Project Report

Artificial Neural Networks (CS 342)

Academic Year- 2020-21

On

Automatic Detection of Coronavirus Disease (COVID-19) Using X-ray Images and Deep Convolutional Neural Networks

Submitted by

1. Anjali Mishra BT17GCS157
2. Arundhati Das BT17GCS016
3. Ayushi Kapoor BT17GCS020

Introduction:

COVID-19 commonly referred to as the Novel Coronavirus disease is considered to be the most hazardous disease that emerged in China towards the end of 2019. This disease is caused by SARS-CoV-2, an endemic that belongs to the big family of coronaviruses. The disease first originated in Wuhan, China in December 2019 and shortly became a world pandemic, spreading to over 213 countries.

The most common symptoms of COVID-19 are fever, dry cough, and fatigue. Other symptoms that people may experience include aches, pains, or shortness of breath. Most of these symptoms show signs of respiratory infections and lung abnormalities which can be detected by radiologists.

Thus, it's possible to use pre-trained neural networks to detect the disease from images of Chest X-rays. Automated applications can be created to assist support radiologists. We used three Deep Learning algorithms, namely: ResNet50, InceptionV3 and Xception.

The models were trained for 500 epochs on around 1000 Chest X-rays images on Google Colab GPU.

Dataset used:

The dataset for the project was gathered from open source Github repositories:

- Chest X-ray images (1000 images) were obtained from: https://github.com/ieee8023/covid-chestxray-dataset

Three algorithms: ResNet50, InceptionV3 and Xception were trained separately on Chest X-rays. 80% of the images were used for training the models and the remaining 20% for testing the accuracy of the models.

Motivation:

There are a limited number of COVID-19 test kits available in hospitals due to the increasing number of cases every day. SARS n-CoV-2 virus is known to affect the lungs of patients with COVID-19. Chest x-rays are the most widely used diagnostic imaging technique due to fast imaging time and low cost. Therefore, it is necessary to use the automatic detection system as an immediate diagnostic method to prevent COVID-19 transmission among people.

Work done:

- **Building the model:**

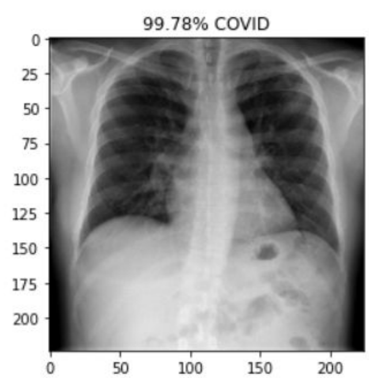
  First we added 3 custom layers to the pretrained models so that they can be trained on our dataset.The images in the dataset were of different sizes. Thus we resized them to a fixed size of 224 x 224 px which is considered to be the ideal size for all the models. Therefore,

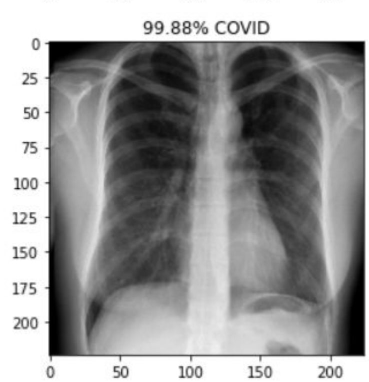
we added the input tensor of shape (224, 224 , 3) to the pretrained models, 3 being the number of channels.
Next, we added a Flatten layer to flatten all our features and a Dropout layer to overcome overfitting. Finally, we added the Dense output layer using softmax function as the activation function. Since the first half of the model is already pretrained, the trainable attribute of the previous layers was set to False. Finally, compiled the model with the Adam optimizer using categorical cross entropy as the loss function.

- **Training the model:**
  We first defined an Image Data Generator to train the models at modified versions of the images, such as at different angles, flips, rotations or shifts. Next, training of the model was performed, with all the required parameters.We have trained the model for 500 epochs with a batch size of 32 images.

