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COVID-19 Detector Using Deep Learning

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***Abstract*— This paper attempt to overcome the existing Covid 19 detection challenge, which aims to predict whether the tested person is a covid positive or covid negative. This research work has utilized the "Covid chest X-Ray" images dataset and the CT scan images dataset of Covid affected people and healthy people from the Kaggle website. Further, the proposed research work has utilized a couple CNN models on the collected dataset to see if the input image was Covid positive or negative. This research study will construct four CNN architectures as a group: ResNet-50, Inception-v3, and Xception. These models will be trained by using chest X-Ray and CT scan images, and then a Web API will be developed by using Flask so that the users may interact within themselves via a website. And the user may self-identify whether he/she is Covid positive or negative by uploading any chest X-Ray or CT scan image of the individual.**

Keywords*— *Deep learning, CNN, feature selection, prediction model, CNN Architectures, VGG-19, ResNet-50, inceptionV3 and Xception, Covid19 predictor, Flask

I. INTRODUCTION

COVID-19, often referred to as "Novel Coronavirus Disease" is an extremely transmittable disease, which is initially emerged in China in late 2019 as this disease is instigated by "SARS-CoV-2" as the "coronavirus" that fit in the "coronavirus family". In "December 2019 the disease initially prevailed in Wuhan China" and rapidly spread to 213 nations by culminating towards a global pandemic and the most normal "COVID-19 symptoms are fever, dry cough, and tiredness" and the other symptoms which the people may encounter include "aches, pains, and difficulty breathing" where the preponderance of these symptoms are indicators of "respiratory infections and lung abnormalities" that are being diagnosed by radiologists as a regular process.

As a consequence, Machine Learning algorithms might be utilized to identify sickness using X-Rays and CT images of the chest. To assist radiologists, automated programs might be developed. VGG-19, ResNet-50, InceptionV3 and Xception are the four Deep Learning methods used in this work.

CNN is selected as it is a fully connected feed forward neural networks;. CNNs are extremely better at minimizing the count of parameters utilized instead of losing the quality of the model as the images considered comprises the maximum dimensionality (each pixel is considered a feature), which matches the capabilities of CNNs.

To attain this purpose, the following steps should be performed:

- Building the model
- Training the model
- Make predictions
- Evaluate the model
- Create a Flask application

For attaining this goal, we use specific steps:

- Problem Statement
- Dataset
- Pre-Processing; dividing data into train and test datasets; and visualization
- Applying CNN algorithms
- Conclusion

II. LITERATURE REVIEW

Paper – [1]: In COVID-Net, Linda Wang, ZhongQiu Lin, and Alexander Wong proposed a model for detecting COVID-19 instances: a customized "deep convolutional neural network architecture" for detecting "COVID-19 cases from chest XRay images" as the model employs the CNN Algorithm designs VGG-19 and ResNet-50 [11]. The proposed COVID-Net was implemented on the Covid dataset using the Adam optimizer with a the "learning rate" approach will decrease as the learning becomes stagnant for a period of time, and then trained using the CNN VGG-19, Resent-50 architecture. Only the VGG-19 and ResNet-50 designs were used in the suggested approach, and only on chest X-Ray images [12]. However, our project includes four different CNN architectures: VGG-19, ResNet-50, InceptionV3, and Xception. We're building a website and testing all four algorithms on two datasets of chest X-Rays

and CT scan pictures. The chest X-Ray pictures are used to train the aforementioned model [13].

- Tools and techniques: Jupyter notebook, VGG-19 and ResNet-50 Model
- Merits: In terms of detecting COVID-19 instances, the model worked admirably.
- Demerits: Requires higher computational time.

Paper – [2]: MohammadRahimzadeha, AbolfazlAttarbSeyed, MohammadSakhaeic, and colleagues proposed a model for COVID 19 case detection utilizing a completely "automated deep learning-based network for identifying COVID-19"over a large and fresh "lung CT scan dataset" as the model is based on the ResNet-50 V2 CNN Algorithm. In this project as they used deep convolutional networks to build a model for categorizing CT scan pictures into COVID-19 or normal. ResNet-50 V2 is used in this model. They used the learned networks to execute the fully automated COVID-19 identification system after training [13]. Also, a testing dataset was used to assess the system. The proposed solution only employed the ResNet-50 architecture and exclusively on CT scan pictures; however, our project includes four different CNN architectures: VGG-19, ResNet-50, InceptionV3, and Xception [14]. We're also working on a website. All four methods are being tested on two datasets of chest X-Rays and CT scan pictures as the above model is trained using the lung CTscan images [15].

