A Deep Learning Model to Detect Corona Virus Infection from Computed Tomography Images

P. S. Ezekiel, O.E. Taylor*, V. T. Emmah

Department of Computer Science, Rivers State University, Port Harcourt, Nigeria
*tayonate@yahoo.com

Abstract Covid-19 is caused by germ called coronavirus, is an ailment that influences relaxing. It was first found in December 2019 in China which lead to closure of business sectors in China. Within four months of the disclosure of the infection in china, the infection has spread to practically all the nations on the planet, tainting millions and killing several thousands. This paper presents a model to detect covid-19 from computed tomography (CT) images. The computed tomography image dataset contains two image folders which are a covid-19 and a non-covid-19 image folder making it a total of 746 images. ImageDataGnerator was used in reading the images from the desktop to the jupyter notebook using the flow_from_directory function. The model was trained using a batch_size =32 and an epoch value of 9, that is 9th iterative steps. The model was scored based on accuracy of about 96.97 on an epoch value of 8, that is having the highest accuracy at the 8th step of training/learning. The trained model was deployed to web using python flask framework to detect covid-19 from computed tomography (CT) images.

Keywords Covid-19, Computed Tomography (CT) images, Convolutional Neural Network, Python Flask Framework

1. Introduction

Covid-19 is caused by germ called coronavirus, is an ailment that influences relaxing. It was first found in December 2019 in China which lead to closure of business sectors in China. Inside four months of the disclosure of the infection in china, the infection has spread to practically all the nations on the planet, tainting millions and killing several thousands. Coronavirus can spread from individual to individual through nasal and throat beads conveying the infection. These beads are discharged when a bearer of the infection hacks, wheezes, speaks or breathe out. Coronavirus can likewise be deposited on items and surfaces; and then contacting them with sullied hands. Coronavirus can likewise be transmitted even before the tainted individual builds up a manifestation of the ailment during first seven day stretch of beginning of sickness. Coronavirus was first recorded in Nigeria on 27th February 2020; this was because of an Italian resident who came back to Nigeria from Millan. The Nigerian Government through the Administrative Service of Wellbeing attempted to control the spread of the infection via doing some safety efforts like closing down of schools, markets, strict exercises and limiting between state developments. This didn't stop the spread of the infection, rather the infection keeps spreading with 400-600 recorded cases every day.

In late December 2019, a flare-up of a baffling pneumonia portrayed by fever, dry hack, and exhaustion, and intermittent gastrointestinal side effects occurred in a fish discount wet market, the Huanan Fish discount Market in Wuhan, Hubei, China [1]. The underlying flare-up was accounted for in the market in December 2019 and included about 66% of the staff there. The market was closed down on January 1, 2020, after the declaration of an epidemiologic alarm by the nearby wellbeing expert on December 31, 2019. Nonetheless, in the next

month (January) a huge number of individuals in China, including numerous territories, (for example, Hubei, Zhejiang, Guangdong, Henan, Hunan, and so on.) and urban areas (Beijing and Shanghai) were assaulted by the uncontrolled spreading of the sickness. Besides, the ailment made a trip to different nations, for example, Thailand, Japan, Republic of Korea, Viet Nam, Germany, US, and Singapore. The primary case detailed in our nation was on January 21, 2019. As of February 6, 2020, a sum of 28,276 affirmed cases with 565 deaths all around were recorded by WHO, including at any rate 25 nations [2]. The microbe of the episode was later distinguished as a novel beta-coronavirus, named 2019 novel coronavirus (2019-nCoV) and reviewed to our psyche the awful memory of the extreme intense respiratory disorder (SARS-2003, brought about by another beta-coronavirus) that happened 17 years prior.Covid-19 normally presents as an intense viral respiratory tract contamination and numerous differential conclusions identified with basic viral pneumonia ought to be thought of, for example, flu, parainfluenza, adenovirus disease, respiratory syncytial infection contamination, metapneumovirus contamination, and atypical microorganisms, for example, Mycoplasma pneumoniae and Clamydophila pneumoniae contaminations and so forth [1, 3]. In this manner, it is urgent to follow the movement and presentation history when moving toward a speculated persistent back from a pestilence zone. What's more, business respiratory syndromic indicative packs that distinguish various etiological operators, (for example, Filmarray Respiratory Board) may support opportune differential analysis. This paper proposes a deep learning model to detect covid-19 from CT_images.