- **Making Predictions:**
  Predictions were generated by running the trained models on images of the test set.

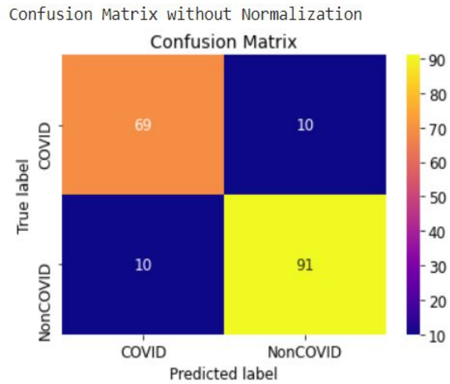
- **Evaluation & Results:**
  Following are a few important results and plots that help estimate the accuracy of the models and get insights on their performance.
  - **Sample output of test set images**

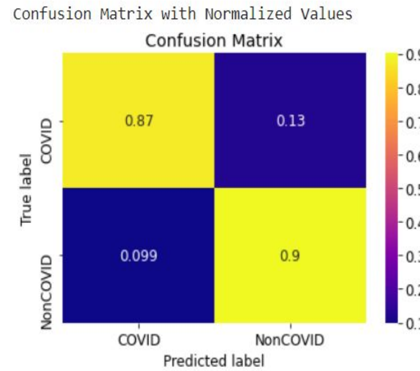




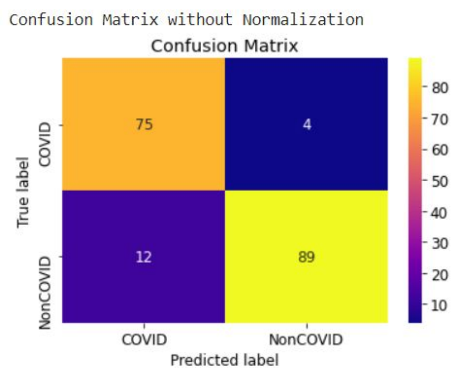
- **Confusion Matrix:**

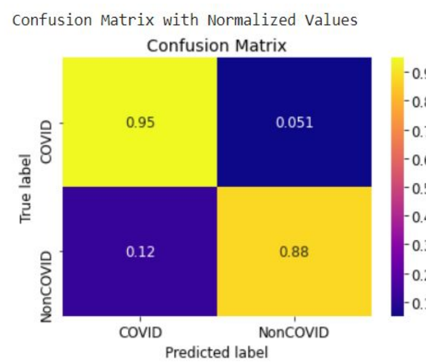
  - Resnet50:



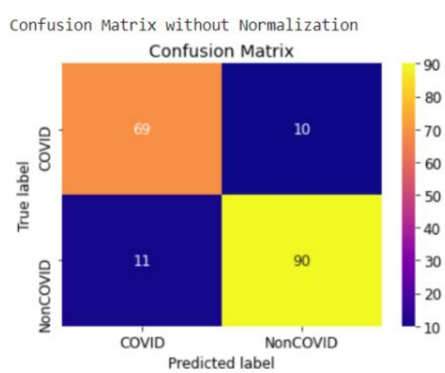


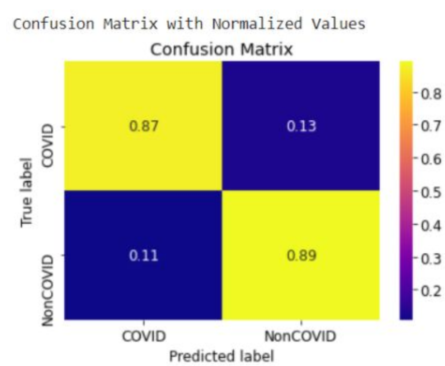
  - InceptionV3:





  - Xception:





- **Classification Report:**
  - Resnet50:

	precision	recall	f1-score	support
0	0.87	0.87	0.87	79
1	0.90	0.90	0.90	101
accuracy			0.89	180
macro avg	0.89	0.89	0.89	180
weighted avg	0.89	0.89	0.89	180

    The accuracy of this model is 89%.

