Deep learning for 40 MHz scouting with Level-1 trigger muons for CMS at LHC run-3

CERN openlab online summer intern project presentations

Maria Popa

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Introduction

Compact Muon Solenoid (CMS)

- Attempts to measure everything that comes out from the collisions
- Record 1000 full events per second to permanent storage

The Large Hadron Collider (LHC)

- the largest and most powerful particle accelerator ever built
- it accelerates protons to nearly the speed of light and collides them at 4 locations, producing new particles

A transverse view of the CMS detector
Introduction

Muons are measured in pseudorapidity range $|\eta| < 2.4$

$$\eta = - \ln \tan \left( \frac{\theta}{2} \right)$$

$p_T = p \times \sin \theta$

azimuthal angle $\Phi$

Reco values = reconstructed values
Motivation

We analyzed the muon parameters from the GMT system with the goal of recalibrating them to make them useful for physics analysis.

We recalibrated them with a simple linear regression (LR) and with a deep learning model.
Deep Model:
- Inputs: $\eta$, $p_T$, $\Phi$, charge
- 3 hidden dense layers with 32 nodes each

Linear Regression:
- Input: $p_T$
- Estimates: $p_T\text{Reco}$
New deep model vs Baseline model

New deep model:
- Inputs: $\eta$, $p_T$, $\Phi$, charge
- 4 hidden dense layers with 128 nodes each

Complex model vs Baseline model on combined dataset (barrel + overlap + endcap)
Summary

We found that the simple LR improves on the raw GMT values.

The NN considerably improves on the raw GMT values, being also better than simple linear fit.

Making the NN more complex by adding hidden layers and increasing the number of nodes doesn’t improve the performance too much.
Thank you for your attention!

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QUESTIONS?

maria.popasb@gmail.com
Complex Model vs Baseline Model