2. Related Work

Role of Machine Learning to Predict the Outbreak of Covid-19 in India [4] developed a model to Predict the impact of covid-19 in India for the following seven days. They tried to recognize the pattern of the spread of crown infection in India and what might be the expanded number of covid-19 case in future days. They assembled their outcome by contemplating the progressing condition in India, checking if the example of the rising case is indistinguishable from that of Italy, South Korea and Wuhan. They likewise got their discoveries by utilizing the forecast of Indian prophets on the ascending of covid-19 cases. They additionally gathered the dataset of quantities of people tainted by the infection and furthermore the quantity of people restored from the infection and dissected them utilizing graphical portrayals. In end, it was discovered that 60% of coronavirus cases revealed to be people younger than 50 in India while the greatest number of covid-19 deaths falls above 60 years or more.

COVID-19 Pandemic Prediction for Hungary; A Hybrid Machine Learning Approach [5] proposes a crossover AI concept to deal with foresee the COVID-19, and they epitomize its potential utilizing information from Hungary. The half breed AI strategies for versatile system based fluffy induction framework (ANFIS) and multi-layered perceptron-settler serious calculation (MLP-ICA) are proposed to foresee time arrangement of contaminated people and death rate. Their model anticipate that by late May, the episode and the complete ethical quality will drop considerably. The approval is performed for 9 days with promising outcomes, which affirms the model precision. It is normal that the model keeps up its precision as long as no critical interference happens. This paper gives an underlying benchmarking to show the capability of AI for future examination.

A Proposed Machine Learning approach for Monitoring Individual's Health Status on Corona virus (COVID19) cases [6]; proposed an end-to-end driven displaying approach that will use online overview survey application to gather information that will be feed to a Supervised Machine learning model so as to find out person's wellbeing status. Their system used a static, deterministic, information driven based methodologies, for the most part. The Artificial Intelligent System provide an efficient and easy approach of checking the wellbeing status of an individual, they are being provided with an input form that will collect various symptoms as data. They prepared their model utilizing a managed AI model say Logistic relapse, Classification choice tree, Random Forest, Support Vector Machine to prepare the model. Their proposed model reenacts person's mindfulness towards controlling the spread of the COVID infection among people.

Coronavirus disease 2019 (COVID-19): A literature review [7] led a writing audit of freely accessible data to sum up information about the microorganism and the current scourge. In their writing audit, they evaluated the hazard factors (they are less instances of covid-19 younger than children of 15), pathogenesis and invulnerable reactions (The host safe framework reaction to viral contamination by interceding irritation and cell antiviral

movement is basic to hinder viral replication and dispersal.), the study of disease transmission, analysis (Using fitting instruments in screening and diagnosing of patients , treatment and the executives of the illness (Isolation and strong consideration including oxygen treatment, liquid administration, and anti-infection agents treatment for optional bacterial contaminations is suggested), control and anticipations techniques (by utilizing face masks and observing social distancing).

COVID -19 Pandemic- A Literature Review [8] conducted a detailed research on covid-19 beginning from how it originated, structure of the virus which signifies which family the virus falls under. The virus belongs to genus Coronaviridae family which comproses of RNA viruses, positive sense, single stranded. They also discussed the incubation period of the virus which is about two to fourteen days. The virus can be transmitted through direct contact with infected person. They also talked about some symptoms of covid-19 which are dry cough, fever etc. Finally, they talked about treatment which they mentioned use hydroxychloroquine, convalescent plasma therapy.

A Narrative Literature Review of Global Pandemic Novel Coronavirus Disease 2019 (COVID-19): Epidemiology, Virology, Potential Drug Treatments Available [9] talks about the pertinent writing, including refreshed examinations, Case arrangement, defensive measure, treatment rules and the suggestions for training as for (novel Coronavirus) contamination. Subsequent to playing out a writing search utilizing ProQuest, MEDLINE, and PUBMED, Google Scholar web crawlers. The hunt terms utilized were COVID-19, Coronaviruses, flare-up, "respiratory disease", "transmission" and contamination control and the board". Looked into 43 articles dependent on the nature of the investigation.

