IRIS-HEP Fellowship Project Proposal

Data Reduction for the ProtoDUNE Detector Control System

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Project Duration: August 1st to October 31st, 2022

1 Introduction

The Deep Underground Neutrino Experiment (DUNE) is a project that aims to increase and improve humanity's knowledge of neutrino behavior. The main purpose of the experiment is to investigate CP-violation in the neutrino sector, which could explain the matter-antimatter asymmetry that we observe in our universe. It can, however, also be used to investigate proton decay and supernovae. The primary detector of DUNE will be a Liquid Argon Time Projection Chamber (LArTPC) [1]. The already operational ProtoDUNE detector at CERN serves as a prototype and is currently the largest LArTPC in the world [2].

The reconstruction of particle trajectories in a LArTPC critically relies on understanding the conditions under which the data was taken [3] such as temperature, purity and pressure of the LAr, or the high voltage between the wire planes. This kind of data is recorded by the Detector Control System (DCS). One use case of this data is to exclude periods of unstable high voltage (from short cuts, power cuts, etc...) for further data analysis. Currently, these unstable periods are identified as cases where the system resistance is lower than a hand-picked value. My project is to improve this filtering system with an unsupervised Machine Learning approach (e.g. Anomaly Detection). That is, using data that was collected in previous years; we can create an algorithm that would automatically detect abnormal behavior of the system.

In this way, the goal of my project is to create such an algorithm that, in the absence of human intervention, would be able to identify periods of unstable voltage. This will improve the quality of the obtained results and eliminate human error in their further analysis. If there is time left, it is also possible to investigate additional use cases of data from the DCS.

2 Software Deliverables

The main result of my project will be a standalone Python program analyzing data from the Detector Control System. The output will define periods of unstable high voltage.

3   Preliminary Time Line

Week 1

- Familiarize myself with the software stack (git, numpy, pandas)

Week 2-4

- Read-in the data and make some basic plots
- Reproduce results of existing cut-based analysis

Week 5-6

- Implement first version of ML model to identify unstable periods

Week 7-10

- Fine-tune ML model and hyper parameters

Week 11-12

- Summarize results on slides
- Present findings in working group meeting

References

[1] The DUNE collaboration, *Deep Underground Neutrino Experiment (DUNE), Far Detector Technical Design Report, Volume I Introduction to DUNE*, 2020.

[2] The DUNE collaboration, *First results on ProtoDUNE-SP liquid argon time projection chamber performance from a beam test at the CERN Neutrino Platform*, 2020.

[3] HEP Software Foundation, *HEP Software Foundation Community White Paper Working Group – Conditions Data*, 2019.