- Tools and techniques: Jupyter notebook, ResNet-50 V2 Model
- Merits: The whole model demanded much less computational time.
- Demerits: False Positives were obtained, Not Accurate.

Paper – [3]: A "Deep Convolutonal Neural Network (DCNN)" which was based on the concatenation of "Xception and ResNet-50V2" was proposed by MohammadRahimzadeha, AbolfazlAttarb, and colleagues for recognizing"COVID-19" patients and pneumonia from "chest XRay photos" [16]. The model employs the "Xception and ResNet-50 V2 CNN Algorithm" designs. In this publication, they suggested a "concatenated neural network based on the Xception and ResNet-50V2 networks for categorizing chest X-Ray images" into 3 categories: "normal, pneumonia, and COVID-19 and the training program" was separated into eight phases, each with its unique set of obstacles. They picked a virtually equal number of students from each class in each of the phases where the proposed network will tend to learn both "COVID-19" and the other two courses' features. Normal healthy and pneumonia images were different throughout each stage that allows the network to better distinguish COVID-19 from other classes. The remaining images were utilized to test the network after the training batch of 3783 shots was completed [17].

- Tools and techniques: Jupyter notebook, Xception and ResNet-50 V2 Models.
- Merits: In terms of detecting COVID-19 instances, the model worked admirably.
- Demerits: Model required higher training time.

Paper – [4]: In their paper "Accelerating Detection of Lung Pathologies with Explainable Ultrasound Image Analysis, Jannis Born, Nina Wiedemann, Manuel Cossio, Charlotte Buhre, Gabriel Brändle, Konstantin Leidermann, AvinashAujayeb, Michael Moor, Bastian Rieck, and KarstenBorgwardt proposed a model for automated detection of covid-19 cases". VGG-19, a CNN Algorithm architecture, is used in the model. They introduced a model based on VGG-19 networks for categorizing the lung ultra sound dataset into two pneumonia and COVID-19 categories in this research. The training set was isolated from the remainder of the photos, which were used to evaluate the network. It might be a video or frame-based classification for a lung ultrasound dataset [18]. To categories both pneumonia and influenza, the proposed solution employed just the VGG-19 Architecture and only the lungs dataset as the above model is trained using the Ultrasound Images.

- Tools and techniques: Jupyter notebook, VGG-19 Model.
- Merits: The model required less training time and computational resources.
- Demerits: Success rate of the model needs to be improved.

Paper – [5]: HaydenGunraj,LindaWang,AlexanderWong published "COVID Net-CT: A Customized Deep Convolutional Neural Network for COVID-19 Case Detection from Chest CT Images". [5,] and colleagues proposed a methodology for recognizing cases of covid-19. ResNet-50, a CNN Algorithm design, is used in the model where the intended "COVID-Net"is considered to be a initially trained on the "ImageNet43 dataset" before being trained on the Covid dataset using stochastic gradient descent and a learning rate method that slows down hyperparameter learning over time, and then trained under the CNN ResNet-50 architecture [19].

- The proposed solution only employed the ResNet-50 architecture and exclusively on CT scan pictures.
- Tools and techniques: Jupyter notebook, ResNet-50 Model.
- Merits: In terms of detecting COVID-19 instances, the model worked admirably.
- Demerits: The Model takes more training time.

Paper – [6]: Identification of "COVID-19" Cases by implementing DNN with chest "X-ray" images by Tulin Ozturk,MuhammedTalo, AzraYildirim,UlasBaranBaloglu, Özalyıldırım,URajendraAcharya and team proposed a model of an automated detection of "covid-19" cases. The model uses DarkCovidNet, a CNN Algorithm architecture [20]. The proposed DarkCovidNet model consisting 19 Convolutional layers was trained on chest "X-Ray" images for multi classification of covid as the proposed solution used only DarkCovidNet architecture on "X-ray" images and the above model is trained using the "X-Ray" images.

