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Introduction

The novel coronavirus illness (COVID-19), which started in 2019, has spread rapidly among folks living in different parts of the world, and it is approaching around 128,125,500. The number of cases is increasing day by day, and the PPE kits available with the hospitals are limited in number. Therefore, it is necessary to implement quick automated applications to detect the virus among people. This study has implemented a Deep Convolutional Neural Network to detect Covid 19 using Chest CT scan Images. A Convolutional Neural Network is a class of Deep Learning algorithms used to work with images by associating weights and biases to objects in the image and differentiate one from the other. The preprocessing and training weights are much lower in convolution neural networks as compared to other traditional algorithms.

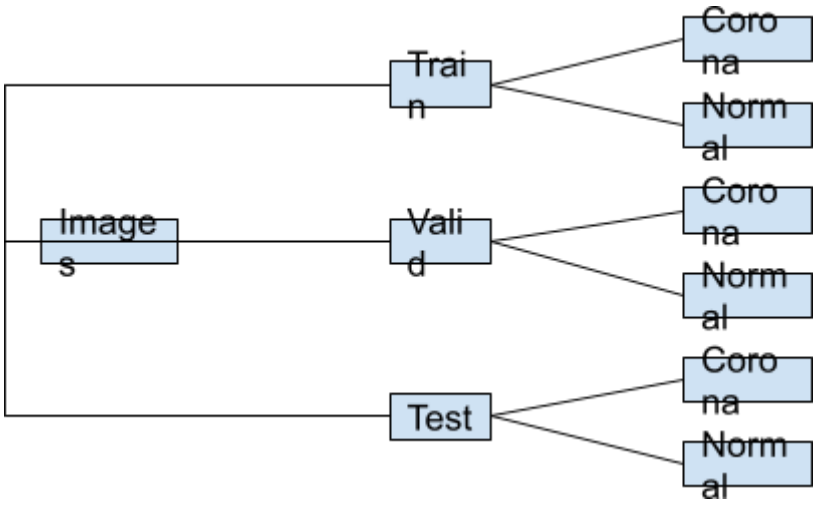
Methodology

➔ Working of a CNN

A Convolutional Neural Network is a class of Deep Learning algorithms used to work with images by associating weights and biases to objects in the image and differentiate one from the other. The preprocessing and training weights are much lower in convolution neural networks as compared to other traditional algorithms. Unlike other algorithms, the weights and biases in a Convolution layer are sometimes independent of image size.

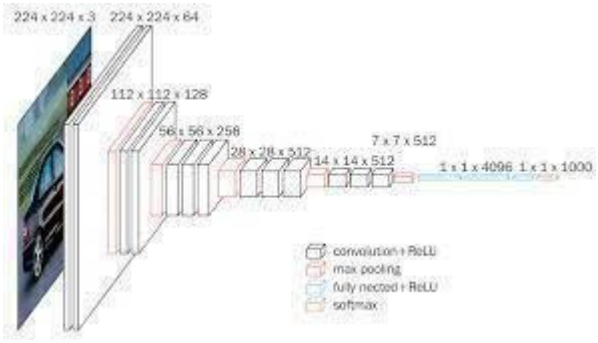
➔ Dataset

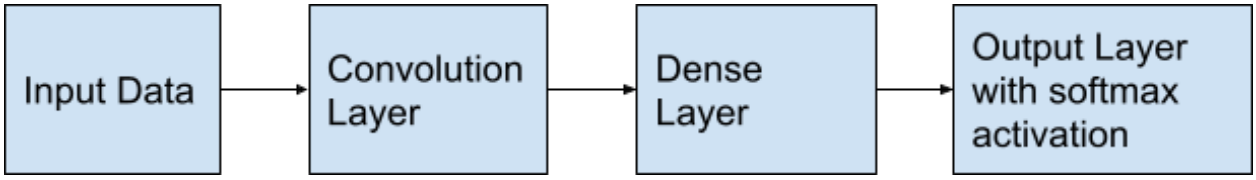
We have trained our models using Chest CT Scan images. The dataset consists of 746 images(349 covid and 397 non covid) which is split into 60% training(449 images), 20% validation(149 images) and 20% test(148 images) images. Out dataset structure is present in the image below.



