A project report on

DETECTION OF COVID 19 BASED ON RADIOLOGICAL IMAGES

submitted in partial fulfillment of the requirements for the degree of

B. Tech
In
Electronics and Computer Science Engineering
By

MOHAMMED ABDELLA AHMED	1830038
ABHILASHI KHALITA	1830074
MUSTEFA ABRAHIM USMAN	1830094
NIKITA DUTT	1830102

Under the guidance of

Prof. T. KAR

School of Electronics Engineering

KALINGA INSTITUTE OF INDUSTRIAL TECHNOLOGY

(Deemed to be University)

BHUBANESWAR

Certificate and digital signature of supervisor

This is to certify that the project report entitled **"DETECTION OF COVID 19 BASED ON RADIOLOGICAL IMAGES"** submitted by

MOHAMMED ABDELLA AHMED	**1830038**
ABHILASHI KHALITA	**1830074**
MUSTEFA ABRAHIM USMAN	**1830094**
NIKITA DUTT	**1830102**

in partial fulfillment of the requirements for the award of the **Degree of Bachelor of Technology** in **Electronics and Computer Science Engineering** is a bonafide record of the work carried out under my(our) guidance and supervision at School of Electronics Engineering, KIIT (Deemed to be University).

Signature of Supervisor 1

Prof. **TEJASWINI KAR**

School of Electronics Engineering

KIIT (Deemed to be University)

ACKNOWLEDGEMENTS

The successful completion of this project would not have been possible without the unlimited guidance and appreciation of some individuals. We are grateful to Prof. **TEJASWINI KAR** extend heartfelt gratitude for her expert and professional guidance and continuous encouragement during the course of this project. Her strict yet helpful attitude has made us motivated at all times.

Students Signature:

Roll Number	Name	Signature
1830038	**MOHAMMED A. AHMED**	Mohammed A. Ahmed
1830074	**ABHILASHI KHALITA**	Abhilashi Kalita.
1830094	**MUSTEFA ABRAHIM**	Mustefa A.
1830102	**NIKITA DUTT**	[illegible]

Date:- 17/11/2021

ABSTRACT

In today's world, COVID 19 is a major epidemic. A recently found coronavirus, an infectious disease, is to blame. The World Health Organization first learned of this new virus on December 31, 2019, after seeing a cluster of cases of viral pneumonia in Wuhan.

The disease quickly spread over the world and became a pandemic. The virus can produce a wide range of symptoms, from a little illness to pneumonia. COVID-19 is disseminated mostly through droplets produced by a COVID-19-infected individual coughing or sneezing. The pandemic has had far-reaching consequences around the world, as well as in everyday life and public health. In almost every industry, the COVID-19 epidemic has resulted in the closure of many businesses, resulting in an unprecedented loss of commerce.

Short-term issues confront retailers and brands, including those relating to health and safety, the distribution network, personnel, working capital, customer appetite, marketing, and sales. It is critical to identify positive cases as soon as feasible in order to prevent the pandemic from spreading further and to treat afflicted patients as promptly as possible.According to recent investigations using CT scan imaging technologies, such data contains significant COVID-19 viral information. Our goal in this study is to create a new paradigm for the automated identification of cases utilising a CT scan and a chest x-ray to identify the need for chest radiography.

TABLE OF CONTENTS

LIST OF FIGURES

Name of Figure

Under X-ray datasets

Under CT-Scan datasets

LIST OF SYMBOLS/ABBREVIATION

Symbol	Abbreviation
3D	Three dimensional
OS	Operating System
GPU	Graphics processing unit
CPU	Central processing unit
PCV13	Pneumococcal conjugate vaccine
PPSV23	Pneumococcal polysaccharide vaccine
CXR	Chest X-Rays
CNN/ CovNet	Convolutional neural network
CT	Computerized tomography
MRI	Magnetic resonating imaging
train	Training
val	Validation
test	Testing
VGG	Visual geometry group
SVM	Support Vector Machine
FP	False Positive
FN	False Negative
TP	True Positive
TN	True Negative

CHAPTER 1
INTRODUCTION

1.1 BACKGROUND

All of the COVID 19 cases had symptoms that were similar to fever, cough, imaging findings of lung infiltrates which is similar to pneumonia. On January 7, 2020, the Centers for Disease Control (CDC) announced the new pneumonia as coronavirus . (NCP) after analysing samples acquired from a throat swab.[1]

To detect COVID 19 we perform two test-
Here
(1) X-ray examination is done to create images of our internal organs.
(2)CT-scan is done which uses a series of computerized views taken from different angles to create detailed internal picture of our body.[2]