- Tools and techniques: Jupyter notebook, DarkCovidNet Model.
- Merits: For performing binary class task as the model will perform exceptionally better while identifying "COVID-19" cases.

- Demerits: while performing comparison of binary class the success rate of various model's comprising of multi class classification task is quite minimal.

Paper – [7]: XinggangWang,XianboDeng,QingFu, Qiang Zhou,JiapeiFeng,HuiMa,WenyuLiu,ChuanshengZheng and colleagues suggested the framework which is weakly supervised over "COVID-19" classification and while performing localization from "chestCT" as this model uses DeCoVNet, a CNN Algorithm architecture. The proposed DeCoVNet model was trained on chest CT scan dataset for classification of covid [22].

- Tools and techniques: Jupyter notebook, DeCoVNetModel
- Merits: The whole model demanded much less computational time.
- Demerits: False Positives were obtained, Not Accurate.

Paper – [8]: RavneetPunia,LuckyKumar,MohdMujahid, RajeshRohilla and his colleagues suggested a model of "COVID-19" classification while performing "Computer Vision and Radiology" for "COVID-19" identification as this model uses both "ResNet-34" and "ResNet-50" based on the CNN Algorithm architectures [21]. The proposed "ResNet-34" and "ResNet-50" models were trained on "X-Ray" images for performing multi classification of covid and the proposed solution used "ResNet-34" and "ResNet-50" architecture on "X-Ray" images as the above models are trained using the "x-ray" images.

- Tools and techniques: Jupyter notebook, ResNet-34 and ResNet-50 Models.
- Merits: The whole model required significantly less processing effort and excelled at finding COVID-19 instances for the binary class task.
- Demerits: False Positives were obtained for the multi-classification.

Paper – [9]: the process of identification of "COVID 19" for performing classification from "chest X-ray" images using a convolutional neural network A model of "covid-19" detection and categorization was proposed by Tatiana Chakravorti, Vinay Kumar Addala, J. Shivam Verma, and others. This model is built with a custom CNN Algorithm [12]. For multiclass categorization of covid, a proprietary CNN Architecture model was trained using X-Ray pictures. On X-Ray pictures, the suggested approach uses Custom CNN architecture.

- Tools and techniques: Jupyter notebook, Custom CNN Model.
- Merits: Higher prediction accuracy and lower loss when compared to traditional machine learning.
- Demerits: This model takes higher training time when compared to traditional machine learning model.

Paper – [10]: the system explored for detecting "COVID-19" using "Recurrent Neural Networks (RNN)" by AbdelfatahHassan,IsmailShahin,MohamedBaderAlsabe and team has proposed a model for detection of "covid-19" using RNN model over LSTM architecture. The system was proposed based on speech and sound analysis using RNN LSTM architecture [6]. The proposed solution used LSTM architecture on speech and sound. The above model is trained using the speech and sound samples of covid patients.

- Tools and techniques: Jupyter notebook, RNN LSTM Model.
- Merits: Requires no image of X-ray or chest CT scan images. Works using their own coughing audio sample.
- Demerits: This model should not be proposed as sound can't be used to perfectly reach for a conclusion.

III. PROBLEM DEFINITION

This is a detecting system called Covid 19that uses chestX-Ray or CT scan pictures to determine if a user is covid positive or negative.

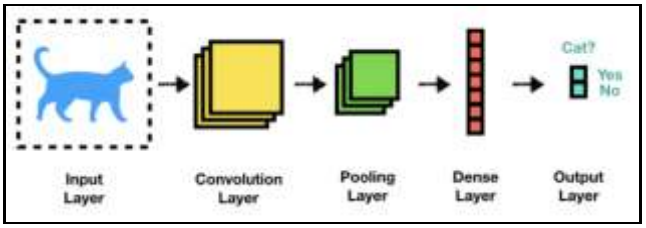


Figure 1. Procedure CNN Classifier

A. DATASET

- The dataset for this experiment was produced through Kaggle:
- From the Kaggle covid19 chest "X-Ray" photographs, 1000 "chestX-Ray" images and CT scan images were obtained.
- A total of eight deep learning models were created by training "VGG-19, ResNet-50, InceptionV3, and Xception on chest X-Rays and CT images" separately. The models were trained using 80% of the pictures, while the remaining 20% were utilised to assess their correctness. Information about a certain song (1000000 rows)
- There are two directories in each of the two datasets (X-Ray and CTscan):
    - Covid Positive: This section provides images of "X-Ray" and CT scans from covid positive patients.
    - Covid Negative: This section offers images of Covid Negative patients from X-Ray and CT scans.