Systematic literature review on novel corona virus SARS-CoV-2: a threat to human era [10] distinguish the significant exploration subjects in COVID-19 writing, they decide the inception, manifestations and methods of transmission of COVID, suggested the mediation and alleviation methodologies embraced by the Governments all around against the spread of COVID-19 and the injury among the general population and study the potential medications/treatment plans against COVID-19. They conveyed at a deliberate writing survey and far reaching examination of 38 exploration articles on COVID-19 followed by an incorporated Research which concentrated on equal boat system and watchword co-event investigation. They watched the accompanying (1) as SARSCoV-2's RNA matches * 96% to SARS-CoV, it is thought to be communicated from the bats. (2) The normal manifestations are high fever, dry hack, weakness, sputum creation, windedness, the runs and so forth (3) A lockdown across 180 influenced provinces for over a month with social-separating and the safeguards taken in SARS and MERS are suggested by the Governments.
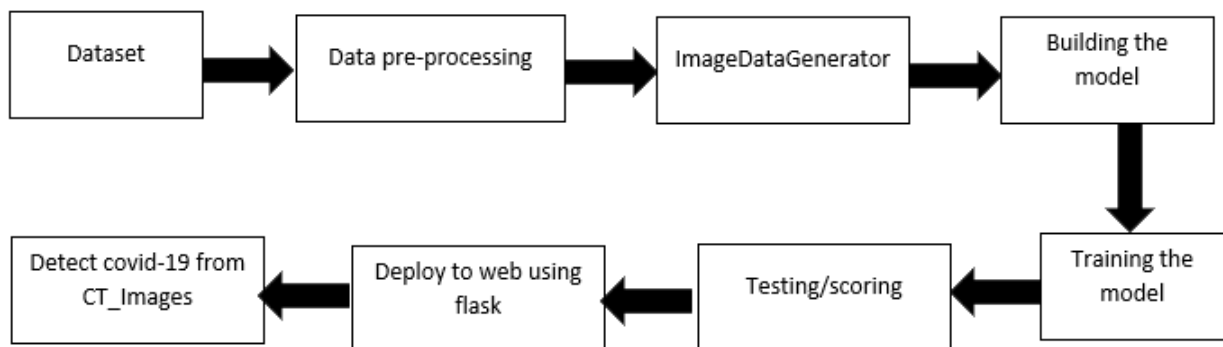
3. Design Methodology

Figure 1: Architectural Design of the proposed system

The design methodology and the system implementation process are as follows:

Dataset: we used a computed tomography (CT) image dataset in building our model to detect covid-19. The dataset consists of two image folders. The first folder contains scanned images of covid-19 patients while the second image folder contains images for non covid-19 patients. The dataset contains a total 746 images for the two folders [11].

Data pre-processing: This has to do with transforming the dataset into understandable format, and also removing inconsistency.

ImageDataGenerator: This is used in expanding the size of the image dataset by creating a modified version of the images in the dataset folder.

Building the Model: The model was built using deep convolutional neural network algorithm with Keras and Tensorflow. The algorithm was made up of five connected layers and three hidden layers which we use ReLU as the activation and two output layer which we use softmax as the activation. The network is made up with an input shape = (200,200)

Training/Scoring the Model: The deep neural network was trained using a batch_size=32 and an epoch value of 9 that is 9th iterative steps. The model was scored based on accuracy of about 96.97 on an epoch value of 8, that is having the highest accuracy at the 8th step of training/learning.

Deployed to Flask: The saved model was deployed to web using flask which is a web framework in python. We created a mini website where hospitals can use the trained model to detect corona virus from computed tomography (CT) image.

Detect covid-19 from CT images: The trained/deployed model will collect scanned computed tomography (CT) image from the user and compare it to its image database, if the image matches that of the covid-19, it sends a report to the user indicting that the patient has covid-19. It also goes through the same process when it matches that of non covid-19 image folder.

