Discussion on Future Plans

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Broad Pictures

We have a primitive NN that can basically reconstruct WC SR e/mu events, so what should we do next?

1. Comparison with conventional algorithm (ongoing)

2. Upgrade to a more realistic scenario and sophisticated architecture

3. Expand to MR reconstruction (as it was said in our paper)

4. Run with some experiments' data to show physics impact

And a lot of technical upgrades such as speed optimization, loss function details, etc.

Upgrades of Input Training Sample

Since now Mo is working to include gamma in the training sample, should we do the work in parallel to include other interesting particles, for example for MR analysis pions might be interesting?

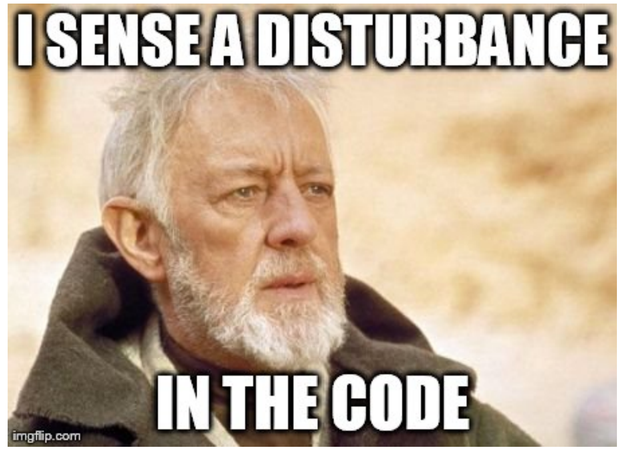
PMT dark noise in MC

+OD and dead zone

Any interests in revisiting the tank geometry (eg. polygons vs. circle)?

Upgrades of Network

The biggest headache — exploding loss function. Currently we put manual regularization on the training sample to avoid numerical instability; should investigate into other direction as well? For example, better way to constrain weight decay and propagation in the NN, etc.?



Last time we have discussed a bit about this: the current model uses the same number of Gaussian subcomponents for both charge and time, which is mostly due to the q-t correlation. Could be interesting to have more freedom in the choice of N_GAUS and find the optimized value. It eventually falls onto the problem of tuning hyper-parameters (a recent paper).

Still interested in GAN? Also just heard that there are alternatives in the market like diffusion-convolutional neural network (this paper). Might be interesting to investigate different options.

Moving to Multi-ring Samples

In principle the current multi-Gaussian likelihood approach is applicable to multi-ring reconstruction since we are able to run up to at least 10 gaussians.

Multi-ring events can probably be represented with a large number of Gaussians clustered in charge & time?

But can we do better than that? Might be related to the hyper-parameter optimization.

Besides, challenge is already seen in the addition of gamma samples.

Running with Real Data

In general will probably need a systematic uncertainty model.

Considering 2 experiments for now: SK and WCTE

SK:

Analysis pipeline is well established, so takes long to add in something new.
Minimum requests to run with SK data:

- SKDetSim (including broken PMT, time-dependent detector condition, etc. SK-IV is good enough for the first shot)
- First attempt with cosmic muons
- Passing the collaboration review

And if we are going to run for SK, I personally think it will be interesting to extend this NN or something else to the lowE analysis. (Can imagine CNN will be difficult to train there due to low hits)

WCTE:

Scheduled to commence in early 2024 -> relatively rigid schedule and soon
Challenges/situations:

- mPMTs (in principle not too difficult by just adding one more dimension in our current tensor for PMT responses, but again may be worth investigating more efficient ways)
- WatchMaL group already has a full pipeline of ML-based analysis

A Quick Look at Speed

All values in wall time

RUNNING WITH 3 Gaussians
Epoch 0.0 0 Starting @ 2022-10-20 **01:58:40**
Filling data starting @ 2022-10-20 **01:59:00**
Data and label filling = 0.006785631179809 57 sec.

- 20 sec to just iterate i++ once over the training data
  “for i,data in enumerate(train_loader):”

- Loading 200 minibatches of >11k floats into memory might be quite intense

- As Cris said can try truncating input with hit PMTs only