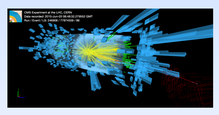
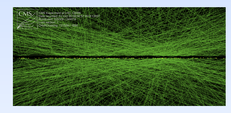
OpenSourceML Community Efforts in High-Energy Physics



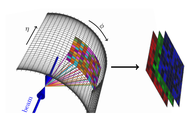


Sergei Gleyzer[1], Lorenzo Moneta[2], Omar Zapata Mesa[3]*

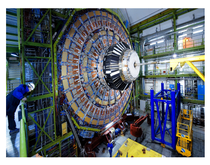
[1]University of FLORIDA, [2]CERN, [3]University of Antioquia

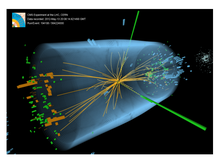
NeurIPS2018

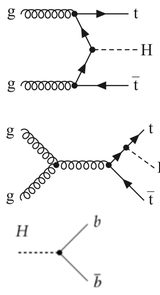
MACHINE LEARNING FOR HIGH ENERGY PHYSICS



Machine Learning (ML) has contributed to high-energy physics (HEP) by improving signal and background separation, particle and event selection and real-time decisions in trigger systems of particle physics experiments.





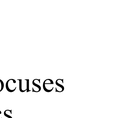


MACHINE LEARNING APPLICATION HIGHLIGHTS

Phys. Rev. Lett. 121801 2018

CMS and ATLAS experiments at CERN used machine learning techniques to discover the Higgs Boson and to search for other particles like dark matter

Phys. Lett. B 716 (2012) 30



arXiv:1807.11916

arXiv:1612.01551

CMS and ATLAS use convolutional neural networks to identify particle images, for example of photons and jets (sprays of particles that result from quarks and gluons)

JINST 11 (2016) P09001

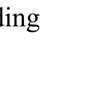
arXiv:1604.01444

NOvA experiment used convolutional neural networks to identify neutrino events with improvement equivalent to 30% increase in exposure time

arXiv:1611.05531, 1808.07629

arXiv:1611.05531

MicroBooNE experiment also used CNNs to identify neutrino interactions on Lar-TPC. 83% efficiency for electrons and 95% efficiency for muons



arXiv:1808.08332

arXiv:1808.08332

MINERvA neutrino experiment used domain adversarial NNs to reduce model bias on data

Similar examples of machine learning use in other experiments: LHCb ALICE Belle II etc.

Many of these results were obtained with open-source machine learning frameworks developed in academia and industry.

HEP-MLOSS COMMUNITY EFFORTS

IML

Inter-Experimental Machine Learning Working Group focuses on applications of machine learning in high-energy physics. Supports efforts in training and MLOSS software development in the HEP community. Founded in 2015

iml.cern.ch

HEP Software Foundation

High-Energy Physics Software Foundation (HSF) was founded in 2016 to support particle physics software efforts including many open-source initiatives.

hepsoftwarefoundation.org

Towards the 2020s

In 2018 high-energy physics machine learning community effort led by the HEP Software Foundation produced a community vision for the future of machine learning in HEP "The High-Energy Physics Community White Paper (CWP) on Machine Learning"

This document outlines the priorities, challenges and roadmap for making progress in this area including machine learning software in the 2020s

HEP-ML Community White Paper: arXiv:1807.02876

Get Involved:

SLACK HEPMachineLearning

MATTERMOST IML

Contact: Sergei Gleyzer sergei@cern.ch
Twitter:@SergeiGleyzer

OPEN SOURCE MACHINE LEARNING IN HEP

Various open-source machine learning tools and initiatives supported and developed by the community:

- ROOT TMVA http://root.cern/tmva http://oproject.org
  Developed by a core team including students, in particular from Google Summer of Code (GSoC)
  O Project Scientific Software
- dianahep http://diana-hep.org supported by National Science Foundation
  http://scikit-hep.org
  Scikit HEP

