TASK 1: MUON MOMENTUM INFERENCE USING DEEP NEURAL NETWORKS

- In the first task, we want you to perform classification where muon momenta are clustered into 4 ranges of absolute p_T ranges: 0-10 GeV, 10-30 GeV, 30-100 GeV and >100 GeV. Develop a Fully-Connected Network using a framework of your choice and evaluate its ability in classifying muon momentum ranges using the raw data muon data that we provided.
- Then, investigate any improvements offered by convolutional layers by implementing a Convolutional Neural Network (CNN) separately.
- Having trained these two models, indicate the set of hyperparameters that you have tuned prior to obtaining the optimal results and provide a visualization of the loss and metrics as a function of the number of epochs. Finally, show the model's ability to generalize to new datasets using the best suitable performance measurements.
- Next, try to regress on the pt (or 1/pt) directly

TASK 2: IMAGE-BASED CLASSIFICATION OF MUON MOMENTA

- Similar to Task 1, this task requires you to implement a FCN and a CNN. Only this time, you have to project the hits provided by the raw data into images. There are different ways to approach muon trajectories as images, so we rely on your creativity to come up with efficient solutions to deal with such sparse data.
- As previously asked, you should report the set of hyperparameters that were tried during training and present niche visualizations of the training process and the model's performance when tested on new data.
- Report the noted differences between the model performance resulting from the image-based approach and that of the model trained on raw data.

TASK 3: JET AS GRAPHS

- Implement a Message Passing Neural Network (MPNN) with a framework of your choice (PyTorch Geometric, Deep Graph Library, GraphNets) to classify jets as being quarks or gluons.
- Provide a description on what considerations you have taken to project this point-cloud dataset to a set of inter-connected nodes and edges (What graph topology have you used? Why do you believe it is efficient?)

OPTIONAL

- Can we inspire from the approach in Task 3 to implement graph approaches on the muon data used in tasks 1 and 2? Discuss any potential graphical approach that come to your mind and mention the limitations, if any. Feel free to submit a pseudo-code for such a process.