B. DATAPRE-PROCESSING

Photos in the form of a pixel array are accepted by the model. As a result, normalize and convert to an array.

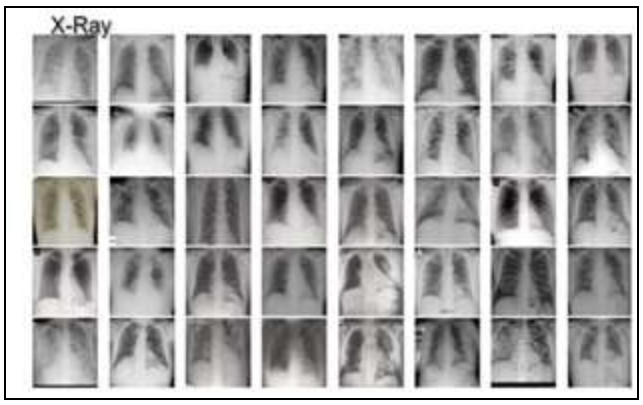


Figure 2. X-Ray Images

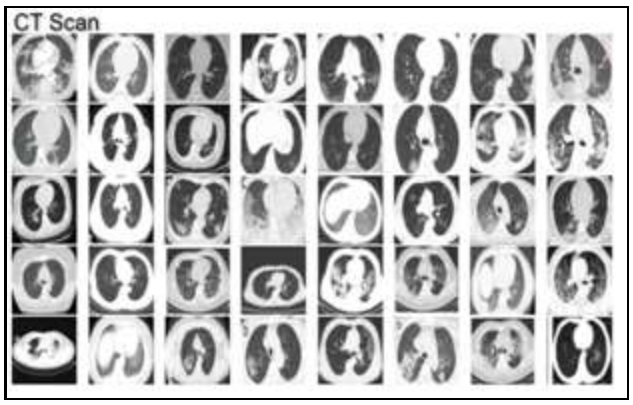


Figure 3. CT Scan Images

The above figure2 and figure3 images were the output obtained after the pre-processing of the image dataset.

C. ALGORITHMS

We use a variety of Deep Learning models, all of which are different CNN Architectures, to solve our classification problem and the top four are:

- VGG-19,
- ResNet-50,
- InceptionV3, and
- Xception.

So, let's get our data ready for the training and testing of our machine learning model.

- VGG-19: is the most convolutional NN comprising of 19 distinct layers while the model employs the possible set of initially trained weights generated through "ImageNetdataset" which comprises of more than 14 million sampled images that fit into 1000 distinct classes as the model obtains 92.6 percentage of better 5 test accurateness as the defaulting "RGB picture input size for the VGG-19 model is 224 by 224 pixels" with three channels comprising of 2x2 stride 2 filter maxpool layer and 3x3 stride 1 filter convolution layers.
- ResNet-50: is a 50 layered "deep convolutional neural network" which utilizes "ImageNet database" for performing import of a initially trained version of the proposed network used of implementing training over a million of photos or images as the network can at the max sort photos in terms of 1000 distinct groupings which includes "keyboards, mouse, pencils, and a variety of animals" in a network as a result wll build up a library of enhanced features that denotes distinct sets of pictures comprising of input size of 224X224 pixels.
- InceptionV3: is a 48layered"deep convolutional neural network" which utilizes the "ImageNet database" for performing import of various initially trained version of the network that comprises of initially trained on over a million photos or images where the network tends to sort various photos or "images into 1000 distinct" categories that includes "keyboards, mice, pencils, and a variety of animals" and the network is constructed based on the library comprising of enhanced feature for denoting the combinations of pictures over any network that comprises of input picture size of 299 by 299 pixels.
- Xception: is an expansion of the "Inception Architecture" that substitutes various tasks that implements using "conventional Modules with depthwise separable convolutions in inception and the Xception" will result to 71layered"deep convolutional neural network that implements using ImageNet database" for improvising the initially trained version of any specific network being initially qualified over a million photos in the network which performs sorting of the photos comprising of 1000 ddistinct categories which includes "keyboards, mice, pencils, and a variety of animals" as the resultant is the "network has constructed over a library of rich feature representations" comprising of distinct pictures with input size is 299 by 299 pixels.