➔ Model Structure and training

We have used VGG16 CNN architecture to train our model in which we have modified the last layer for binary classification purposes. We have added a softmax layer with two nodes for classifying covid and non-covid images.





Results

➔ Task 1

We have implemented a DCNN model with five convolution layers, each followed by one max-pooling layer. Then we have two fully connected dense layers followed by one output layer.

➔ Task 2

```
.....................Testing.......................
.............ADAM MODEL'S ACCURACY...................
Test loss: 0.21436507334351068
Test accuracy: 0.9960474371910095
```

```
...............Testing..............
.........................SGD Optimizer's accuracy............
Test loss: 0.00017846480247531483
Test accuracy: 1.0
..........................................................
```

```
----------------------Testing-----------------------------------------
---------------------- RMSprop's accuracy-----------------------------
Test loss: 0.38909966389652295
Test accuracy: 0.9960474371910095
----------------------------------------------------------------------
```

Train on 1011 samples, validate on 253

samples Epoch 1/15

1011/1011 [==============================] - 64s 63ms/step - loss: 1.3133 - accuracy: 0.9288 - val_loss: 3.4497 - val_accuracy: 0.8221

Epoch 2/15

1011/1011 [==============================] - 55s 55ms/step - loss: 0.7652 - accuracy: 0.9753 - val_loss: 0.6212 - val_accuracy: 0.9881

Epoch 3/15

1011/1011 [==============================] - 57s 57ms/step - loss: 0.4310 - accuracy: 0.9862 - val_loss: 1.9924 - val_accuracy: 0.9644

Epoch 4/15

1011/1011 [==============================] - 54s 53ms/step - loss: 0.3407 - accuracy: 0.9881 - val_loss: 2.9487e-05 - val_accuracy: 1.0000

Epoch 5/15

1011/1011 [==============================] - 59s 58ms/step - loss: 0.1359 - accuracy: 0.9921 - val_loss: 0.3834 - val_accuracy: 0.9881

Epoch 6/15

1011/1011 [==============================] - 59s 58ms/step - loss: 0.2715 - accuracy: 0.9951 - val_loss: 0.1606 - val_accuracy: 0.9921

Epoch 7/15

1011/1011 [==============================] - 54s 53ms/step - loss: 0.2668 - accuracy: 0.9960 - val_loss: 0.0000e+00 - val_accuracy: 1.0000

Epoch 8/15

1011/1011 [==============================] - 58s 57ms/step - loss: 0.0494 - accuracy: 0.9980 - val_loss: 9.4237e-10 - val_accuracy: 1.0000

Epoch 9/15

1011/1011 [==============================] - 58s 58ms/step - loss: 0.1337 - accuracy: 0.9960 - val_loss: 0.0133 - val_accuracy: 0.9960

Epoch 10/15

1011/1011 [==============================] - 57s 56ms/step - loss: 0.0329 - accuracy: 0.9970 - val_loss: 1.4827 - val_accuracy: 0.9960

Epoch 11/15

1011/1011 [==============================] - 59s 58ms/step - loss: 0.8214 - accuracy: 0.9901 - val_loss: 6.4572 - val_accuracy: 0.9447

Epoch 12/15

1011/1011 [==============================] - 57s 57ms/step - loss: 0.8485 - accuracy: 0.9921 - val_loss: 7.2737 - val_accuracy: 0.9605

Epoch 13/15

1011/1011 [==============================] - 59s 58ms/step - loss: 0.2000 - accuracy: 0.9951 - val_loss: 0.1374 - val_accuracy: 0.9960

Epoch 14/15

1011/1011 [==============================] - 59s 59ms/step - loss: 0.1047 - accuracy: 0.9960 - val_loss: 0.1847 - val_accuracy: 0.9921

Epoch 15/15

1011/1011 [==============================] - 57s 56ms/step - loss: 0.4981 - accuracy: 0.9951 - val_loss: 0.2144 - val_accuracy: 0.9960

.....Testing.....

.....ADAM MODEL'S ACCURACY.....

