A Deep Learning Algorithm to Detect Covid-19 from Lung X-Ray Images

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Abstract:
Covid-19 Predictive Model Using Deep Learning algorithm on X-Ray images of different patients. The individuals have been infected with the virus in the recent years due to large population spreading of covid- 19 virus has increased, A real-time reverse transcriptase- polymerase chain reaction (RT-PCR) kit serves to identify the illness. This project provides another solution by implementing a model that distingue, the covid and normal patients by using lung X-Ray images. In this project we consider the following three dataset such as coronavirus pneumonia (NCP) contaminated by SARS-COV-2, common pneumonia (CP) and normal control to implement the deep learning model during predicting covid-19. These model gives better accuracy and efficiency in anticipating covid-19 infection.

Keywords: Deep learning, covid-19 X-Ray images, Kaggle dataset, accuracy, and efficiency

1. Introduction

Medical care plays an important role for both the mental and physical well-being illness among patients around a whole. In 2019 a corona virus [COVID-19] effected the world in march 2020 so to overcome the effects of the corona virus people started maintaining the social distance using masks. The severe acute respiratory syndrome coronavirus (SARS-COV-2) were another identity within a COVID-19 virus. When a person who has the infection speaks, laughs, sings, coughs, or sneezes are how the coronavirus spreads. However, A tiny portion will become unwell and require medical attention. Vaccinating, donning a mask during times of high transmission, maintaining a 6- foot distance between individuals, frequently washing your hands, and avoiding ill people are the greatest protective strategies.

Most People infected with the virus will recover from mild to moderate illness. Nucleic Acid Amplification Test (NAATs), identifies one or more RNA genes from viruses and are extremely sensitive for specific methods used to determine the presence of COVID-19. The most used kind of NAAT for COVID- 19 testing is DNA fragments of the virus are examined via Reverse Transcription Polymerase Chain Reaction (RT- PCR) testing, it includes taking a sample of the patient's nose or throat. After a test result in a positive result, viral RNA might remain in the body for up to 90 days.

To determine whether COVID-19 is present when a sick person approaches the doctor, he checks and examines their lungs to see whether COVID-19 is present. This is done by using Computed tomography (CT) scan images to diagnose diseases. A Computed tomography scan is a practical and quick visualization method providing aid in determining the COVID-19 infection by 90% to 95%percentages of the medical imaging examinations for suspected patients. It is crucial to assess the patient's status through the lung examination to recognize the specificity and severity of the condition.

During the period of COVID everything became online even the treatment, during this period through tele medicine many doctors provided medication online that helped in reducing the virus from covid effected patients. In July, 2020 some mental health clinics had organized the mental health awareness online. For the professionals aged 18and above a survey was conducted for 15minutes remotely based on the web server they have examine how often people use telemedicine treatment is a valuable method for reaching and supporting the population’s mental health from a distance.[1].

Recently, artificial intelligence is state of art and accordingly and several models are proposed to addresses different data intensive problems. Out of which convolution neural network has reached top level, CNN as part of deep learning method is mostly used for document and Image analysis. CNN has shown good results among actuality applications include face recognition and scene labelling, picture classifying, human position estimates as well as examination of document. It was also successful in categorizing the medical pictures.

The globe was facing a massive growing of corona virus and it is also known as covid-19 since December in 2019it might be illness that transmits from animal to humans leading to a death incident of about 2% to 5%. As it is entail with the air bone transmission, because the disease growth factor is extremely high with, 0.556 million cases and12.32 million confirmed cases, globally as of July 11, 2020, approximately 4.04 million, and on May 11, 2020 more than 94 times even if the, safety measures, face masks and social distancing was incorporated. The count of sick people arrived at 12.32 million, on July 11, 2020. To overcome the corona virus patient, need to follow the doctor’s precautions and taking the medication based on the patient’s condition. To combat this global pandemic the only way was to detect covid-19 positive individuals as well as take appropriate actions for curing the virus in patients.[2].

2. Related work

Our proposed AI-based diagnostic method looks at the relationship between COVID-19 lung damage and the kind of respiratory assistance patients receive in order to forecast it will be determined whether COVID-19 patients require breathing support. CT scans will be used to evaluate three assistance levels: degree 0 (lowest degree of support), Level 1 (non-invasive support such as oxygen), and Level 2 (invasive support such as mechanical ventilation). In order to generate a model for each COVID-19 lesion, the system will first detect the lesions in the CT scans using a particular method known as the 2D rotation- invariant Markov-Gibbs random field (MGRF) model. There will be three distinct MGRF models were made, including one for every respiratory support stage. These will assist the system in differentiating between COVID-19 individuals' varying degrees of severity.

The Based on the combined output of the three MGRF models, a neural network will make the final judgment foreach patient. Using307 COVID-19 patients, we tested the system and obtained 97.72% ± 1.57 accuracy, 97.76% ± 4.08 sensitivity, and 98.87% ± 2.09 specificity, demonstrating the high level of accuracy of our system.[3].

It recommends using Custom Convolutional Neural Networks, a deep learning method. (Custom- CNNs) to identify COVID-19 infections in chest X-rays. An eight-layer Custom-CNN model reduces overfitting and enhances performance through the use of batch normalization and dropout. The approach we utilized to categorize samples as COVID- 19, normal, or pneumonia samples was able to reach a 98.19% classification accuracy.