IV. BUILDING THE MODEL

The dataset included images of various sizes. As a result, they had to be resized to a specific size before being fed to deep learning models. The images are scaled to 224X224 pixels, which is considered the ideal size for the models. As a consequence, the input tensor of shape was utilised (224, 224, 3), with 3 being the number of channels, to pre-train the Respective model. Then, to avoid overfitting, we add a "Flatten layer to flatten all of our features and a Dropout layer" to avoid over fitting aspect in the Dense output layer is then added and will be triggered with the softmax function as the trainable property of the preceding layers was set to False since the first half of the model has already been pre-trained as we have utilized the Adam optimizer to put the model together, with categorical "cross-entropy" for implementing the loss function.

The images in the dataset were available in a range of sizes. As a result, before they could be used to train "deep learning models", they had to be shrunk to a specific size. As a consequence, images were reduced to 224,224 pixels, The shape input tensor (224, 224, 3) was also included to the VGG-19 model., with three channels.

To avoid overfitting, add a "Flatten layer to flatten all of our features and a Dropout layer" to overcome it using the "softmax function" as the "activation function" is implemented to add the huge output layers for training the model with 500 epochs and 32 batches using the Adam optimizer using categorical "cross-entropy as the loss

function" whereas all the models are built in similar manner by simply change the name of the model in line 1.

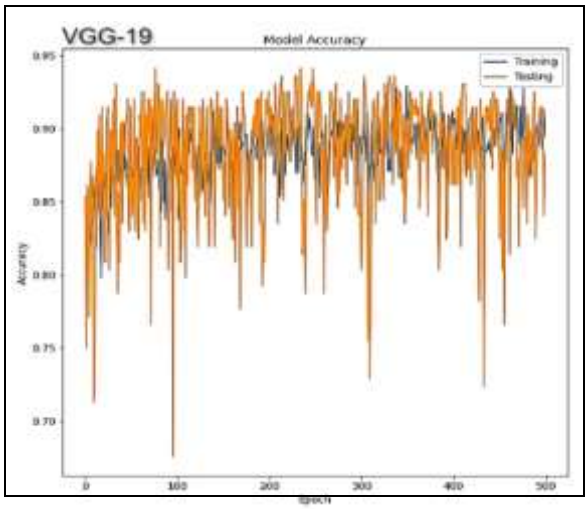
A. COMPARATIVE STUDY

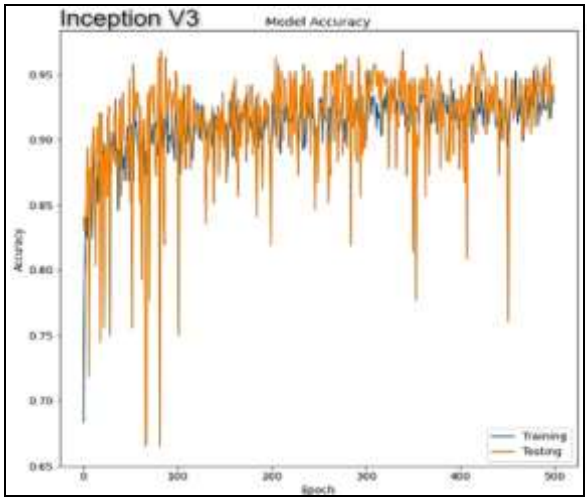
We have collected the accuracies of the existing publications