4. Result and Discussion

In this paper we used a computed tomography (CT) image dataset in training our convolutional neural network model. This dataset contains two image folders. The first folder contains scanned images of covid-19 patients while the second image folder contains images for non covid-19 patients. The dataset contains a total 746 images for the two folders. The dataset was pre-processed by creating directory variables. ImageDataGenerator is a module which is being used in reading images with the flow_from_directory function. The model was built using an input shape of 200 x 200 with a 3 bytes colour, five connective layers and three hidden layers, 64 input neurons and two output layer which classify if the image is a non covid-19 image or a covid-19 image. The dataset was trained using fit_generator function from keras which have an epoch of 9 and a batch size of 32. The model was scored based on accuracy of about 96.97 on an epoch value of 8, that is having the highest accuracy at the 8th step of training/learning. The model was then deployed to web using python flask frame for easy execution/detecting covid-19 and non-covid-19 images from a computed tomography (CT) images.
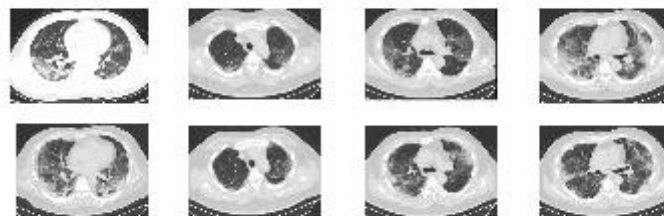

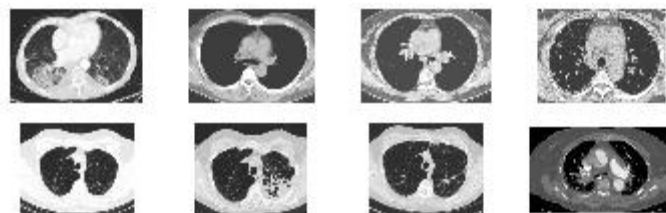*Figure 2: Covid-19 images from computed tomography scanned images*

Figure 3: Non covid-19 (the person is not infected with virus) images from computed tomography scanned images

Figure 4: Histogram representation of non-covid-19 images

Figure 5: shows a histogram representation of a covid-19 images

```
model.summary()

Model: "sequential"

_____
Layer (type)                 Output Shape              Param #
=================================================================
conv2d (Conv2D)              (None, 198, 198, 32)      896

max_pooling2d (MaxPooling2D) (None, 99, 99, 32)        0

conv2d_1 (Conv2D)            (None, 97, 97, 32)        9248

max_pooling2d_1 (MaxPooling2 (None, 48, 48, 32)        0

flatten (Flatten)            (None, 73728)             0

dense (Dense)                (None, 64)                4718656

dense_1 (Dense)              (None, 2)                 130
=================================================================
Total params: 4,728,930
Trainable params: 4,728,930
Non-trainable params: 0
_____
```

Figure 6: The summary of the model which contains the training parameters

```
Epoch 1/9
20/20 [==============================] - 267s 13s/step - loss: 2.2695 - acc: 0.5818
Epoch 2/9
20/20 [==============================] - 237s 12s/step - loss: 0.5444 - acc: 0.7451
Epoch 3/9
20/20 [==============================] - 246s 12s/step - loss: 0.4197 - acc: 0.8252
Epoch 4/9
20/20 [==============================] - 243s 12s/step - loss: 0.3595 - acc: 0.8605
Epoch 5/9
20/20 [==============================] - 240s 12s/step - loss: 0.4123 - acc: 0.9037
Epoch 6/9
20/20 [==============================] - 242s 12s/step - loss: 0.1987 - acc: 0.9358
Epoch 7/9
20/20 [==============================] - 242s 12s/step - loss: 0.0790 - acc: 0.9695
Epoch 8/9
20/20 [==============================] - 239s 12s/step - loss: 0.1202 - acc: 0.9697
Epoch 9/9
20/20 [==============================] - 243s 12s/step - loss: 0.2147 - acc: 0.9575
```

