Application of Transfer Learning Tuning to a Convolutional Neural Network for Image classification to the analysis of collisions in High Energy Physics

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DID YOU KNOW ?

Atom is not the smallest Particle in the world

- The typical sizes are around 100 picometers ($1x10^{-10}$).
- Atom is made up of three tiny particles called subatomic particles; **protons**, **neutrons** and **electrons.**
- The protons and the neutrons make up the center of the atom called the **nucleus.**
- The electrons orbit around the nucleus.

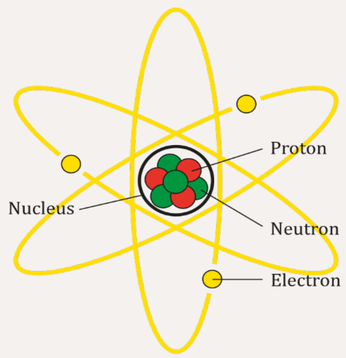


Figure 1. Atom Model

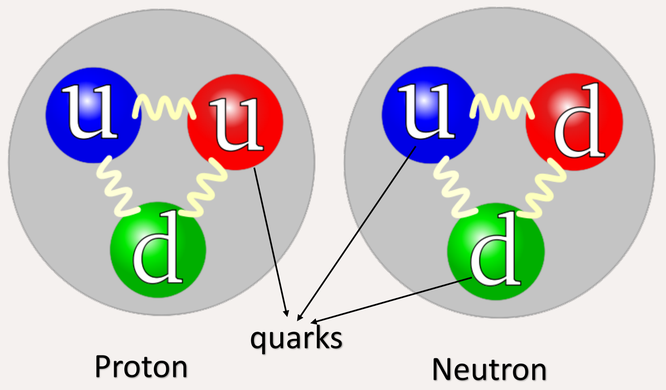


Figure 2. Inside Protons and Neutrons

What is Quark ?

- It is fundamental particles so it cannot be broken up into anything smaller like electrons.
- There are six types of quarks which are Up, Down, Charm, Strange, Top and Bottom

Protons and Neutrons are not fundamental particles, unlike Electrons

- This means that protons and neutrons are made up of even smaller particles called "**quarks**".

1. BACKGROUND

What is Large Hadron Collider (LHC) ?

- It is the world's largest particle collider which located in Geneva, Switzerland.
- It is used to accelerate particles beams and guide particle's collision.
- Groups of protons collide together at the speed that closes to light (nearly 40 million times per minute), the energy of the collision turns into new particle.

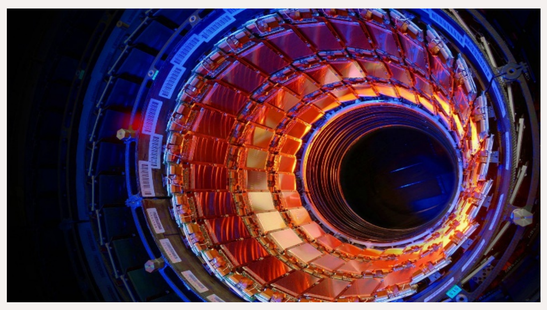


Figure 3. Particle Accelerator in LHC

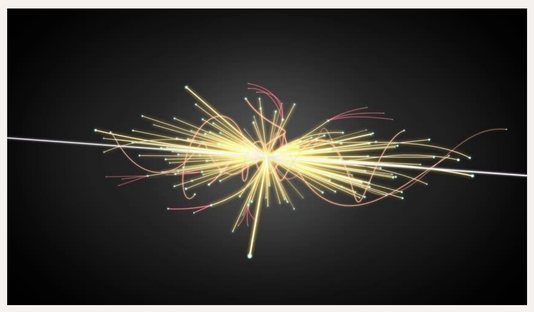


Figure 4. Particles Collision

What is Compact Muon Solenoid (CMS) ?

- It is a particle detector in the LHC. It detects the process of the particle collision and record the result.
- Then scientists collect these data together and put them online (**CMS Open Data portal**) for public to use them on further experiments.

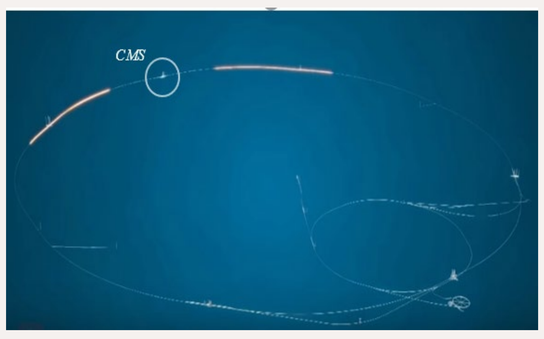


Figure 5. LHC Structure

Figure 6. CMS Detector

2. WHAT IS ML AND DL

The differences between Machine Learning and Deep Learning.

Machine Learning	Deep Learning
• It is an approach to achieve Artificial intelligence.	• It is a techniques for implementing Machine Learning
• It uses algorithms to parse data, learn from data, and make decisions based on what it has learned.	• Deep learning structures algorithms in layers to create an artificial neural network that can learn and make intelligent decision on its own
• Good with small datasets.	• Good with larger datasets
• Takes less time	• Takes longer time
• Uses algorithms like KNN, Random Forest and many more.	• Interprets the data with the help of neural networks.

