White Paper

• As Kazu mentioned, one of main goals of this workshop is to produce a white paper

• Title: White Paper on Machine Learning in Neutrino Physics

• Purpose: Community statement about future research directions
  – How can ML enable the physics we want to do over the next 10 years?

• We hope for this to be an input to the Snowmass process, both in the Neutrino and Computing Frontiers

• We need all of your help to make this happen!
## 1 Introduction

1.1 Life-cycle of Experimental Neutrino Physics

## 2 Survey of Machine Learning Tools

2.1 Classical ML Techniques
2.2 Modern ML Techniques

## 3 Challenges Requiring New Techniques

3.1 Design Optimization
3.2 Analysis Pipeline
3.3 Operations and Control
3.4 Trigger
3.5 Uncertainty Quantification
3.6 Data Reconstruction
  3.6.1 Waveform
  3.6.2 Multi-modal detector signals
  3.6.3 Geometrical and topological pattern recognition
  3.6.4 Particle kinematics and type reconstruction
  3.6.5 Particle flow reconstruction
3.7 Physics Inference
  3.7.1 Neutrino signal identification
  3.7.2 Oscillation parameters
  3.7.3 Neutrino-nuclear cross-section
3.8 Physics Modeling
  3.8.1 Neutrino event generator
  3.8.2 Detector simulation

## 4 Machine Learning at Current Experiments

4.1 ANNIE
4.2 COHERENT
4.3 NEXT
4.4 nEXO and EXO-200
4.5 DUNE
4.6 Hyper-Kamiokande
4.7 IceCube
4.8 KamLAND-Zen
4.9 MicroBooNE
4.10 SBN
4.11 NOvA
4.12 Project 8
4.13 Theia
4.14 Inter-Experimental Collaborations
  4.14.1 Distributed Computing
  4.14.2 DeepLearnPhysics
  4.14.3 Exa.TrkX
  4.14.4 HXML
  4.14.5 DIDACTS

## 5 Conclusions

## 6 Acknowledgements

## References
What Do We Need?

- White paper is on overleaf
  - https://www.overleaf.com/7722928115sggdrxvbfwzb
- Your contributions are needed in the middle sections:
  - 2) Survey of Machine Learning Tools
    - Conveners: Nick Prouse and Taritree Wongjirad
  - 3) Challenges Requiring New Techniques
    - Conveners: Corey Adams and Patrick de Perio
  - 4) Machine Learning at Current Experiments
    - Conveners: Jianming Bian and Marco Del Tutto
How To Get Involved

• If you are presenting a long talk, a slot has already been reserved for you in the section “Machine Learning at Current Experiments.”
  – Please add a short summary of the machine learning activities you showed in your presentation.

• If you are presenting a short talk, a convener may request you contribute to a specific section. Regardless, please look through the document and see if there is a natural place for you to contribute.

• If you are a participate, but not a presenter, we want you to contribute too! Contact a convener to let us know what your expertise is. Consider looking for any topics we left out that you could provide.
Format Of Your Contribution

Discuss with the appropriate conveners the contribution you want to make – you can contact with DMs on Slack or through the channel #workshop-whitepaper

Find the file corresponding to the section you are contributing to

Add your contribution as \paragraph – include a title of the topic you are covering. This is the only way we can know who the authors of the paper are!
Adding Images

Figure 1: A workflow in a life cycle of experimental physics

Preamble

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10 July 2020

Adam Aurisano
Adding References

All references should be in BibTeX format. For physics papers, copy format from inspirehep.net. For all other papers, copy format from doi2bib.org.

The authors also would like to thank the following colleagues who have endorsed this paper while they are not authors: other endorsers.

References


Add all references to the common bib file.
Final Word

• This will only work if everyone is invested in this process
• The most important thing is to get the raw material down quickly
  – Don’t be concerned with word-smithing now – there will be an editing process going forward
• On the last day, I will go over the status of the white paper, and we will discuss timelines for turning it into a finished product
  – Ideally most of the raw material will be in the overleaf within ~1 week after the end of the workshop
• Please start contributing today – as speakers finish talks, turn your attention to putting material in the document