Realtime polymerase chain reaction is the most widely used technique in order to identify COVID- 19 (PCR). Unfortunately, this technology has a number of drawbacks, these include exorbitant expenses, protracted processing durations, and the potential for low sensitivity to provide false-negative results. Other techniques, such as X-rays and CT scans, are also utilized to detect the disease in order to address these issues. Because X-ray machines are more accessible, less expensive, and use less radiation, CT scans are performed less frequently than chest X-rays. Chest X-rays with COVID-19 exhibit certain indicators that radiologists must manuallylocate. This procedure is sluggish and prone to mistakes. As a result, creating the automated system for analyzing chest X-rays is essential. Techniques for deep learning can expedite this process. In this investigation.[4]

The aim of this work is to develop a Thresholding Chaotic Butterfly Optimization Algorithm with Gaussian Kernel TCBOAGK) founded approach for COVID-19 segmentation in X-rays. In X-ray pictures, our system automatically identifies impacted regions. To make the method simpler, the photos are first separated using the MapReduce (MR) Model. With the Gaussian kernel, comparable COVID regions are calculated for each map. The TCBOAGK algorithm looks for pixels that resemble regions affected by COVID-19. The areas found by the TCBOAGK are compared using the Gaussian kernel to see how similar they are. Next, the segmented images are classified using a classifier named DeTrac (Decompose, Transfer, and Compose). Class decomposition enhances the classifier's ability to manage abnormalities in data distribution and define boundaries with greater flexibility. The results of the investigation demonstrated that DeTrac can accurately identify COVID- 19 patients utilizing a global collection of X-ray images. The examination was conducted using five commonly used metrics: F1 score, accuracy, correctness, completeness, specificity, and Matthew Correlation Coefficient (MCC).

COVID-19 is the present global catastrophe. Identifying COVID-19 accurately and quickly is essential for making decisions that enable for prompt treatment and avoid fatalities. The characteristics of the infection can vary, and there is minimal variation in intensity between normal and infected tissues, making it difficult to identify affected areas in chest X-ray pictures.[5].

We suggested a novel approach in this study to get over a few of the previously listed drawbacks. These are the stages that our model takes: To improve the chest X-ray's contrast pictures, there first apply contrast limited adaptive histogram equalization (CLAHE). Next,we change their color space within these pictures from CLAHE to YCrCb. Utilizing the Illumination-Reflectance system, we may calculate contemplation from chrominance. Lastly, using a normalized local binary patterns histogram extracted from reflectance (Cr) and YCb, we establish a classification feature vector. As classification techniques, we employed logistic regression, K-nearest neighbor, decision trees, Naive Bayes, and support vector machines. Experiments on three separate datasets demonstrated the superiority of our technique with accuracy rates of 99.01%, 100%, and 98.46%. The most successful probabilistic machine learning algorithm was Naive Bayes.[6].

3. Resnet-18 Architecture Block Diagram’s Functions:

ResNet-18 is a compassionate from Convolutional Neural Network (CNN) with 18 layers. CNNs are particularly good at analyzing visual data, like images, because they can automatically detect crucial elements (such as textures, forms, and edges) without needing manual intervention. The special relationship between image pixels by taking features from the input datasets as such reducing the image's dimensions. The representation of size is 224*224 with 64 channels is inputted to the convolution layer and in convolution block the image of shape 224* 224 with 64 channels. The first convolution layer transforms the input image to 224 * 224 image with 64 channels by applying 3*3 kernels, 2*2 stride with 1*1 padding and applies RELU on it. Then the outcome of first convolution layer was inputted for second convolution layer and a resulted image was of same shape (224*224*64). The Figure 2 resnet-18 architecture shown in the below image. Now, the residual is applied where the output of convolution is included in the previous convolution output to increase a system's performance. In order to perform this step, we need apply another convolution with 1*1 filter and 2*2 stride, with input channel 64 and output channel 512. Convolution block is responsible for converting the output from one block using Upon adding the convolution layers, the activation RELU is applied to its output and which is then sent to the identity block. Identity block also similar to residual used to sum up the outputs of the last two consecutive convolution layers, and applies the RELU on it. Identity blocks are required when the input and output are same & to establish residual connection between them. When the convolution process is stated 50% of the image filter is processed and the same process is continued server time till the input dataset is compared with the inbuilt dataset,70-80% filtrations process is done then the comparison of this input image and inbuilt data of the output is processed. **Figure-1**block diagram of resnet-18 architecture shown in the below image.