Figure 7: Training steps of the model

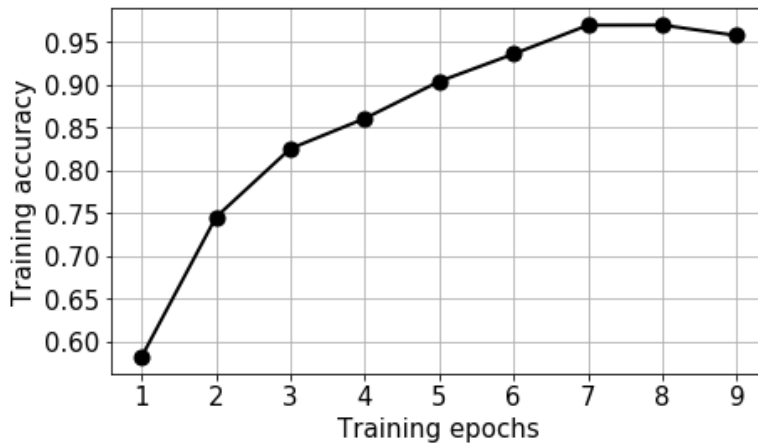*Figure 8: Plot showing the number of training steps and the accuracy gotten from each training steps*
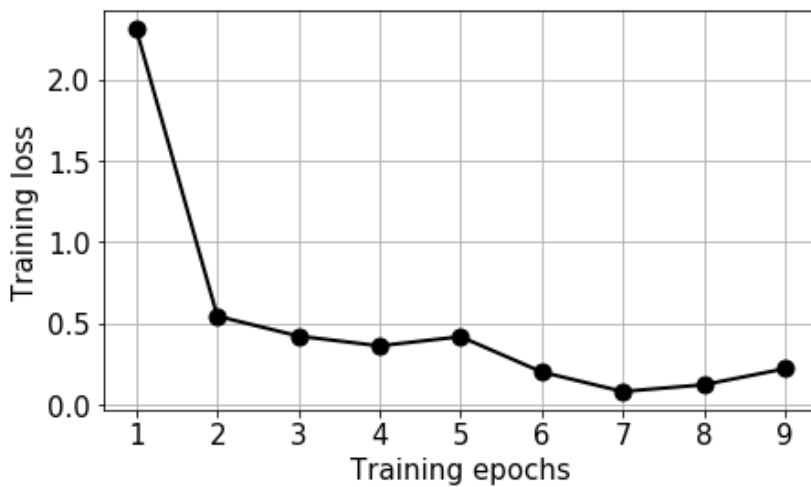
Figure 9: Plot of the loss values on each training steps

A Medical System for Detecting Corona Virus

Select a scanned x-ray image

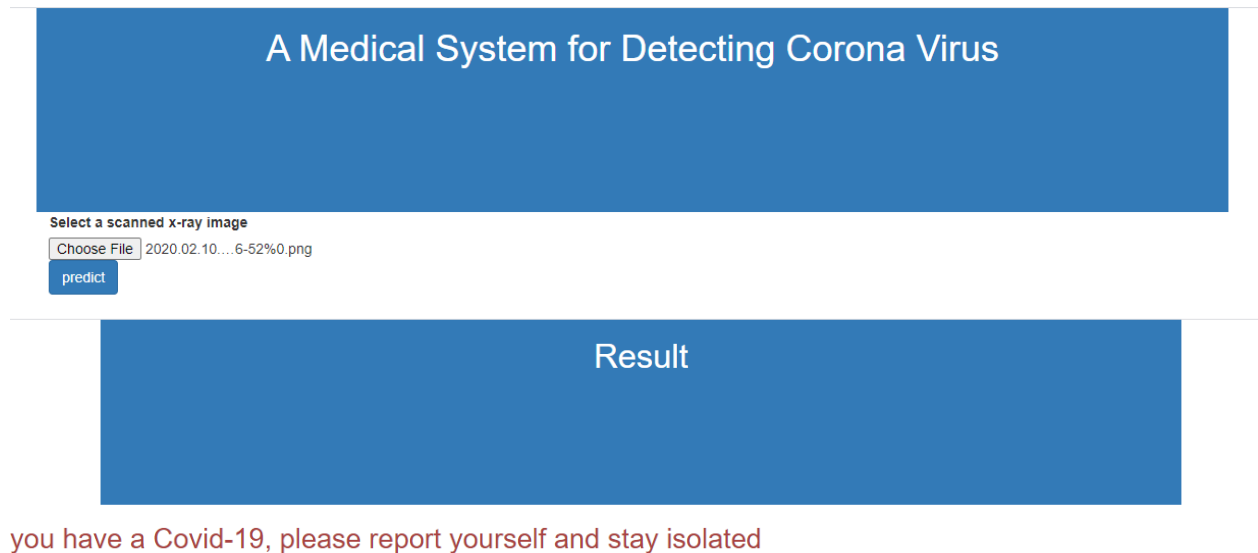Choose File | 2020.02.10....6-52%0.png

predict

Result

you have a Covid-19, please report yourself and stay isolated

Figure 10: Result showing a detected covid-19 image from web, by uploading computer tomography images