Table 1. The differences between Machine Learning and Deep Learning

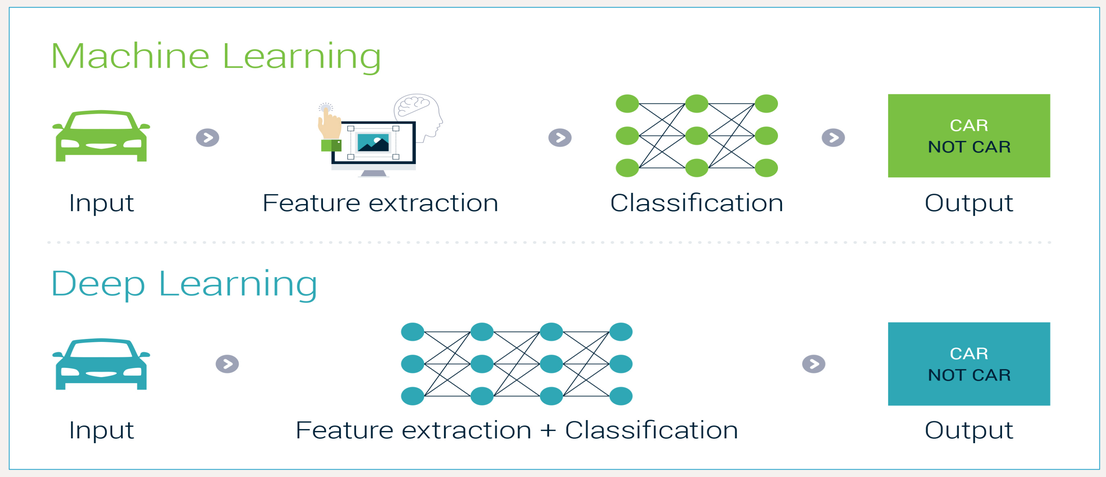
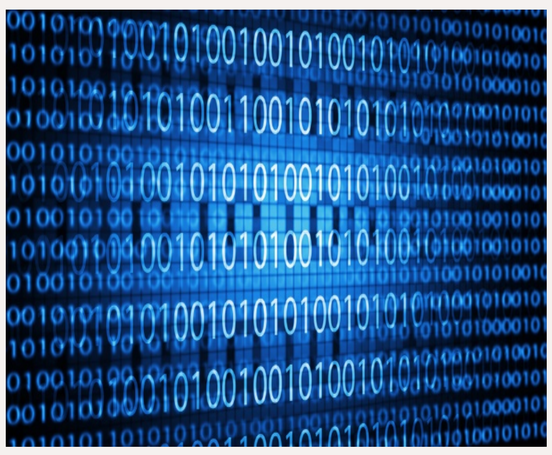


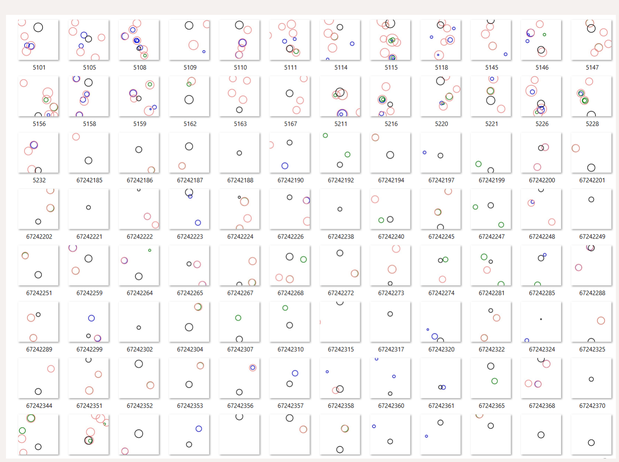
Figure 7. Example for both Machine Learning Vs Deep Learning

3. EXPERIMENT

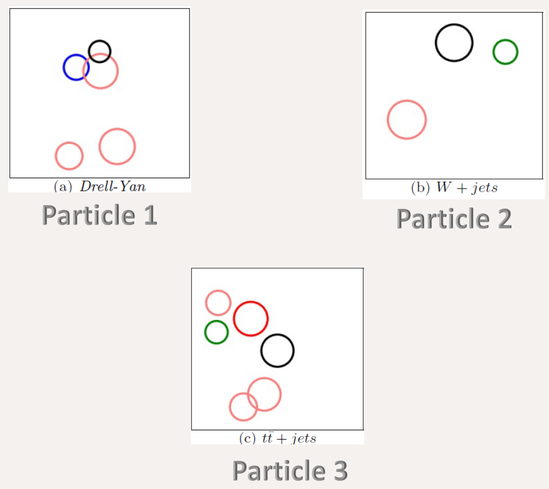
The amount of data for particle collision is very huge, which is the basic condition to use machine leaning. In our experiment, we extract the collision data from CERN's website and transfer them into images. We use different machine learning model to identify three classes of the mixed images.



Data



Images



Results

SCAN ME

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