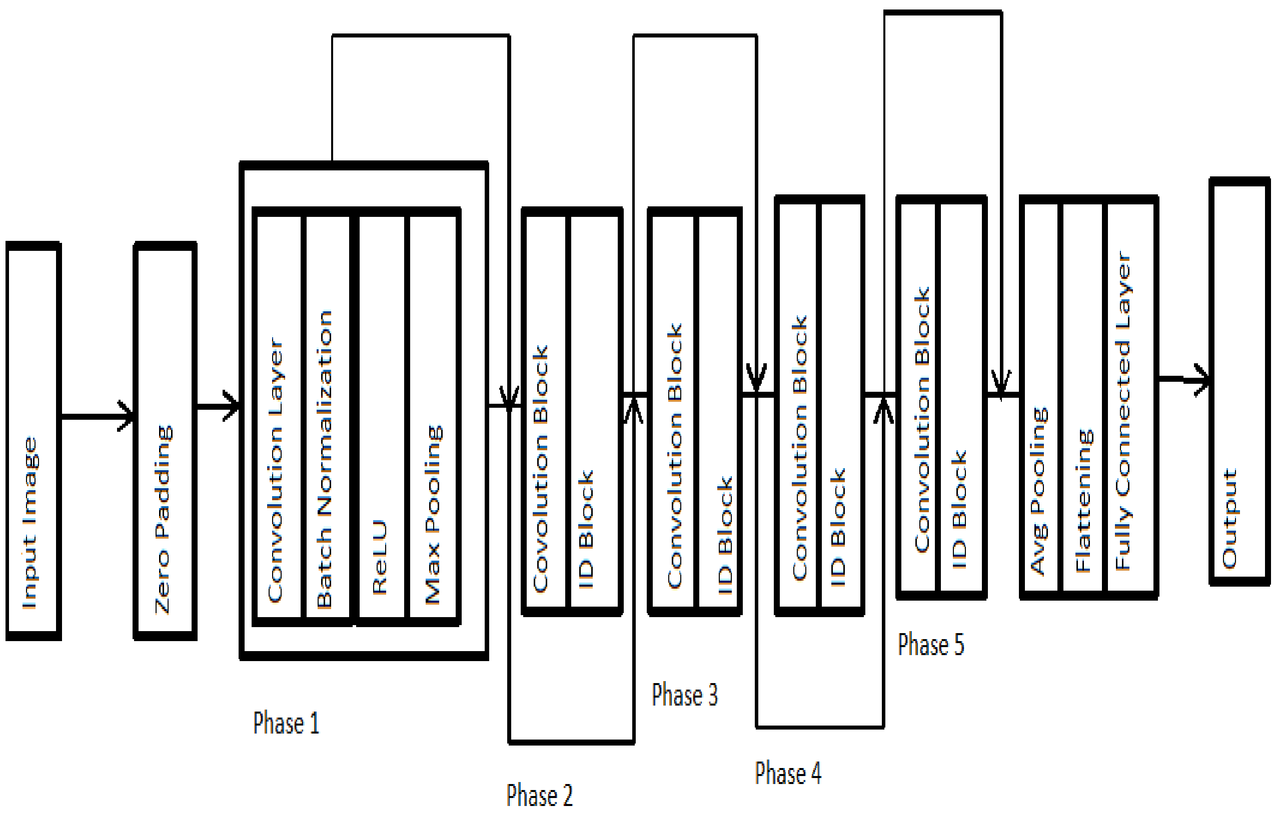


Figure 1: Block Diagram of Resnet-18 Architecture

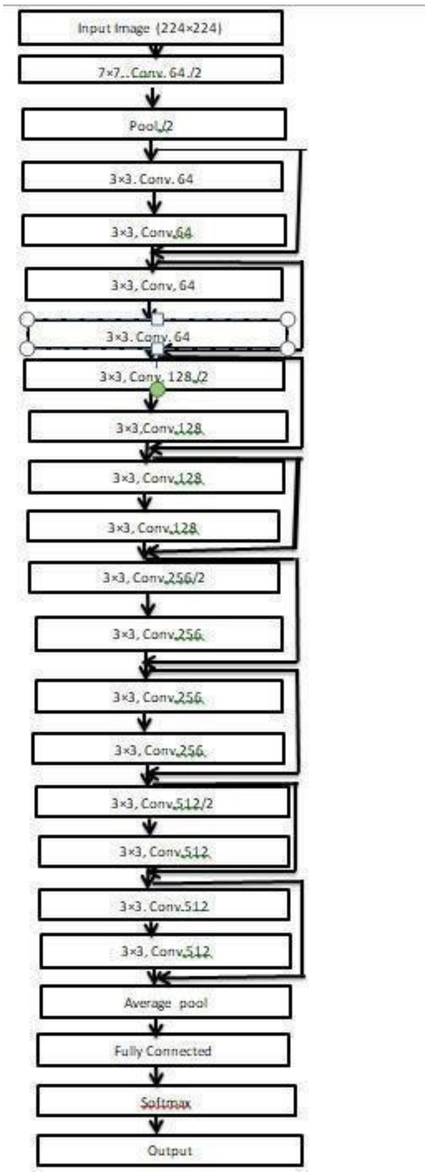


Figure 2: Resnet – 18 Architecture

4. Steps to Develop the COVID-19 Detection Model

Compile a data collection of lung X-ray pictures. photos from patients with COVID-19 as well as photos from healthy people and patients with other lung diseases should also be included in this dataset subsequently data gathering and then the data is preprocessing. Resize photos: To match the input scale required by ResNet-18, make sure all the photos are the same size, usually by 224 pixels. Normalization is the process of scaling pixel values to a range (e.g., values between 0 and 1) that facilitates and stabilizes training. Now split the dataset into the three sections that is test set, training set, and both. The model is trained using the training set, parameters are adjusted using the validation set, and the model's ultimate performance is evaluated using the test set. Make use of ResNet-18, which consists of residual blocks, activation functions (ReLU), batch normalization, and convolutional layers. The issue is resolved by the residual blocks of disappearing gradients in deep networks by enabling the network to skip levels, which improves learning. In training the model Loss Function: Make use of a loss function that calculates the distinction between the real class label as well as the projected probabilities, such as crossentropy loss.

