ABSTRACT

The COVID-19 pandemic has created much damage to society and brought panic all around the world. This deadly SARS-CoV-2 virus is highly contagious and has affected almost all countries. To stop spreading this virus, quick and accurate diagnosis followed by effective isolation and patient treatment is mandatory at the early stage of virus breakouts. The disease is currently confirmed using reverse transcription-polymerase chain reaction (RT-PCR) testing.

However, through research and other reports, it is confirmed that the sensitivity of RT-PCR might not be high enough for early detection and treatment of patients who are assumed to have to have COVID-19. In recent times, artificial intelligence using deep learning technology in the medical imaging domain has excellent success. Deep Learning was applied to efficiently detect and accurately differentiate between bacterial and viral pneumonia in chest CT scans.

CT Scan is an imaging approach used to identify the characteristics and effectively serve for early diagnosis and screening of COVID-19. Detection of COVID-19 Using Deep Learning CT Image Classification using convolutional neural networks: Improving Testing with Deep Learning and Computer Vision.

In this project we shall discuss, how testing is done for the covid-19 and how deep learning tools will be useful for medical imaging can help us in improving the testing quality of COVID-19.
We aim to research and implement a Deep Learning classifier that contains the information of COVID and non-COVID patients, which can classify patients based on which we declare the results of the patients with utmost accuracy. The sensitivity of predicting is high enough to detect at the early stage of the virus. As it is a Deep Learning model, the processing time to give the testing results is very fast.

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1. INTRODUCTION

In 2019, Chinese health authorities got to know a new unknown origin of pneumonia. The name SARS-CoV-2 (severe acute respiratory syndrome) means the lungs and respiratory tract are highly affected, leading to the cause of novel coronavirus. This virus was originated from bats and spread to people through an unknown origin. Severe corona symptoms are difficulty breathing, chest pain, and several other common and mild symptoms like cold, headache, fever.

At the beginning of the coronavirus, an RT-PCR test (Reverse Transcription-polymerase chain reaction) was used to predict the virus. This method is inaccurate because it gives false positives, which means people who are not infected by the virus are told that they have been tested positive, and false negatives, which means people who have the virus, are classified as harmful by our algorithm.

This way of wrongly classifying is alarmingly shortcoming as it would allow many infected people to go home and spread the virus. RTPCR results lead to an increase of spreading the virus as testing consumes more time, whereas now there are computer-based models to predict the values and give accurate results. For the RT-PCR test, all the collected samples are delivered to testing in less than two days; else, there is a considerable possibility of false results. The accuracy decreases with an increase in time. Hence this method is not reliable.

As a non-invasive imaging approach, CT-Scan can depict specific characteristics manifestations in the lung associated with COVID-19. Therefore, CT-Scan could serve as the most accurate way for early diagnosis of COVID-19.

We used the VGG-19 with batch normalization as our inspiration model. We shall be constructing our own neural network model and shall be training the model with our training data.

Our aim is to improve accuracy and metrics such as sensitivity, specificity and Area under the curve of the preexisting model. We will be using KERAS and TensorFlow created by the Google Brain team, TensorFlow is an open-source library for numerical computation and large-scale machine learning. TensorFlow bundles together a slew of machine learning and deep learning (aka neural networking) models and algorithms. TensorFlow is mainly used for: Classification, Perception, Understanding, Discovering, Prediction and Creation.

The main goal of this paper is to improve the accuracy of true positive and negative results.

TECHNOLOGIES USED:

1.1 : Artificial Intelligence And Deep Learning

Definition: Artificial Intelligence (AI) is the study and creation of computer systems that can perceive, reason and act.

The primary aim of Al is to produce intelligent machines. The intelligence should be exhibited by thinking, making decisions, solving problems, more importantly by learning. Al is an interdisciplinary field that requires knowledge in computer science, linguistics, psychology, biology, philosophy and so on for serious research.

1.1.3 : Framework for approaching the Machine Learning process

1. **Problem Statement:** Rephrasing our problem as machine learning problem.
   The four major types of machine learning are supervised learning, unsupervised learning, transfer learning and reinforcement learning (there's semi-supervised as well but I've left it out for brevity). The three most used in business applications are supervised learning, unsupervised learning, transfer learning.

