Executive Summary

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1 About the contribution

This contribution focuses on a neural network based UHE neutrino reconstruction method for the Askaryan Radio Array (ARA).

2 What is interesting

The model can be used to reconstruct both neutrino vertex and neutrino propagating direction. It is flexible enough to be applied to a variety of detector configuration. After training a neural network, it is capable of rapid reconstructions (e.g. 0.1 ms/event compared to 10000 ms/event in a conventional routine) that is useful for real time trigger and filter decisions.

3 What has been done

A multi-task convolutional neural network (CNN) has been developed to provide rapid and accurate reconstructions in the case of candidate neutrino events. The CNN takes extracted event features as input and outputs an estimate of the incident neutrino direction and the position of the interaction vertex in the south pole ice. Its performance is estimated by applying it to an unseen test data set. A grid search has been applied in a limited hyper-parameter space of number of nodes, number of layers and batch size to optimize the network. The model stability has been estimated by applying 10 fold cross validation. The relationship between data size and performance has also been studied.

4 Results

The model trained on a training set can be generalized to a test set without overfitting. Of the best reconstructed 68% events, relative error of horizontal distance of vertex is below 10%, errors of azimuth and zenith angles of vertex are below 0.5 deg, and errors of azimuth and zenith angles of neutrino direction are around 5 deg. The model is stable with different training set and test set. Training with more data can improve the performance.