Optimizer: Based on the loss function, modify the network's weights using an optimization technique such as Adam. Epochs and Batch Size: Training the model over many epochs (full runs through the training data) and using an appropriate batch size (number of samples processed prior to the model being updated) are important consideration. Then evaluate the model performance following training in the test set to ascertain how well it can distinguish COVID-19 from previously unseen lung X-rays. Measurements like the F1 score, recall, accuracy, and utilized to assess the performance of the model. Refine these models through a manipulation of hyperparameters, incorporation of data augmentation methods (such as rotation, zoom, and flip), or use of more sophisticated methods like transfer learning.

5. SYSTEM METHODOLOGY

5.1 System Model:

The system is implemented using the following stages. The following section provide synopses of these feature

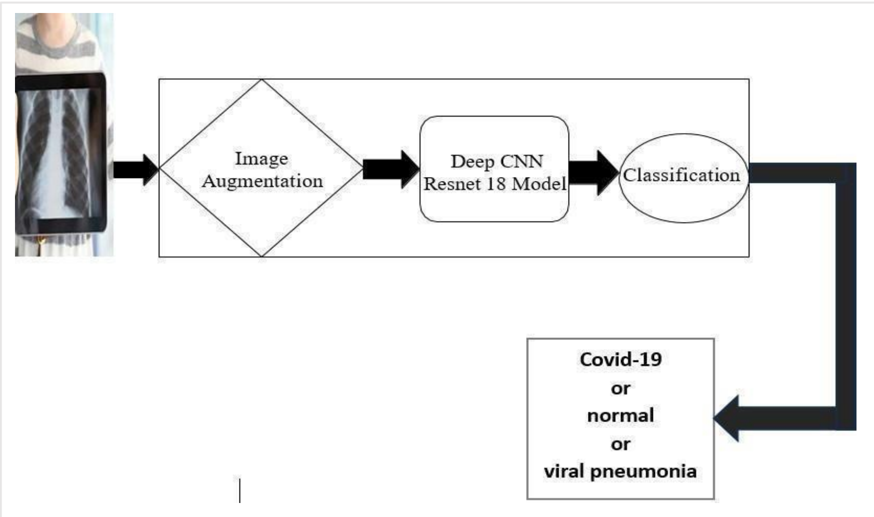


Figure 3: System Model

The lung X-ray dataset is gathered in the first stage of COVID-19 among sick persons, along with COVID-19 also X-Ray images of various lung illnesses and healthy controls. The x- ray data set for COVID- 19 is the model with 80% of the dataset, which includes8153 healthy people, 1076 pneumonia, and 2892 covid-19 patients. A trained information is fed into the Resnet-18 architecture to classify the image and generate the output result. Loaded into a model as part that load dataset activity, and the input images are subjected to data preprocessing, which resizes the image and performs data labelling and annotation. In this process, the Convolution layer takes characteristics from the input image. After extracting the features, the kernel filter with a size of 7*7 moves around the input data and uses the input data's subregion to conduct a dot product, producing the feature map as the result.

A feature map will then be obtained by striding across the image, followed by padding to increase the image's size. The max pooling layer is used to determine the essential feature from the feature extraction, then a vector is created by flattening the feature as well finally the neural network's coverages of the input pattern are classified and the procedure is executed. The learning model hyper parameter tuning is then carried out during the model creation process to minimize errors and generate an optimal model that ensures model fitness. After the model is created, the developer trains the model using a variety of data sets, assesses the performance, and deploys the model into the server. The final user then makes a request. The end user then sends a request to the server with the necessary information, such as access to the Anaconda prompt and a second navigation to the designs folder using the cd command to display the results. This generates a link for the code's output, which is then pasted into the web browser to view the output here, it takes the images of the covid lung X-Ray images as input and uses to identify the covid, health, pneumonia the image is giving to the deep learning model using a convolution neural network predictor to verify the lung images whether it is covid, normal, pneumonia. Later, the user submits the expected picture from a desktop, and a code analyses it before displaying the result to the user. This process is ongoing, and the model will produce efficient and accurate results based on the different data sets. Figure 3 system model as shown from the above image.

6. Experimental results

The prediction results of this model's COVID-19 detection from lung X-ray pictures are shown in this section. We obtained the best accuracy, which is 90% the below. Figure 4 shows the predicted results. Figure 4 the below graph shows how accurately the model is trained from starting epoch 1/10.

