DeepRL with E2E Deep Learning CMS

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Overview

End to End Deep Learning for reconstruction of the Compact Muon Solenoid (CMS) experiment for study of Physics beyond the Standard Model at the Large Hadron Collider at CERN. Simulated CMS Opendata to be used for training.

Inspired by:

End-to-End Physics Event Classification with CMS Open Data Applying Image-Based Deep Learning to Detector Data for the Direct Classification of Collision Events at the LHC M. Andrews, M. Paulini, S. Gleyzer, B. Poczos

arXiv:1807.11916

Exploring use of Deep Reinforcement Learning (deep RL) to generate high resolution outputs.

The exciting part is to observe and experiment with the behaviour of the deep RL model when feeding it 'A to B mappings' from the results of the E2E DL classification of two body diphoton decay.

Specifications

The machine learning techniques in the aforementioned paper (arXiv: 1807.11916) can be used to process the low level data.

This can then be fed to a Reinforcement Learning model, or a deep RL model (would be better for the sheer amount of data)

This should lead to the deep RL model generating different results for the same data.

As a further exploration, the E2E Deep Learning classification model can be modified to take low level data, and give low level results. This data when input to the deep RL model would allow for the possibility of multiple final results.

In this way, the model can be moved, albeit gradually towards more relevant inferences from the same data. This would require intensive computing resources, but also promises to be exciting and deliverable.

On the same note, Generative Adversarial Networks (GANs) can also be used (arXiv:1406.2661v1).

Feeding low level processed data from the E2E DL model to a GAN can give remarkable insights from a dataset, previously unnoticed, or unorganized/arranged in a conducive manner.

Alternatively, GANs can also be applied to the already obtained data from CMS Opendata and set to compete against high level conclusions/inferences obtained from the E2E DL model's processing of low-level event data.

This could be a fun way to test the limits of GANs and could be helpful to better the E2E model.

Additionally, it could be interesting to look at the usage of CPUs in training Deep Learning systems as opposed to GPUs with respect to the E2E DL using the algorithm/implementation described in a recent study: arXiv: 2103.10891v1 and benchmarking the same.

Deliverables

Recognize and separate particles, and derive inferences by applying different learning techniques, even sequentially to low level data from the LHC's collisions. For this purpose data from CMS Opendata can be used

Related works:

arXiv:1807.11916 (E2E DeepLearning)

arXiv:1406.2661v1 (GANs)

arXiv:1902.08276 (E2E Jet Classification)

arXiv:1509.02971 (Usage of deep RL)

arXiv: 2103.10891v1 (CPUs instead of GPUs for Deep Learning)

Personal Info:

Swapnal Varma

1st Year student at Vellore Institute of Technology, Chennai, India, enrolled in the program:

'B. Tech in Computer Science and Engineering with specialization in Artificial Intelligence and Robotics'

Never before contributed to an open source project

Worked in Python, C++, R, MATLAB

Finalist at Gov-Tech-Thon 2020 organized by IEEE, National Informatics Centre (NIC) and Oracle, under the aegis of the Ministry of Electronics and Information Technology (MeitY), Government of India for chosen problem statement of 'AI in agriculture'

Inextensive experience in working on AI-ML projects.

Still starting out, and looking to explore and learn!

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