Teaching Machine Learning in High Energy Physics

Round Table on Machine Learning @DESY

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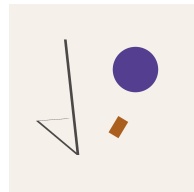
Introduction

- **Who**
  - eclectic team of 6 HEP and 2 ML young scientists
  - H physics & τ polarisation (CMS), neutrino scattering (RED-100), calorimeter studies (ILD)
  - multi-task learning, generative models, self-driving cars (ML research)
- **What**
  - course aiming to introduce ML to HEP audience
  - initially for HEP-ex students at alma mater
  - now probing new venues
- **Why**
  - ML skills becoming indispensable in HEP world
  - scarsely educated in HEP academia
  - ➔ bridge the gap and solidify ML growth in HEP



Syllabus

module = lecture + seminar + homework
ML $\longleftrightarrow$ HEP balance

- per week, each 1.5 hours long
- lecture: absorbing knowledge
- seminar: intensive coding
- homework: exploration

1 Kick-off & Python

l: ML & HEP landscape overview

s/hw: basic syntax, NumPy, Pandas, SciPy, plottings

2 Introduction to ML

l: types of problems, general pipeline, linear models

s: mass regression in $H \to \tau\tau$ @CMS

hw: class imbalance & Portuguese students

3 Trees

l: Decision Trees, Random Forest, Gradient Boosting

s: hyperparameters & decision boundary

hw: particle ID in high granularity calorimeters

4 Neural Networks

l: backpropagation, bells & whistles

s: top tagging @CMS

hw: circles & models

5 Computer Vision & Generative Models

l: CNN, AE, VAE, GAN, WGAN(-GP)

s: MNIST exercises

hw: GANs in HEP

6 ML in HEP

l: recent developments in the field

s: useful libraries/packages

hw: paper study

Present & Future

- **Current results**
  - First round of teaching almost complete
  - Materials and more details available here
  - So far well-accepted amongst listeners
- **Future plans**
  - more topics: GNN, NLP, NF, advanced HEP studies
  - invited talks
  - journal club
  - new audience (DESY, CMS)
- **Discussion**
  - interest from HEP community @DESY?
  - or ML education @DESY in general?

We are open to your thoughts/comments/suggestions!

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Discussion