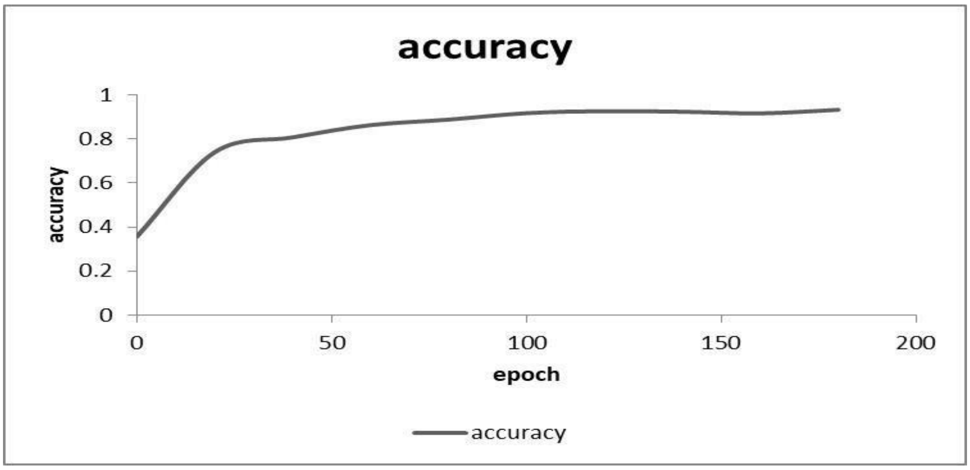


Figure 4: The above graphs show how accurately the model is trained from starting epoch 1/10:

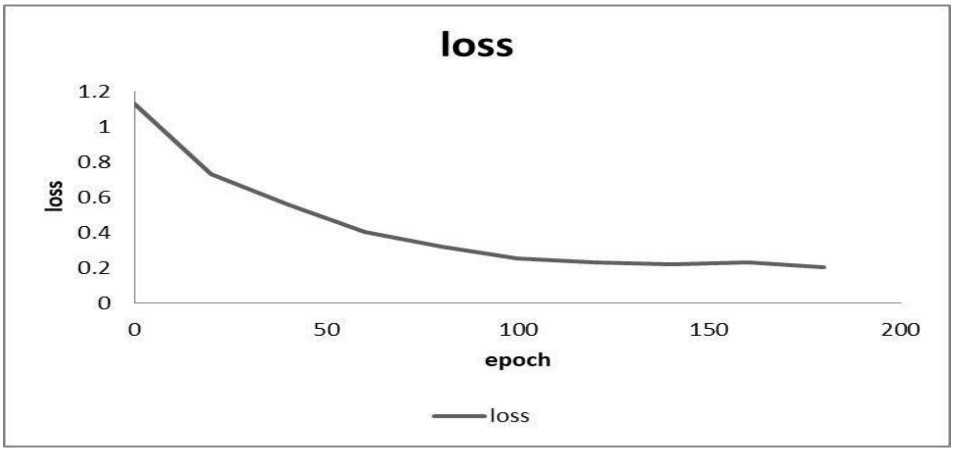


Figure 5: The above graph shows the loss in the trained model

Here the model is trained through dataset need to be divided into batches, such as her 6,6 are one batch and here the one by ten epoch rounds. In the first batch we used the 80% of the dataset to train the system and then test with the 20 batches for samples are compared with the inbuilt dataset like chest X-ray pictures. The system is trained with a new batch of data, and this procedure is repeated until the accuracy reaches 90%, at some point the condition is terminated. Figure 5 above graph show the loss in the trained model.

7. The steps followed for building an application

The below shows figure the experimental stages and the results: Figure 6 is Anaconda prompt
The first step Is to open the file in the browser window should open, showing the files and folder located in the folder.

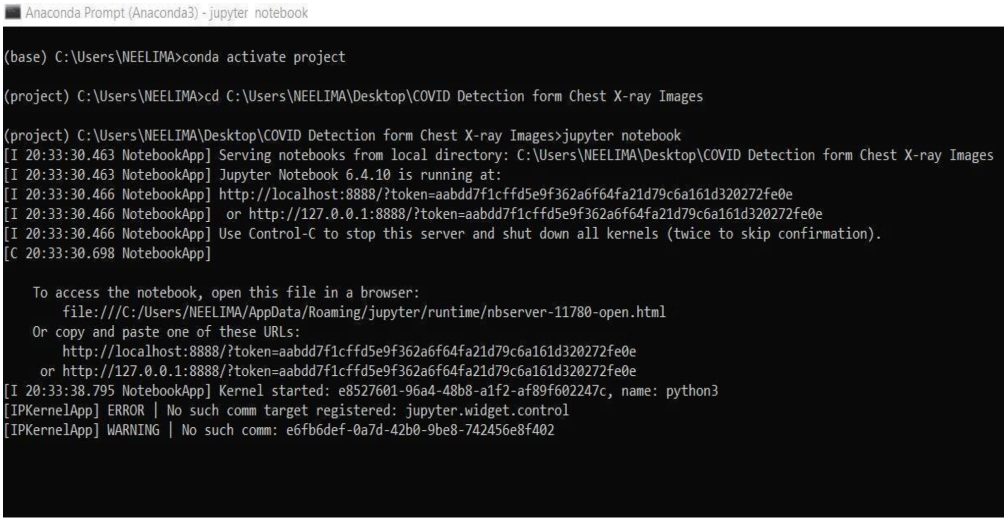


Figure 6: Anaconda prompt

Accesses to anaconda prompt which activates the anaconda environment. Once the anaconda environment is activated upload the images from drive using the following command. Jupyter Notebook it is used to open the file in the browser window should open, showing the files and folder located in the folder. Now select the jupyter notebook and run the code. After entering the command which generate the URL link for the output of the code. Now select the image from the desktop for predict the image. Figure 7 is Activates the anaconda environment.