2. **Data:** The data you have or need to collect will depend on the problem you want to solve. If you already have data, it's likely it will be in one of two forms. Structured or unstructured. Within each of these, you have static or streaming data.

3. **Evaluation:** A 95% accurate model may sound pretty good for predicting who's at fault in an insurance claim. But for predicting heart disease, you'll likely want better results. Other things you should take into consideration for classification problems. False negatives, false positives, True negatives, True positives, Precision, Recall, ROC.

4. **Features:** What features does our data have and which model can be used to build our model. The three main types of features are categorical, continuous (or numerical) and derived.

5. **Modelling:** Choosing our model and how to improve it and comparing our model with other models. Modelling breaks into three parts, choosing a model, improving a model, comparing it with others. When choosing a model, you'll want to take into consideration, interpretability and ease to debug, amount of data, training and prediction limitations.

6. **Experimentation:** Experimentation should be conducted on different portions of data i.e., testing dataset, training dataset, validation dataset.

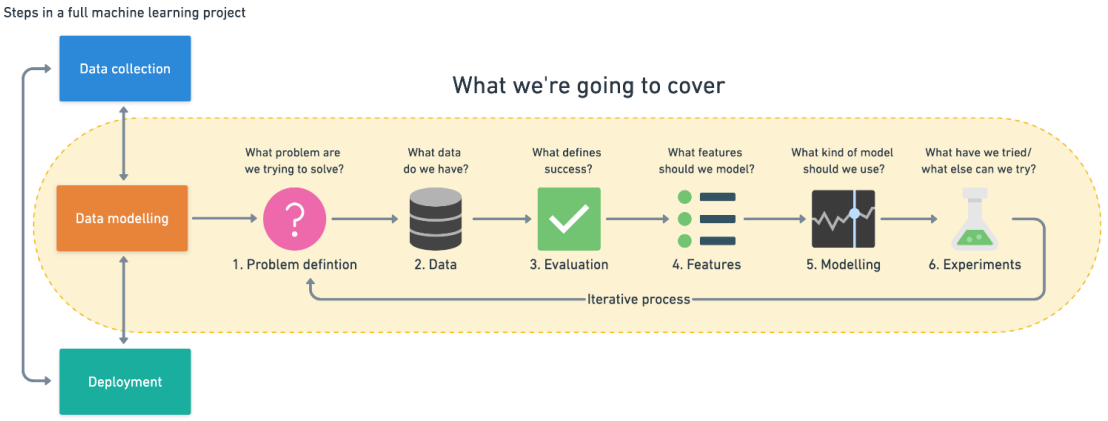


Fig 1.1.3: Machine Learning process

- Python works on different platforms (Windows, Mac, Linux, Raspberry Pi, etc).
- Python has a simple syntax similar to the English language.
- Python has syntax that allows developers to write programs with fewer lines than some other programming languages.
- Python runs on an interpreter system, meaning that code can be executed as soon as it is written. This means that prototyping can be very quick.
- Python can be treated in a procedural way, an object-orientated way or a functional way.

1.2.1 : Machine Learning in Python

Machine learning is learning based on experience. As an example, it is like a person who learns to play chess through observation as others play. In this way, computers can be programmed through the provision of information in which they are trained, acquiring the ability to identify elements or their characteristics with high probability. There are various stages of machine learning:

- Collect and prepare data
- Make sense of data
- Use data to answer questions

- Algorithm development
- Checking algorithm generated
- Create predictive applications
- Keep building

Machine learning algorithms divided into two groups:

● Supervised learning:

Supervised learning, as the name indicates, has the presence of a supervisor as a teacher. Basically, supervised learning is when we teach or train the machine using data that is well labeled. Which means some data is already tagged with the correct answer. After that, the machine is provided with a new set of examples(data) so that the supervised learning algorithm analyses the training data(set of training examples) and produces a correct outcome from labeled data.

Supervised learning classified into two categories of algorithms:

- **Classification**: A classification problem is when the output variable is a category, such as “Red” or “blue” or “disease” and “no disease”.
- **Regression**: A regression problem is when the output variable is a real value, such as “dollars” or “weight”.

●Unsupervised learning:

Unsupervised learning is the training of a machine using information that is neither classified nor labeled and allowing the algorithm to act on that information without guidance. Here the task of the machine is to group unsorted information according to similarities, patterns, and differences without any prior training of data.

