of High-Energy Particle Collisions with Graph Networks

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Background

Generative Adversarial Networks (GANs) :

• A popular generative model in machine learning, include a generator and a discriminator

• Generator: produces the simulations

• Discriminator: tries to distinguish between real and generated simulations

• The generator and discriminator are trained together adversarially. By improving the discriminator's ability to distinguish, we can simultaneously improve the generator's ability to produce models closer to real jets
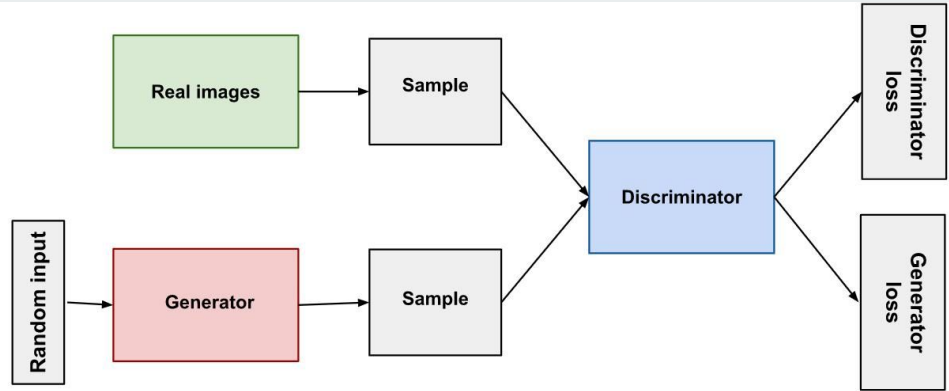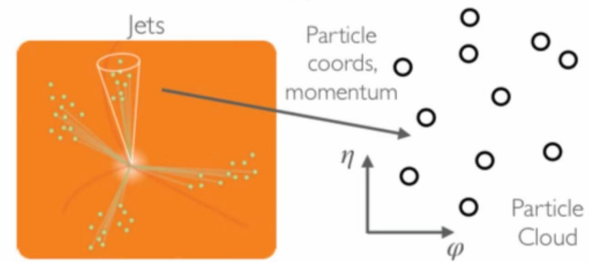
Auxiliary Classifier GAN (ACGAN)

• An advanced training method for GANs that is developed recent years

• The discriminator outputs **both the probability of the jet to be real and predictions of the jet's features**

• Allows us to generate jets of **specific types and momenta**, as would be required in practical applications at LHC

Graph Neural Networks (GNNs)

- A class of neural network for processing data best represented by graph data structures

- Can be directly applied to graphs, and provide an easy way to do **node-level, edge-level, and graph-level prediction tasks**

- In our project, GNNs is used to be **graphical representation describes jets as nodes & edges, and combine them as a network**

- **Less computational complexity, high efficiency with more information**

Goals

• The proposed result should be **a strong ACGAN MPGAN algorithm using GNN to generate conditional models of jets with high fidelity**. This model can generate jets in a more efficient way with controllable features of the jets, which can serve as a strong tool for future applications

The benefits of this method are:

1. compared with traditional GANs, it will be able to model jets conditionally (e.g. jets of specific types or momenta);

2. It's more efficient and performant for jet simulations due to the use of GNNs instead of image-based models. Overall, the development of such a method of conditional generation could have a large impact on computation at CERN and provide more useful data for furthering high-energy-particle physics research

Thank You!