

nCOVID-19 Detection with Frontal Chest X-Ray Scans Using Deep Learning Technique

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Abstract

The novel coronavirus (nCOVID-19) epidemic, which has infected millions of people and killed a large number of people throughout the world, was immediately declared a global emergency. This disease is caused by the highly infectious virus 'Severe Acute Respiratory Syndrome CoronaVirus-2 (SARS-COV-2)', in which infection with cryptogenic organizing pneumonia can be spread even from asymptomatic patients during the incubation stage. According to the expert's perspective, the virus mainly affects the human respiratory tract, causing severe bronchopneumonia with fever, dyspnea, dry cough, tiredness, and respiratory failure. For identifying nCOVID-19, the usual 'Reverse Transcription-Polymerase Chain Reaction (RT-PCR)' clinical confirmatory test is manual, complex, and time-consuming. One of the key reasons for the need for a faster and easier method of diagnosing infected individuals to be separated and cared for is the limited availability of domain experts and test kits in hospitals. An automatic screening method may act as a second opinion for medical practitioners to rapidly identify infected individuals who require immediate isolation. Additional clinical confirmation is necessary when there is a transitory spike in the number of infected patients. We are proposing a deep learning technique to detect the nCovid-19 using frontal Chest X-ray scans.

Keywords: Covid-19, Chest X-ray, Deep learning, Convolution Neural Network.

1. Introduction

There are three primary tests to detect COVID-19: RT-PCR Test, Rapid Antigen Test, and Antibody Test. RT-PCR tests check for the presence of viral RNA in the body, which can be detected before antibodies are formed, or signs of the disease appear. It gives a metric called the Cycle Threshold value, which signifies the number of cycles required to amplify the viral RNA to reach a detectable level. It is accurate but requires a longer processing time, whereas the other two tests are rapid and inexpensive but are not very reliable.

“Chest X-Ray (CXR) is a critical, non-invasive clinical adjunct that plays an essential role in the preliminary investigation of different pulmonary abnormalities. It can act as an alternative screening modality for the detection of nCOVID-19 or validate the related diagnosis [1-2]”. “The diagnosing sensitivity of PCR is 60%–70%, so X-ray scans have been adopted to screen for covid-19 cases [3]”. “Expert radiologists interpret the CXR images to look for infectious lesions associated with nCOVID-19. The earlier studies reveal that the infected patients exhibit distinct visual characteristics in CXR images [1]”. In non-ICU patients, multifocal, bilateral ground-glass obscurities (GGO) and patchy complicated nodular opacities are shown on X-rays, while ICU patients have dense pulmonary consolidations. Nevertheless, manually interpreting these minor visual characteristics on CXR scans is challenging and necessitates the assistance of a domain specialist.

The alarming rise in infected patients makes it difficult for the radiologist to finish the diagnosis on time, resulting in significant morbidity and death. The parameters to be considered include patchy obscurities and glass-like opacities in the X-ray images.

We created an image classifier with TensorFlow by implementing a CNN (Convolutional Neural Network) to differentiate between CXR images with COVID-19 infections versus those not. Moreover, thereby detect the infected patients for treatment at a faster pace with minor delay. We built and trained a Convolutional Neural Network (CNN) using Keras with TensorFlow as a backend. Furthermore, the dataset contains the Chest X-Ray images of both the groups (infected and non-infected). Data Visualization using Matplotlib is employed to interpret the data. The model will also be able to make predictions on new data.

2. Ensemble Deep Learning Model for nCOVID-19 on Chest X-ray Scans

2.1 Data Set

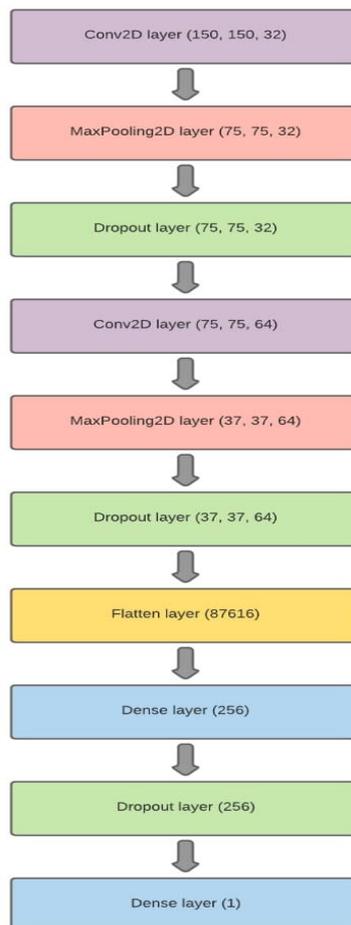
The project is carried out of two class datasets: Normal images and Covid-19 images, as shown in figure-1. The total images present in the training set is 1811, of which 1311 scans are normal reports, and 480 scans are covid reports. The total images present in the testing set is 484, of which 314 scans are normal reports, and 170 scans are covid reports.

Figure 1 - Illustration of Chest X-ray Images, (a) Normal, (b) Covid-19



(a) (b)

Figure 2 - Working Model of Convolution Neural Network Tensor-flow Architecture



2.2 Working Model

We designed a deep learning model using Keras and TensorFlow as a backend and sequential model, as shown in figure-2. We used a sequential model because it is the simplest way to form a model in Keras. It permits making a model layer by layer. We used the 'add()' operation to feature layers to our model. We adopted necessary libraries, such as Conv2D, MaxPooling2D, Dropout, Flatten, Dense layers, ImageDataGenerator, NumPy, Matplotlib, and Adam optimizer.