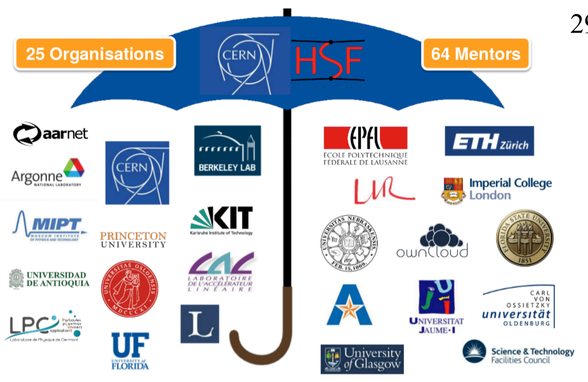
CERN-HSF Google Summer of Code

Google Summer of Code

CERN participated in GSoC since 2011 and CERN-HSF became an umbrella organizationfor high-energy physics in 2017

24 students in 2017
8 MLOSS projects

29 students in 2018
12 MLOSS projects



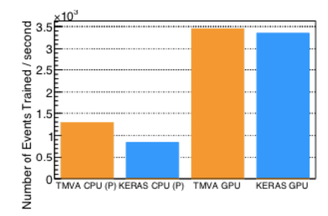
Our program tripled since 2016

https://g.co/gsoc

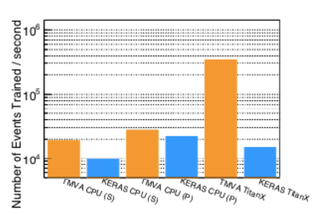
Some (GSoC) MLOSS Examples

Deep Learning Library developed and benchmarked on particle physics use cases

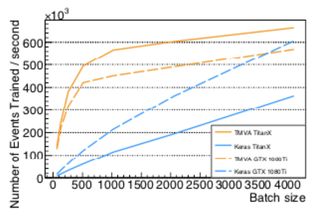
- FCN, CNN, RNN, LSTM, VAE, GAN
- For details about projects please see: https://hepsoftwarefoundation.org/activities/gsoc.html



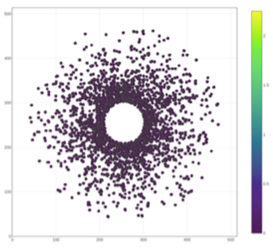
(a) Event throughput for different backends for batch size 32.

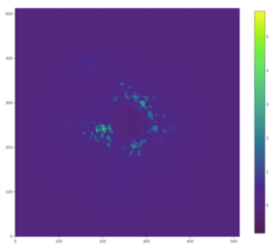


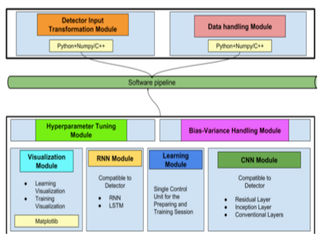
(a) Event throughput for different backends for batch size 100.



(b) Scaling for GPU implementations with varying batch size.







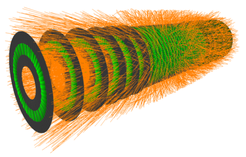
OTHER RELATED EFFORTS

CERN openlab

INSIGHTS

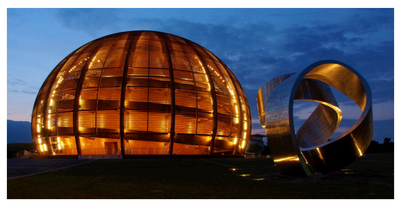
Fermilab 50 Years of Discovery Machine Learning

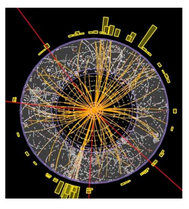
@NeurIPS2018:

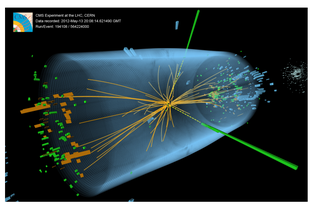


TrackML

Kaggle Competition







*Many additional authors, please see the author-list of arxiv:1712.06982