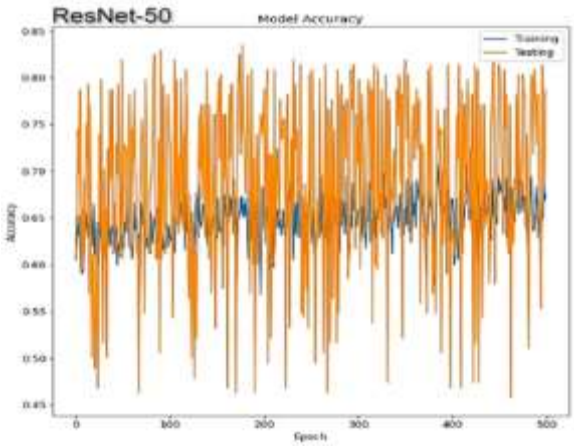
TABLE I. ALGORITHMS AND ACCURACY

Sl.No.	*Reference*	*Algorithm*	*Accuracy in percentage*
1	[1]	VGG-19	87
2	[1]	ResNet-50	91
3	[2]	Xception	86
4	[2]	ResNet-50 V2	83
5	[3]	Xception	91.31
6	[3]	ResNet-50 V2	89.7
7	[4]	VGG-19	87.8
8	[5]	ResNet-50	93
9	{6]	DarkCovidNet	Binary: 91.4 Multi: 83
10	[7]	DeCoVNet	81.6
11	[8]	ResNet-34	Binary: 89.5 Multi: 83.1
12	[8]	ResNet-50	Binary: 92 Multi: 86
13	[9]	Custom CNN	91.6
14	[10]	LSTM	78.8

B. PREDICTIONS







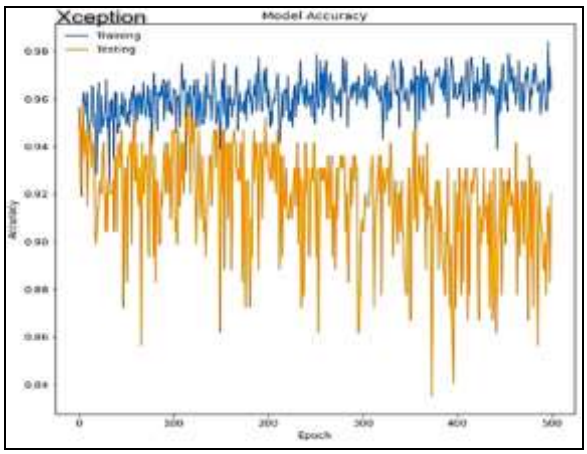


Figure 4. Epochs vs Accuracy graph

The above Figure 4 represents the "Epoch vs Accuracy graph" which refers to the Model Accuracy of all the four different models that were implemented. We predict from test data; these following were the predictions made from four different models that were implemented