The dataset is cloned and explored from GitHub, which is from Kaggle [4]. We designed a convolutional neural network with the subsequent layers. We compiled the model with the Adam optimizer with a learning rate set to 0.001 and the loss to binary cross-entropy because it consists of 2 categories. We then trained the model, charging thirty epochs, fitting train, and validation information whereas checking for parameters like loss, accuracy, validation loss, and validation accuracy. The Working model of CNN architecture- Tensor flow diagram as shown in figure 2.

We evaluated the model's performance by plotting graphs between coaching and validation accuracy and coaching and validation losses. Further, we used the testing information to predict new information and classify the given X-Ray pictures into nCOVID-19 affected or not affected.

3. Experimental Result and Analysis

We designed the convolutional neural network to detect the X-Rays of nCOVID-19 infected patients from the unaffected ones and display the result. The below picture shows the performance evaluation of the deep learning model in terms of training and validation loss. The other displays performance in terms of training and validation accuracy.

Figure 3 - Training and Validation Loss

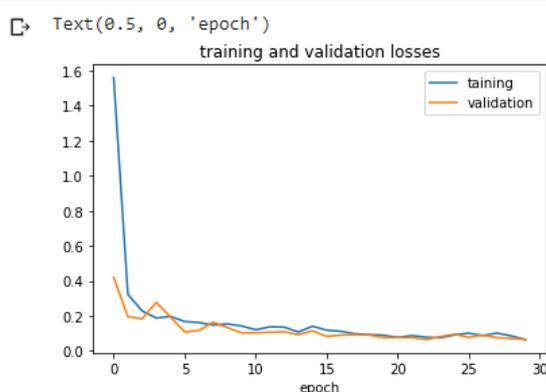


Figure 4 - Training and Validation Accuracy

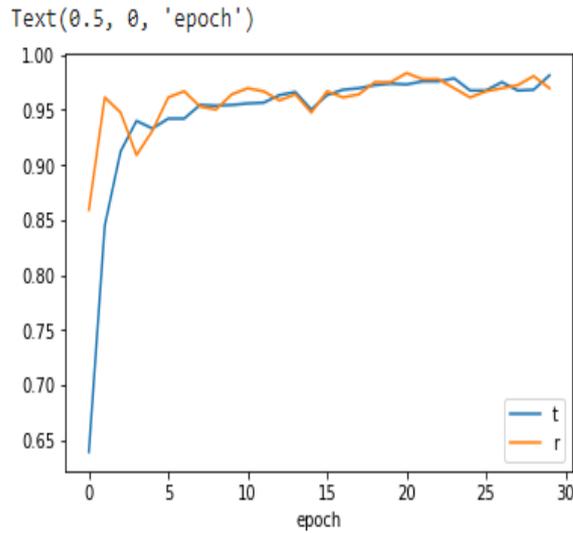


Figure 5 - Training Loss & Accuracy and Testing Loss & Accuracy

```
16/16 [=====] - 10s 616ms/step - loss: 0.0882 - accuracy: 0.9649  
test loss :0.08817709982395172 test acc :0.9648760557174683
```

Finally, we use the test data to test the accuracy of the trained model. We give four random Chest X-Ray images as input, out of which two being nCOVID-19 infected and two being non-infected, and the results of the prediction on new data are displayed below figure-6.

Figure 6 - Prediction on Tested Data

```
📁 Choose Files 4 files  
• covid1.jpeg(image/jpeg) - 118595 bytes, last modified: 5/2/2021 - 100% done  
• covid2.jpg(image/jpeg) - 74751 bytes, last modified: 5/2/2021 - 100% done  
• normal1.jpg(image/jpeg) - 492479 bytes, last modified: 5/2/2021 - 100% done  
• normal2.jpeg(image/jpeg) - 646168 bytes, last modified: 5/2/2021 - 100% done  
Saving covid1.jpeg to covid1.jpeg  
Saving covid2.jpg to covid2.jpg  
Saving normal1.jpg to normal1.jpg  
Saving normal2.jpeg to normal2.jpeg  
covid1.jpeg  
covid detected  
covid2.jpg  
covid detected  
normal1.jpg  
your report is normal  
normal2.jpeg  
your report is normal
```

4. Conclusion

To diagnose COVID-19, two types of testing are used worldwide: the antibody test and the RT-PCR test. The antibody test, an indirect method of testing, can detect if the immune system has contacted the virus. Because antibodies can take up to 9–28 days to develop after an infection has taken hold, the procedure is lengthy, and by that time, the sick individual may have transmitted the disease. On the other hand, the RT-PCR testing is quick and can identify COVID-19 in as little as 1-2 days.

The suggested deep learning algorithm overcomes these constraints, and it can detect a COVID-19 positive or negative in under 5 seconds. With the data we had, we were able to attain a 96 % positive rate. We can improve accuracy by adding additional samples of chest X-rays to the training data set to the same proposed architecture. This approach might aid hospital administrators and medical professionals take the appropriate actions to manage COVID-19 patients following their rapid diagnosis.

References

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