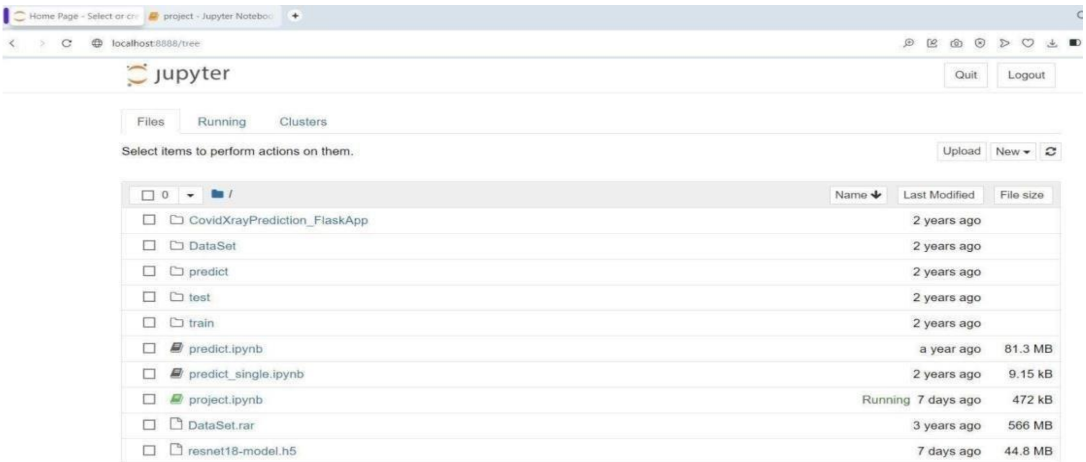


Figure 7: Activates the anaconda environment

Generating the URL The predicted images is displayed with the image. Generate the URL Now activate the URL and select the required images from the desktop and then predicted output will be displayed in which for predicting the image from the desktop.

