Dark Machine Collider Session: Guide to the Discussion

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“Traditional” use of Machine Learning for Collider physics

Supervised problems (e.g., signal vs. background classification)

Use of ML for analyses (re-)established a few times as essential discovery tool:

1. CP violation at B factories: 2000 (NNs for b-tagging)
2. Single Top at Tevatron: 2000-2009 (fits to MVA classifier outputs)
3. Higgs boson at LHC: 2012 (BDTs for classifications and regressions)

Established methods and usual sociological trauma when going from one ML technology to the other

- I.e., people will eventually be convinced that Deep Learning is the way to go. But it might take some time

Practical problems

Training: Access to GPUs is still an issue at CERN

- Need to raise the discussion to lab management (e.g., an open letter) and convince the seniors who control funds

Inference: Need to work towards efficient solutions to integrate Deep Learning libraries into C++ experiment-specific frameworks

1. e.g., implementation of TensorFlow interface to CMS software took 1 year

Benchmark datasets for out-of-experiment collaborations:

- Several ideas discussed in the last 12 months
- Need to converge to a proposal and implement it

There will be a discussion on this after this session. Join us if you have ideas, Datasets to offer or if you want to know what is going on

Beyond Supervised approaches

Explore unsupervised/semi-supervised techniques

- At trigger level to reduce filter bias (we make 40M collisions/sec, we store 1000 of them)
- Offline, to extend searches beyond typical benchmarks

Possible directions: (so far) Anomaly detection with (variational) autoencoders and similar

Other approaches:

- Dimensionality reduction for robust inference (INFERNO);
- Likelihood-free inference, exploring latent space (mining gold, Cranmer/Brehmer/Pavez/Louppe)...

Beyond analysis

Can we envision a use of Deep Learning to improve detector-related aspects of collider physics?

- Optimization of detector geometry, tuned to future DNN reco capability
- (real-time) detector monitoring
- Optimization of the trigger menu (O(500) paths sharing bandwidth)
- Entirely new solutions to particle ID (e.g., tracing nuclear interactions in thin radiator layer within tracking)

Invitation to the
mini-workshop on "*Machine Learning for fundamental physics*"
at the
International Conference on New Frontiers in Physics VIII
Kolimbari, Crete (Greece), 21-29 August, 2019

Accepting proposals for contributions from **you**

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