# Context Enriched Prong CNN performance studies in NOvA

**Akshay Chatla for the NOvA Collaboration**

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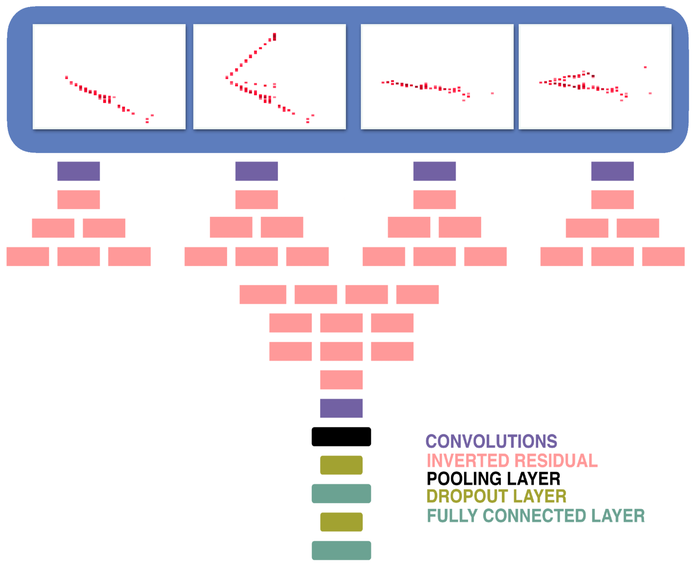
## Introduction

- NOvA is a long baseline neutrino oscillation experiment with a near detector at 1 km and a far detector at 810 km.
- The oscillation measurements depend on neutrino flavour identification and neutrino energy measurement.
- NOvA uses Convolutional Neural Network (CNN) for event classification.

## Prong CNN

- While NOvA uses Event CNN which can classify events, identification of final state particles of the event is needed to better our energy reconstruction and enable cross-section measurements of final states.
- Prong CNN goal is to identify all the final-state particles of a given neutrino event.
- Prong CNN uses CNN architecture based on MobileNet2 [1]. It has a four-tower siamese-type for including context information i.e it takes both event (Context) views and prong (Independent) views.



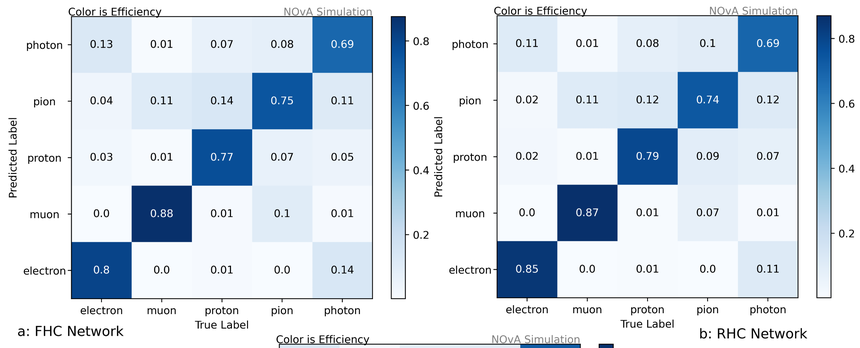

- The previous iteration of Prong CNN used by NOvA trained on neutrino (FHC) and anti-neutrino(RHC) dataset separately. In this work, the network is trained on a combined (FRHC) neutrino and anti-neutrino dataset and compared with the separately trained networks.
- Following selection cuts are used on the training sample:

| Selection cuts | Description |
|---|---|
| Containment Cut | Selects the prong and the event contained within the detector boundaries |
| Cosmic Veto | Removes cosmic events |
| Purity Cut | Realistic looking cluster with prongs $\mu^{\pm}, \gamma$ : 50 %, $e^{-}$ : 40 %, $\pi^{\pm}, p^{+}$ : 35 % |
| Prong length | Cut prongs with prong length more than 5 m |

- The resulting dataset is then balanced to contain an approximately equal number of each type of particle.

## Results

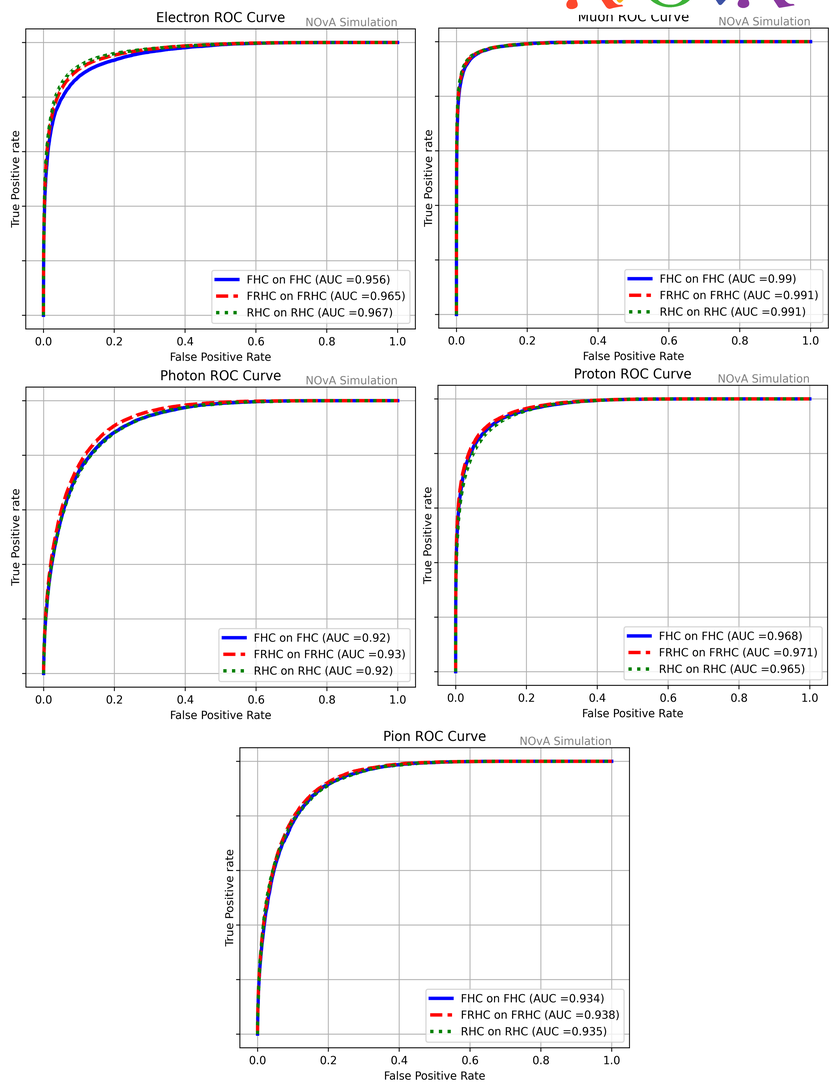
- Here, the evaluation efficiency of different networks i.e: FHC, RHC and FRHC network are shown respectively. Here, the evaluation efficiency of different networks i.e: FHC, RHC and FRHC




a: FHC Network

b: RHC Network

c: FRHC Network




## Conclusion and Future Work

- We see that FRHC network performs slightly better than RHC and FHC networks trained separately even though FRHC has double the dataset.
- **Future:** Will try to find if the network performance can be improved by tuning the network parameters.
- **Future:** Train with complete dataset and compare the three networks.
- **Future:** Check the effect of purity cuts on network performance.

[1] Howard, Andrew G *et al.* "Mobilenets: Efficient convolutional neural networks for mobile vision applications", [arXiv preprint arXiv:1704.04861]