Test loss: 0.21436507334351068

Test accuracy: 0.9960474371910095

.....

.....Training SGD MODEL.....

Train on 1011 samples, validate on 253

samples Epoch 1/15

1011/1011 [==============================] - 53s 53ms/step - loss: 6.2699 - accuracy: 0.9782 - val_loss: 29.6158 - val_accuracy: 0.9565

Epoch 2/15

1011/1011 [==============================] - 52s 51ms/step - loss: 16.5912 - accuracy: 0.9496 - val_loss: 20.8240 - val_accuracy: 0.8854

Epoch 3/15

1011/1011 [==============================] - 52s 52ms/step - loss: 0.2724 - accuracy: 0.9931 - val_loss: 18.4014 - val_accuracy: 0.8893

Epoch 4/15

1011/1011 [==========] - 51s 50ms/step - loss: 0.2454 - accuracy: 0.9921 - val_loss: 1.4968 - val_accuracy: 0.9763

Epoch 5/15

1011/1011 [==========] - 51s 51ms/step - loss: 0.0155 - accuracy: 0.9980 - val_loss: 0.3258 - val_accuracy: 0.9960

Epoch 6/15

1011/1011 [==========] - 51s 51ms/step - loss: 0.2693 - accuracy: 0.9931 - val_loss: 0.4896 - val_accuracy: 0.9921

Epoch 7/15

1011/1011 [==========] - 51s 51ms/step - loss: 0.0561 - accuracy: 0.9990 - val_loss: 0.1421 - val_accuracy: 0.9960

Epoch 8/15

1011/1011 [==========] - 51s 51ms/step - loss: 0.1358 - accuracy: 0.9951 - val_loss: 0.0733 - val_accuracy: 0.9960

Epoch 9/15

1011/1011 [==========] - 51s 50ms/step - loss: 0.0000e+00 - accuracy: 1.0000
- val_loss: 0.1193 - val_accuracy: 0.9960

Epoch 10/15

1011/1011 [==========] - 51s 51ms/step - loss: 0.1370 - accuracy: 0.9970 - val_loss: 0.1083 - val_accuracy: 0.9960

Epoch 11/15

1011/1011 [==========] - 52s 51ms/step - loss: 0.0209 - accuracy: 0.9990 - val_loss: 0.3736 - val_accuracy: 0.9960

Epoch 12/15

1011/1011 [==========] - 52s 51ms/step - loss: 0.3478 - accuracy: 0.9951 - val_loss: 0.0505 - val_accuracy: 0.9960

Epoch 13/15

1011/1011 [==========] - 51s 50ms/step - loss: 4.1990e-06 - accuracy: 1.0000 -
val_loss: 0.0817 - val_accuracy: 0.9960

Epoch 14/15

1011/1011 [==========] - 52s 51ms/step - loss: 1.7313e-05 - accuracy: 1.0000 -
val_loss: 0.1012 - val_accuracy: 0.9960

Epoch 15/15

1011/1011 [==============================] - 53s 53ms/step - loss: 0.0888 - accuracy: 0.9980 - val_loss: 1.7846e-04 - val_accuracy: 1.0000

.....Testing.....

.....SGD Optimizer's accuracy.....

Test loss: 0.00017846480247531483

Test accuracy: 1.0

.....

_____Training RMS Model_____

Train on 1011 samples, validate on 253

samples Epoch 1/15

1011/1011 [==============================] - 56s 56ms/step - loss: 0.0000e+00 - accuracy: 1.0000
- val_loss: 3.5281e-05 - val_accuracy:

1.0000 Epoch 2/15

1011/1011 [==============================] - 55s 55ms/step - loss: 0.2708 - accuracy: 0.9941 - val_loss: 0.0018 - val_accuracy: 1.0000

Epoch 3/15

1011/1011 [==============================] - 56s 55ms/step - loss: 0.0417 - accuracy: 0.9980 - val_loss: 38.0300 - val_accuracy: 0.7549

Epoch 4/15

1011/1011 [==============================] - 56s 56ms/step - loss: 0.7653 - accuracy: 0.9941 - val_loss: 21.5026 - val_accuracy: 0.8024