  - InceptionV3:

	precision	recall	f1-score	support
0	0.86	0.95	0.90	79
1	0.96	0.88	0.92	101
accuracy			0.91	180
macro avg	0.91	0.92	0.91	180
weighted avg	0.92	0.91	0.91	180

    The accuracy of this model is 91%.

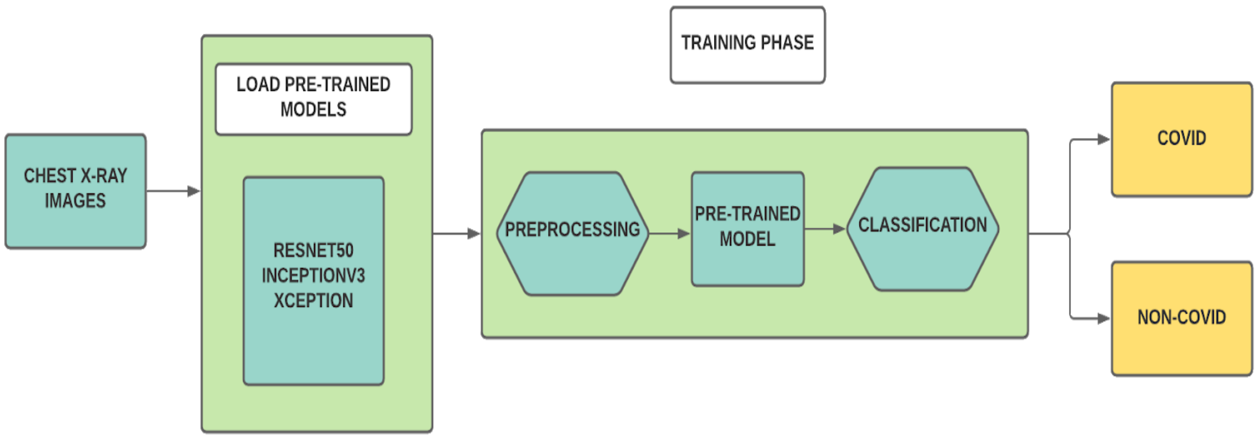
  - Xception:

	precision	recall	f1-score	support
0	0.86	0.87	0.87	79
1	0.90	0.89	0.90	101
accuracy			0.88	180
macro avg	0.88	0.88	0.88	180
weighted avg	0.88	0.88	0.88	180

    The accuracy of this model is 88%.

We can see that InceptionV3 performs much better than other models.

Architecture:



Schematic representation of pre-trained models for the prediction of normal (healthy) & COVID-19 patients

Tools and technologies :

- Python
- Deep CNN
- Machine learning
- Google colab

Applications:

- The proposed method can be used as initial screening which can help health-care professionals to better treat the COVID patients by timely detecting and diagnosis of the infection.
- This model could help hospital administration and medical experts in order to make necessary steps to manage the COVID-19 patients after getting its fast detection.
- With the fast detection of COVID-19, it will then be possible to contact and isolate the COVID-19 patients and reduce community transmission.

Conclusion:

In conclusion, fast, versatile, accurate, and accessible tools are needed to help diagnose and manage COVID-19 test infections. Current laboratory testing is time-consuming and expensive, adding delays to the testing process. Chest radiography is a widely available and inexpensive tool to diagnose patients with low respiratory symptoms or suspected COVID-19 pneumonia.

In this project, we reviewed and compared three deep learning techniques for detecting COVID-19. After investigating 3 different pre-trained neural networks, our results showed that InceptionV3 is an optimal pre-trained deep learning network to detect COVID-19.