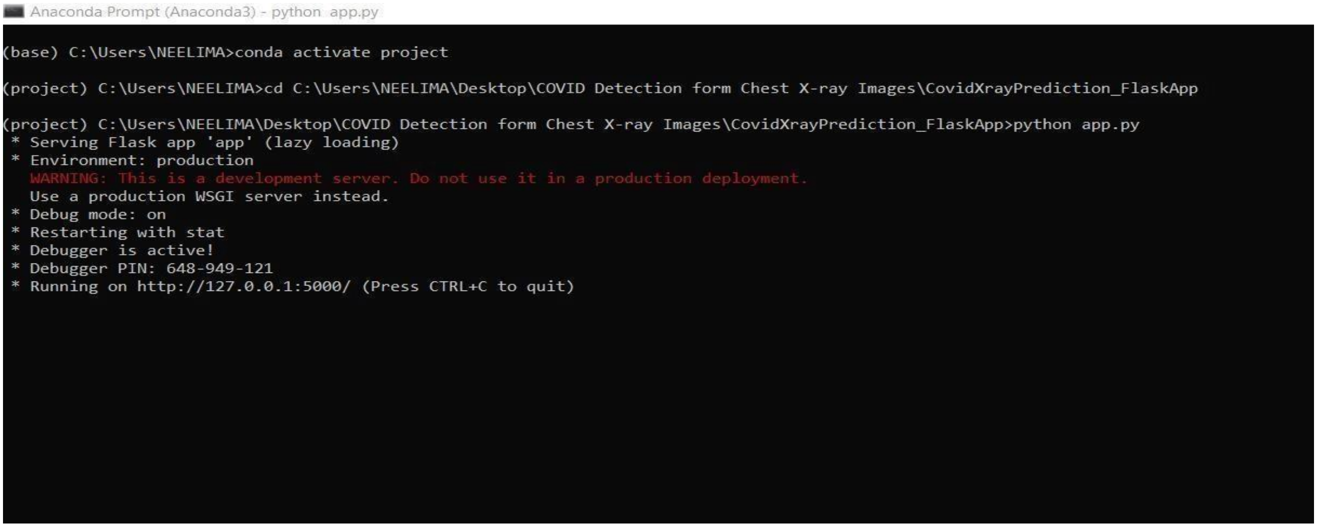


Figure 8: Generating the URL

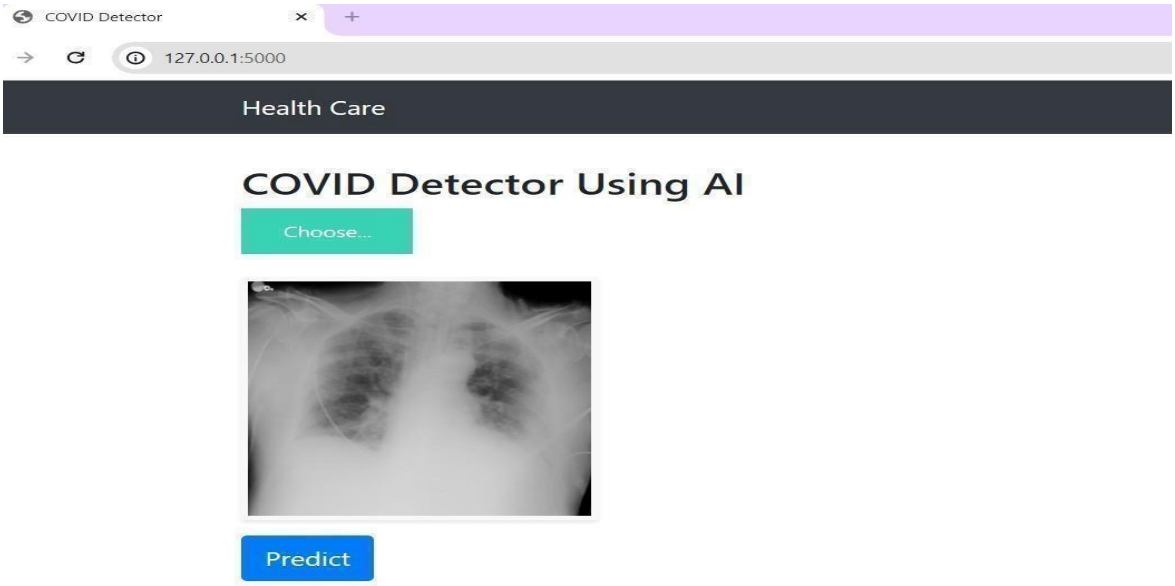


Figure 9: Detection of Covid

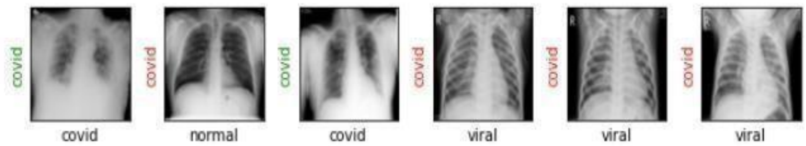
8. RESULT:

The dataset required to be divided into batches, such as her 6, 6 are one batch and here the one by ten epochs rounds. The dataset specify to be trained by now. In the first batch, we used the 80% of the dataset to train the system and then test with the 20%. Batches for samples are compared with the inbuilt dataset like lung x- ray pictures. We possess certain data such as healthy, pneumonia, and Covid-19 lung x-ray images built into this system in order to instruct the model. After each sample is examined, the output will be generated. If COVID affirmative, it will be presented as a green signal; if it does not match the sample, it will give the example of the red signal It is identified as viral if the sample is COVID-19. We will retrain the system with the accuracy of 0.3343 and validation loss of 1.1476 to obtain better accuracy results. The system is trained with a new batch of data, and this procedure is repeated until the accuracy reaches 90%, at which point the condition is terminated.

Inputs: X-ray images (10191 healthy, 1345 pneumonia, and 3615 confirmedCOVID-19)

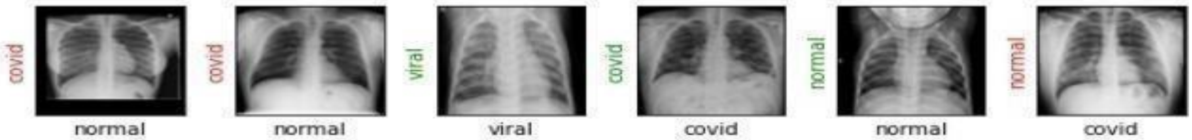
Output: Images of classifications

```
Starting training..
====================
Starting epoch 1/10
====================
Evaluating at step 0
Validation Loss: 1.1476, Accuracy: 0.3343
[[ 15  23 968]
 [  3  32 979]
 [ 10  28 963]]
Class Level Accuracy: [ 1.49105368  3.15581854 96.2037962 ]
F1-Score : 0.33432638199271764
```



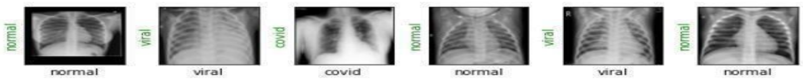

```
Evaluating at step 20
```

```
Evaluating at step 40
Validation Loss: 0.6277, Accuracy: 0.7309
[[641  66 305]
 [ 41 575 377]
 [ 24   0 992]]
Class Level Accuracy: [63.33992095 57.90533736 97.63779528]
F1-Score : 0.730883813306852
```



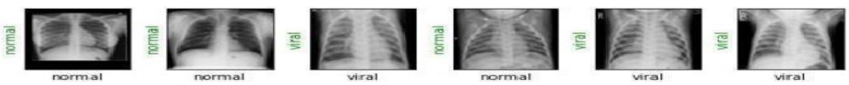

```
Evaluating at step 60
Validation Loss: 0.3403, Accuracy: 0.8858
[[860  85  75]
 [ 38 927  26]
```

```
Evaluating at step 80
Validation Loss: 0.2994, Accuracy: 0.8931
[[830  93  45]
 [ 32 994  16]
 [119  18 874]]
Class Level Accuracy: [85.74380165 95.39347409 86.44906034]
F1-Score : 0.8930817610062893
```




```
Evaluating at step 100
Validation Loss: 0.2596, Accuracy: 0.9047
[[884  32  84]
 [ 84 879  20]
```

```
Evaluating at step 100
Validation Loss: 0.2596, Accuracy: 0.9047
[[884  32  84]
 [ 84 879  20]
 [ 62   6 970]]
Class Level Accuracy: [88.4        89.42014242 93.44894027]
F1-Score : 0.9046673286991063
```




```
Performance condition satisfied, stopping..
Wall time: 14min 9s
```

9. Conclusion:

To prevent the recent global pandemic from spreading, early detection and broad COVID-19 testing are essential.