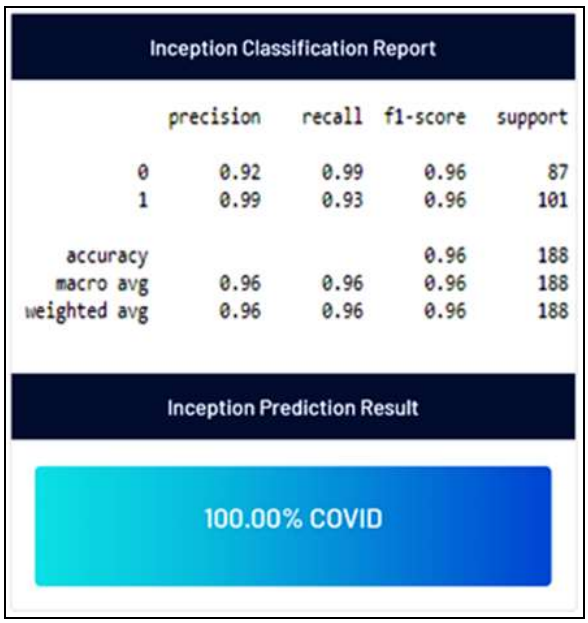


Figure 5. Inception Classification Report

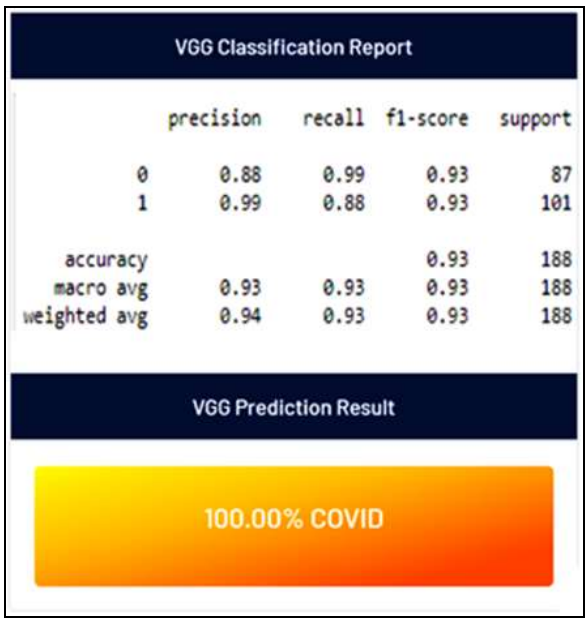


Figure 6. VGG Classification Report

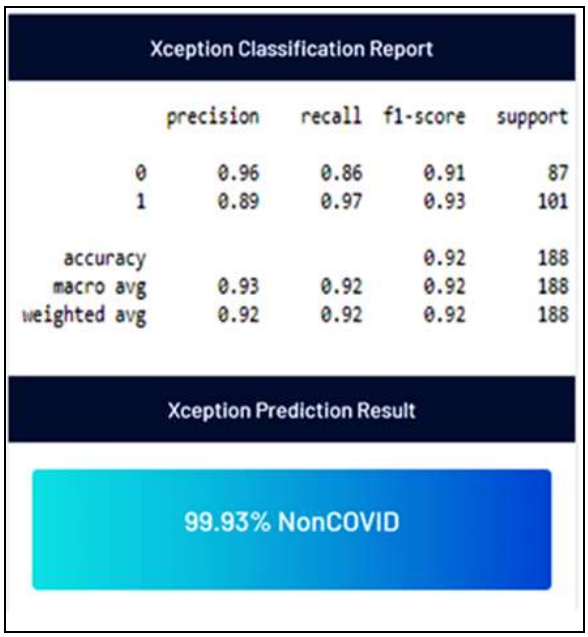


Figure 7. Xception Classification Report

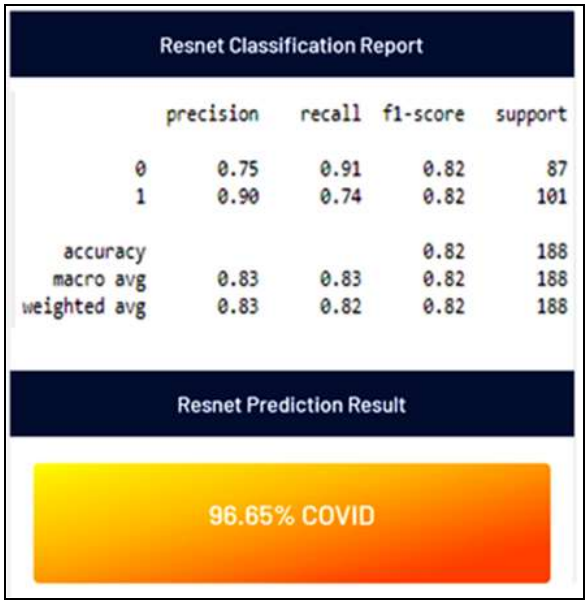


Figure 8. Resnet Classification Report

Figure 5 to figure 8 represents the results obtained through X-Ray images and CTScan images considered for the study where the inception prediction results to be 100% then the same is achieved using VGG Classification report then in Xception classification report accuracy of 99.93% of "Non Covid" is detected and finally using ResNet Classification Report accuracy of 96.65% of accuracy is achieved for confirming its Covid using precision, recall, f1-score and support attributes.

V. CONCLUSION

We created a Flask app that takes an X-Ray or CT scan and delivers a result indicating if the user is covid positive or negative. We employed four different algorithms to analyse and report the findings of all models, resulting in more accurate results.

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