A Medical System for Detecting Corona Virus

Select a scanned x-ray image

Choose File | 1%1.jpg

predict

Result

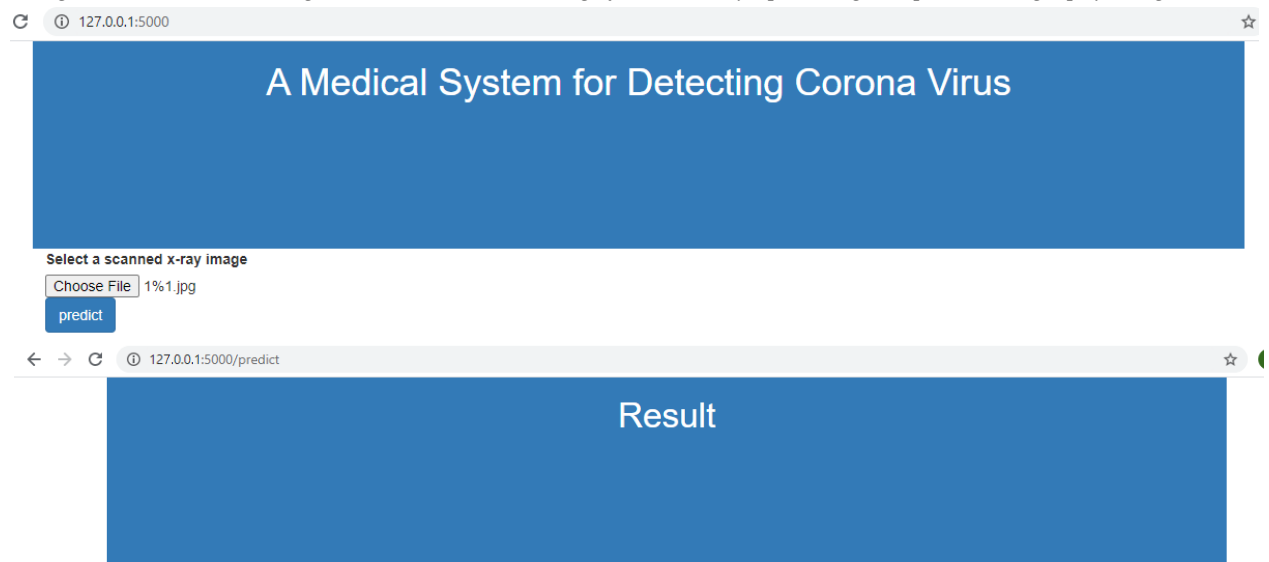you do not have Covid-19 but plase do well to stay safe, coronavirus is real

Figure 11: Result showing a detected non covid-19 image from web, by uploading computer tomography images

5. Conclusion and Future Scope

Covid-19 is caused by germ called coronavirus, is an ailment that can lead to death if not taken proper care of. It was first found in December 2019 in China which lead to closure of business sectors in China. Coronavirus can spread from individual to individual through nasal and throat beads conveying the infection. This paper presents a model to detect covid-19 from computed tomography (CT) images. The computed tomography image dataset contains two image folders which are a covid-19 and a non-covid-19 image folder, was trained using a batch_size =32 and an epoch value of 9 that is 9th iterative steps. The model was scored based on accuracy of about 96.97 on an epoch value of 8, that is having the highest accuracy at the 8th step of training/learning. The trained model was deployed to web using python flask framework. This paper can further be extended by increasing the number of training steps and also by changing some trainable parameters (input shap: 200 x 200, byte color: 3 batch_siz: 32, training steps: 9) to improve on the accuracy. It can also be extended by making it a real life covid-19 detection system.

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