It takes 15 seconds to generate the result from the test dataset and accuracy are the two primary factors in every disease detection procedure, including COVID-19. This study suggests using a CNN-based model for recognition COVID-19 cases via patient lung X-rays images to address these issues. The system is trained using a set of 15151chest X-ray pictures that are evenly split into three groups: ‘Normal’, ‘COVID- 19’and ‘pneumonia’.

Similarly, the model is validated using an equally divided picture set consisting her 6, 6 are one batch and here the one by ten epochs rounds. The dataset needs to be trained by now. In the first batch, we used the 80% of the dataset to train the system and then test with the 20%. Batches for samples are compared with the inbuilt dataset such as chest x-ray images. We possess certain data such as healthy, pneumonia, and Covid-19 chest x-ray pictures built into these system to instruct the system. After each sample is examined, the output will be generated. If COVID affirmative, it will be presented as a green signal; if it does not match the sample, it will give the example of the red signal It is identified as viral if the sample is COVID-19. We will retrain the system with the accuracy of 0.3343 and validation loss of 1.1476 to obtain better accuracy results. The system is trained with a new batch of data, and this procedure is repeated until the accuracy reaches 90%, at which point the condition is terminated. The input we are takes as X-ray images (10191 healthy, 1,345pneumonia, and 3615 confirmed COVID-19) and we obtained the output as images classification.

This model's precision and accuracy are 90%respectively. Additionally, these system is contrasted with the other two CNN models using varying numbers of layers of convolution. The first convolution layer transforms the input image to 224 * 224 image with 112 channels by applying 3*3 kernels, 2*2 stride with 1*1 padding and applies RELU on it. Then the outcome of first convolution layer is inputted with second convolution layer and the resulted image has been of same shape (224*224*64). Now, a residual is applied where the output of convolution is included in the previous convolution output to increase the system’s performance. To perform this step, we need apply another convolution with 1*1 filter and 2*2 stride, with input channel 64 and output channel 512. Convolution block is responsible for converting the output from one block using Upon adding the convolution layers, the activation RELU is applied to its output and which is then sent to the identity block. Identity block also like residual used to sum up the outputs of the last two consecutive convolution layers, and applies the RELU on it.

The comparative investigations show that, in terms of F1-score and overall performance, the suggested model (Model 1) performs better than the other two. This algorithm can be improved much further with access to a larger dataset. As a result, CNN has a great possibility of finding COVID-19 with comparatively little funding, time, or effort. The suggested model is not clinically tested, despite showing encouraging results. Further developments and clinical testing are needed for this model to be helpful in clinical diagnosis.

REFERENCES

1. Demi Zhu, Samantha R Paige, Henry Slone, BS, Arianna Gutierrez, Caroline Lutzky, Hannah Hedriana, Janelle FBarrera, TritonOng, and Brian E Bunnell, “Exploring telemental healthpractice before, during, and after the COVID-19 pandemic”, https://journals.sagepub.com/doi/full/10.1177/1357633X211025943#bibr17- 1357633X211025943, 2021.
2. Khandaker Foysal Haque; Fatin Farhan Haque; Lisa Gandy; Ahmed Abdelgawad,“Automatic Detection ofCOVID-19 from ChestX-ray Images with Convolutional Neural Networks”, https://ieeexplore.ieee.org/document/9231235, 2020.
3. Ibrahim shawky Farahat, Ahmed Sharafeldeen , Mohammed Ghazal, Norah Saleh Alghamdi, Ali

Mahmoud,James Connelly,Eric van Bogaert, Huma Zia, Tania Tahtouh,Waleed Aladrousy, Ahmed Elsaid Tolba, Samir Elmougy & Ayman EI-Baz "An AI-based novel system for predicting respiratory support in COVID-19 patients through CT imaginganalysis" https://www.nature.com/articles/s41598-51053-9, 2024

4. Ahmad MohdAziz Hussein, Abdulrauf Garba Sharifai, Osama Moh'd Alia Laith Abualigah, Khaled H. Almotairi, Sohaib K. M. Abujayyab & Amir H. Gandomi "Auto- detection of the coronavirus disease by using deepconvolution neural networks and x-rayphotographs" https://www.nature.com/article/s41598-023-47038-3, 2024
5. Afnan M.Alhassan "Thresholding Chaotic Butterfly Optimization Algorithm with Gaussian Kernel (TCBOGK) based segmentationand DeTrac deep convolution neural network for COVID-19 X-ray images" https://link.springer.com/article/10.1007/s111042-024-18175-2 , 2024.
6. Rukundo prince, Zhendong Niu, Zahid Younas Khan Masabo Emmanuel & Niyishaka Patrick, "COVID-19 detection from chest X-ray images using CLAHE- YCrCb, LBP, and machine learning algorithms" https://link.springer.com/article/10.1186/s12859-023- 05427-5, 2024.