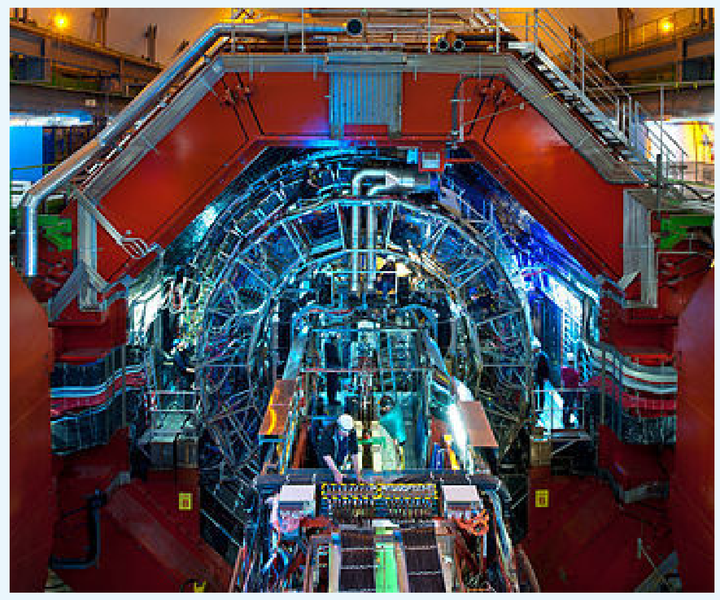
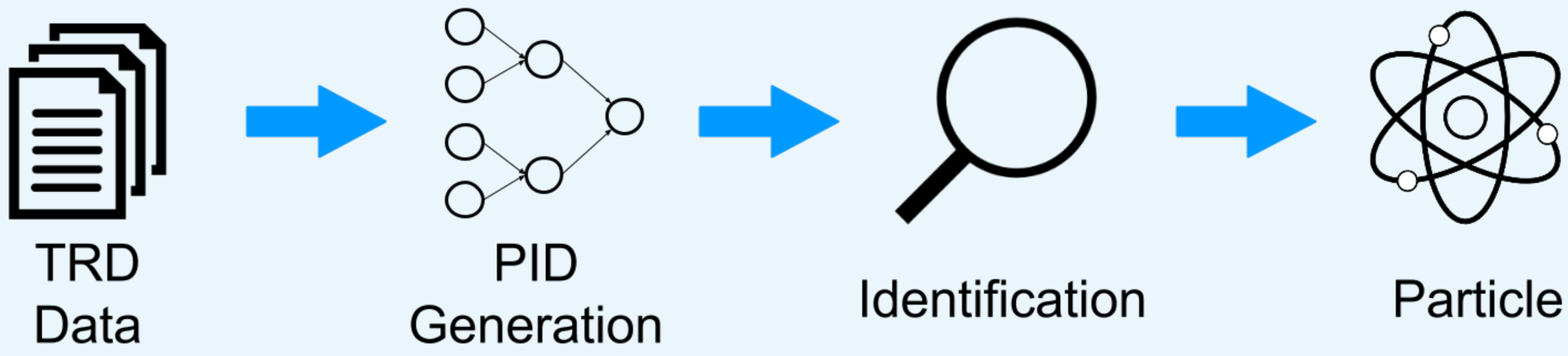
Particle Identification with the LHC ALICE Transition Radiation Detector

Overview: The ALICE experiment at the LHC uses machine learning to identify subatomic particles emitted from heavy ion collisions. In 2017 ALICE is scheduled for an upgrade which will limit the bandwidth from the transition radiation detector to the particle identification algorithm to six 8-bit particle IDs (PID) per particle.

The aim is to investigate algorithms for the generation of PIDs and which machine learning algorithm is suited to processing them.





Particle ID Generation:

Summation and Artificial Neural Network approaches were compared on simulated data to create 8-bit PID numbers.

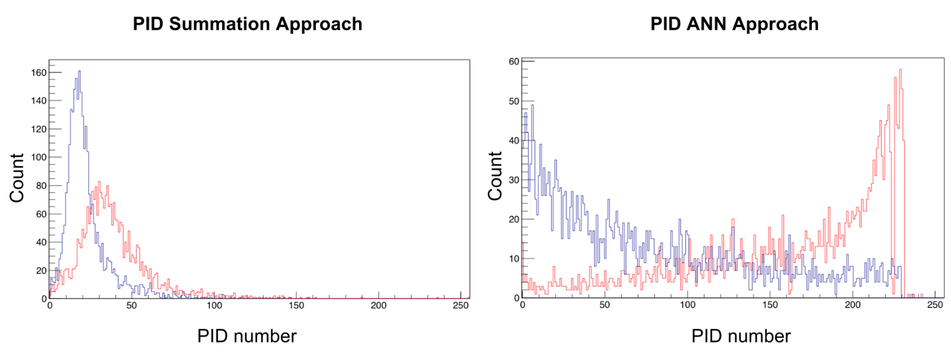


Figure : Plots comparing summation approach and the ANN algorithms

Conclusions:

- The summation approach limits the distribution of PID numbers and it is difficult to distinguish the difference between electrons and pions.
- The Artificial Neural Network approach produces PID numbers distributed across the 8-bit range and makes it easier to distinguish between electrons and pions.

Particle Identification Algorithms:

Boosting and ANN models were compared on simulated data with the new data format to determine which will be better suited to ALICE after the upgrade.

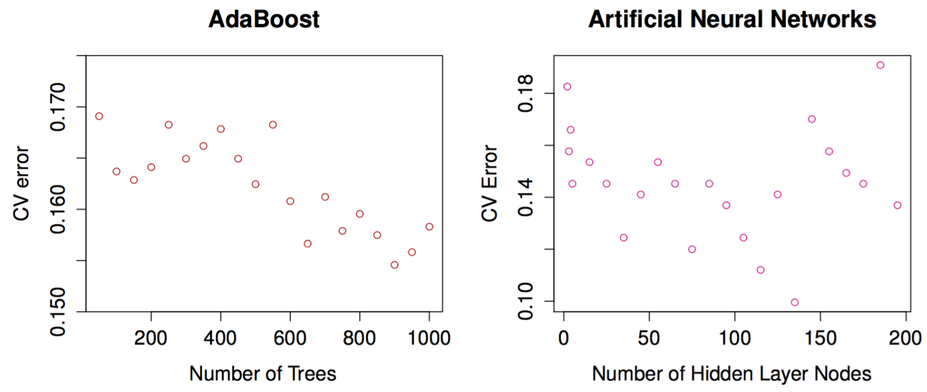


Figure : Plots comparing the optimal boosting and ANN algorithms.

Conclusions:

- AdaBoost performed better than ε-Boost and ε-LogitBoost.
- ANNs were better weak learners than decision trees.
- The best performing ANN configuration was more accurate, learnt faster and trained more quickly than the best boosting configuration.

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