Unlike supervised learning, no teacher is provided that means no training will be given to the machine. Therefore, the machine is restricted to find the hidden structure in unlabeled data by itself.

Unsupervised learning is classified into two categories of algorithms:

- **Clustering**: A clustering problem is where you want to discover the inherent groupings in the data, such as grouping customers by purchasing behavior.
- **Association**: An association rule learning problem is where you want to discover rules that describe large portions of your data, such as people that buy X also tend to buy Y.

1.2.1.1 : OS Module

The OS module in Python provides functions for interacting with the operating system. OS comes under Python's standard utility modules. This module provides a portable way of using operating system dependent functionality.

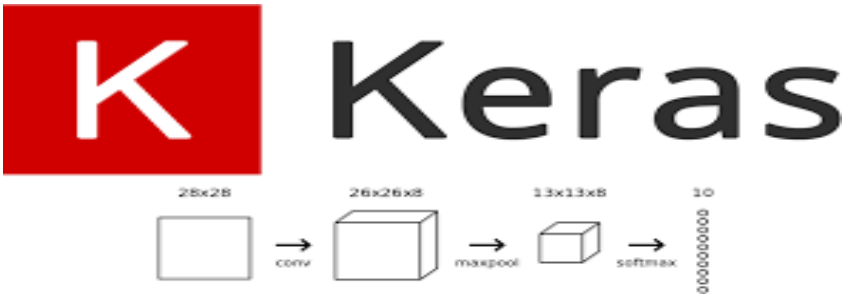
●The *os* and *os.path* modules include many functions to interact with the file system.
●To change the current working directory(CWD) os.chdir() method is used. This method changes the CWD to a specified path. It only takes a single argument as a new directory path.
●os.mkdir() method in Python is used to create a directory named path with the specified numeric mode. This method raise FileExistsError if the directory to be created already exists.
●os.makedirs() method in Python is used to create a directory recursively. That means while making leaf directory if any intermediate-level directory is missing, os.makedirs() method will create them all.

1.2.1.2 : Open CV

OpenCV-Python is a library of Python bindings designed to solve computer vision problems.
cv2.imread() method loads an image from the specified file. If the image cannot be read (because of
missing file, improper permissions, unsupported or invalid format) then this method returns an empty matrix.
Python is a general purpose programming language started by Guido van Rossum that became very popular very quickly, mainly because of its simplicity and code

1.4.1: Keras layers

Convolution Layer: This layer is the first layer that is used to extract the various features from the input images. In this layer, the mathematical operation of convolution is performed between the input image and a filter of a particular size MxM. By sliding the filter over the input image, the dot product is taken between the filter and the parts of the input image with respect to the size of the filter (MxM).
The output is termed as the Feature map which gives us information about the image such as the corners and edges. Later, this feature map is fed to other layers to learn several other features of the input image.



Pooling Layer:

In most cases, a Convolutional Layer is followed by a Pooling Layer. The primary aim of this layer is to decrease the size of the convolved feature map to reduce the computational costs. This is performed by decreasing the connections between layers and independently operates on each feature map. Depending upon method used, there are several types of Pooling operations.

In Max Pooling, the largest element is taken from feature map. Average Pooling calculates the average of the elements in a predefined sized Image section. The total sum of the elements in the predefined section is computed in Sum Pooling. The Pooling Layer usually serves as a bridge between the Convolutional Layer and the FC Layer

Fully Connected layer:

The Fully Connected (FC) layer consists of the weights and biases along with the neurons and is used to connect the neurons between two different layers. These layers are usually placed before the output layer and form the last few layers of a CNN Architecture.

In this, the input image from the previous layers are flattened and fed to the FC layer. The flattened vector then undergoes few more FC layers where the mathematical functions operations usually take place. In this stage, the classification process begins to take place.

Dropout:

When all the features are connected to the FC layer, it can cause overfitting in the training dataset. Overfitting occurs when a particular model works so well on the training data causing a negative impact in the model's performance when used on a new data.

To overcome this problem, a dropout layer is utilised wherein a few neurons are dropped from the neural network during training process resulting in reduced size of the model. On passing a dropout of 0.3, 30% of the nodes are dropped out randomly from the neural network.