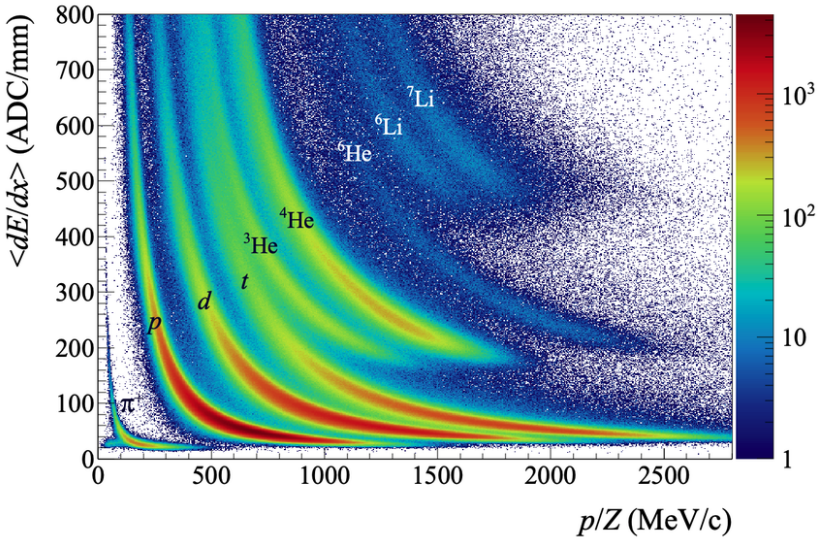
Particle identification with ALICE at CERN-LHC

The challenge:

ALICE detector at CERN LHC record up to 20.000 particles per Pb-Pb collision. Most of them are pions (~90%) while the rest is composed by kaons, protons, electrons etc etc. Typically, in a physics search, only 2-3 of those particles are interesting while the rest is just combinatorial background.
The ALICE detector offers the unique opportunity to perform particle identification using the information of the particle energy loss $\mathrm{d}E/\mathrm{d}x$ ([1], page 5) in the ITS and TPC detectors of the ALICE experiment in Run 1 [2]. In this way different particles, leaving specific signatures in the detectors, can be identified. Usually, the process of particle identification is lengthy and pursued via cuts on gaussian fits of the different species.



The PID is a crucial step in each analysis. Imagine you have an unknown particle decaying in 3 daughter particles, one of which is a proton. Protons are only about 4% of the produced particles during the collision and if you have an unambiguous way to identify them you will avoid considering the other 96%, removing a large amount of combinatorial background.

The project:

The data of this project were collected by ALICE in 2010 and correspond to 240 million pp collisions at $\sqrt{s}$ = 7 TeV. In this data sample 200000 electrons, pions, kaons, protons, and deuterons were selected with different techniques. In particular, pions were selected via K0S→π+π− decays, protons via Λ→pπ^- decays, kaons via the kink topology of $K^+ \to \mu^+ \nu_\mu$ decays, electrons via $\gamma \to e^+e^-$ conversions, and deuterons using the information from the time-of-flight detector.
The goal of the project is to perform a multiclass classification to be able to predict the identity of the particle on new data. The students should investigate different learning algorithms proposing the most suitable strategy.

Bibliography:

[1] https://alpha.physics.uoi.gr/foudas_public/APP/Lecture4-EnergyLoss.pdf
[2] https://cds.cern.ch/record/2282027/files/arXiv:1709.00288.pdf