Epoch 5/15

1011/1011 [==============================] - 56s 56ms/step - loss: 0.3695 - accuracy: 0.9960 - val_loss: 0.0024 - val_accuracy: 1.0000

Epoch 6/15

1011/1011 [==============================] - 58s 57ms/step - loss: 0.3937 - accuracy: 0.9941 - val_loss: 0.8585 - val_accuracy: 0.9842

Epoch 7/15

1011/1011 [==============================] - 56s 55ms/step - loss: 0.2279 - accuracy: 0.9980 - val_loss: 0.2074 - val_accuracy: 0.9960

Epoch 8/15

1011/1011 [==============================] - 54s 54ms/step - loss: 0.0000e+00 - accuracy: 1.0000
- val_loss: 0.2397 - val_accuracy:

0.9960 Epoch 9/15

1011/1011 [==============================] - 58s 57ms/step - loss: 0.2737 - accuracy: 0.9980 - val_loss: 0.2040 - val_accuracy: 0.9960

Epoch 10/15

1011/1011 [==============================] - 56s 56ms/step - loss: 0.0000e+00 - accuracy: 1.0000
- val_loss: 0.1989 - val_accuracy:

0.9960 Epoch 11/15

1011/1011 [==============================] - 61s 60ms/step - loss: 0.3514 - accuracy: 0.9970 - val_loss: 0.2714 - val_accuracy: 0.9960

Epoch 12/15

1011/1011 [==============================] - 55s 54ms/step - loss: 0.0000e+00 - accuracy: 1.0000
- val_loss: 0.2266 -

val_accuracy: 0.9960 Epoch 13/15

1011/1011 [==============================] - 53s 53ms/step - loss: 0.0000e+00 - accuracy: 1.0000
- val_loss: 0.1969 -

val_accuracy: 0.9960 Epoch 14/15

1011/1011 [==============================] - 55s 54ms/step - loss: 0.1566 - accuracy: 0.9980 - val_loss: 0.1576 - val_accuracy: 0.9960

Epoch 15/15

1011/1011 [==============================] - 55s 55ms/step - loss: 0.0533 - accuracy: 0.9990 - val_loss: 0.3891 - val_accuracy: 0.9960

_____Testing_____

_____RMSprop's accuracy_____

Test loss: 0.38909966389652295

Test accuracy: 0.9960474371910095

➔ Task 4

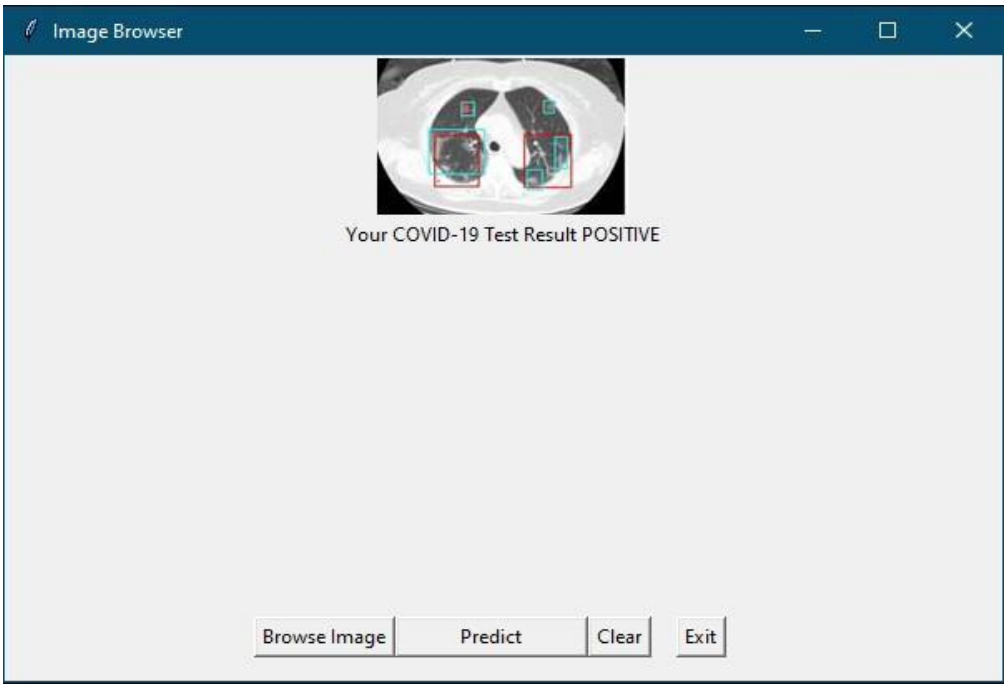


Image Browser
Your COVID-19 Test Result POSITIVE
Browse Image
Predict
Clear
Exit

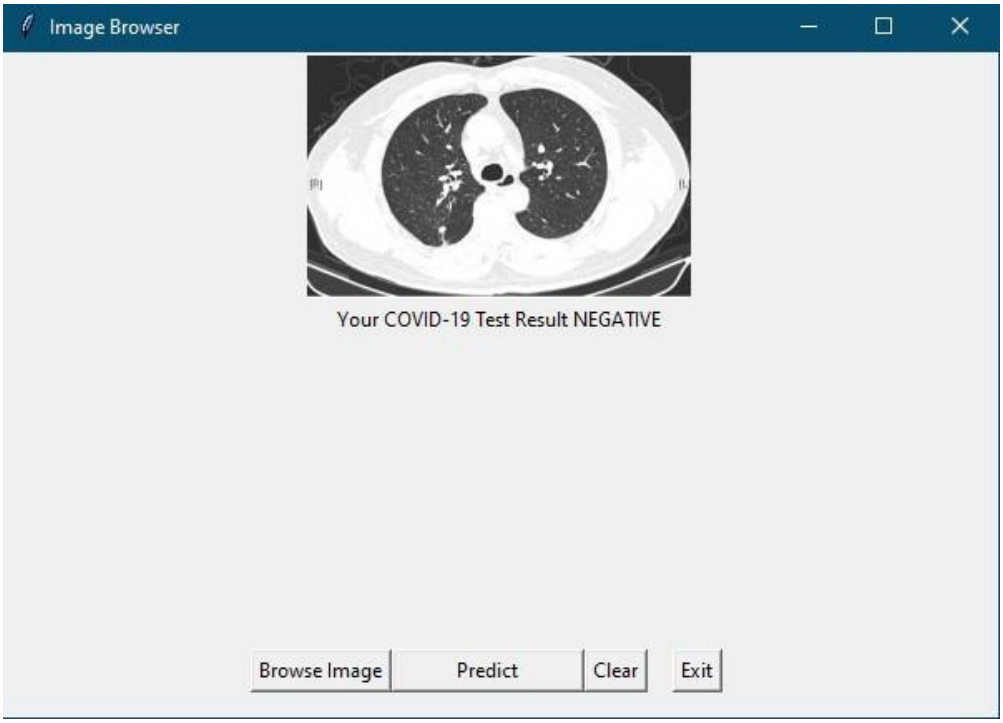


Image Browser
Your COVID-19 Test Result NEGATIVE
Browse Image
Predict
Clear
Exit

Conclusion

Covid 19 is a fatal disease that can damage the human lungs in a short period. If it is not treated early, it can cause irreversible damage. A comprehensive analysis of covid 19 CT scans was undertaken using deep convolutional neural networks in this study. The results of the DCNN were best due to a lack of training data. All the results are mentioned in the above tables. Also, developing an accurate segmentation model is challenging as it involves delineating the lungs by experts. Having an accurate ground truth is another challenge.

Technical References

1.1. Simonyan, K., & Zisserman, A. (2014). Very deep convolutional networks for large-scale image recognition. CoRR, abs/1409.1556.

1.2. Ahonen, T., Hadid, A., & Pietikinen, M. (2006). Face description with local binary patterns: Application to face recognition. Pattern Analysis and Machine Intelligence, 28(14), 2037–2041.

1.3. P. Arora, H. Kumar, and B. K. Panigrahi, “Prediction and analysis of covid-19 positive cases using deep learning models: A descriptive case study of india,” Chaos, Solitons & Fractals, p. 110017, 2020