Deep Learning refers to a mixture of machine learning techniques.It primarily focused on picture categorization and automatic feature extraction. When used in conjunction with clinical variables, the chest radiograph has a low sensitivity and is suggestive of COVID-19 in individuals whose radiographs have the characteristic of COVID-19 results. During the COVID-19 pandemic, chest radiography allowed for the speedy and cost-effective diagnosis of COVID-19 in a subgroup of affected patients.[3] We have used the Binary class classification to perform this project under this classification by using SVM we have done
1 Resnest50-svm
2 Vgg16-svm
3 Vgg19-svm on the X-ray datasets

Binary Class classification involve one class which is in normal state and another one which is in abnormal state. This classification are used in various algorithms like

- Logistic Regression
- k-Nearest Neighbors
- Decision Trees ,etc.[4]

1.2 WORK ENVIRONMENT AND TOOLS

The main technologies that we've an inclination to used in our project:

- Python
- Machine Learning

Platform independence indicates a programming language or framework that enables developers or users to create and run code on one platform and then utilise it on another with few changes Python's quality is due to the fact that it is a platform independent language. Python is still supported on platforms such as the UNIX operating system, macOS and Windows. Python code is used to create standalone programmes for a variety of operational systems, implying that the Python software package is deployed alone and utilised on such platforms, rather than a Python interpreter[5].

Python frameworks and libraries have become popular among programmers as a way to cut development time. A software package library is a collection of pre-written code that developers can use to address common programming problems. Python has i a massive variety of libraries for computing and machine leaming, thanks to its built in technological stack[6].

Here are a few to mention:

1.Keras. TensorFlow, and Scikit-learn used for machine leaming

2.NumPy is used for superior scientific computing and data analysis

3.Seily is used for advanced computing
4.Pandas unit used for general info analysis
5. Seaborn is used for info visual image

The main surroundings that we've an inclination to used in our project:

- Google colab
- Jupyter Notebook

The Jupyter Notebook is a collaborative of online notebook which allows students and faculties to learn computational information (data, code, statistics) while also incorporating narrative, graphs and multimedia. Faculty use it to create interactive textbooks with lots of explanations and examples which students can exercise on internet browsers. Jupyter Notebook can be used by students to elaborate their reasoning, show their work, and make links or connections between their classroom work and the outside world. It can be used by scientists, journalists, and academics to publish their data, explain the stories behind their computations and code. It promote future collaboration and innovation[7].

The Jupyter Notebook is an open-source web application that enables data scientists to create and share documents that include computational outputs, equations, live code, visualisations, and other multimedia resources, as well as text that serves as an explanation.

Colab notebooks are Jupyter notebooks that are hosted by Google Colab.
Colab allows users to collaborate and run code that takes advantage of Google's cloud resources, such as GPUs, TPUs, and documents saved in Google Drive.

Google Colab and Jupyter notebook differences:

1. Hardware Goods

Apart from its current GPU and CPU instances, Google Colab has a Processing Unit called as tensor processing unit(TPU).
Because of this it's a huge change for every individuals with model.

2. Price

The services are absolutely free those are supplied by google colab, despite being so good at hardware. It has made it even more impressive.

3. Infrastructure

Google Colab runs on the Google Cloud Infrastructure and because of this it is, durable, customization, and scalable.

4. Google Drive Integration

Google Drive is used as a file system that is google colab collaborative.

5. Research Benefits

This is the technology on the market that has supplied customers with a decent PaaS for free, which has been highly beneficial for deep learning start-ups, research communities, and students.

CHAPTER 2
LITERATURE REVIEW

The number of chest radiography data to examine the availability of COVID 19 detection is restricted, according to a review of COVID 19 patient research. Deep learning is far more effective at detecting. It makes use of a chest CT scan and an X-ray. The finding falls under the false negatives category when using traditional RT-PCR.

This research provides an overview of the diagnosis of positive COVID 19 patients using a deep learning network using datasets obtained from CT scans and chest x-rays. Ulhaq et al[8] initially reviewed the research on deep learning computer vision algorithms for COVID 19 diagnosis, prevention, and control. They also talked about how deep learning algorithms can help with infection management and treatment.

In the fight against COVID-19, Shi et al[9] used medical imaging tools. This paper discusses various contact-free image capture techniques, deep learning-based lung segmentation, x-ray, and CT screenings, and severity analysis of Covid 19 using a database. Their analysis of current datasets is woefully inadequate. [10]Routine imaging, particularly CT, should not be used as a first-line diagnostic test, according to the American College of Radiology, the Society of Thoracic Radiology, and the American Society of Emergency Radiology.

During the exponential growth phase of the COVID-19 outbreak in New Orleans (March 13–25, 2020), a retrospective research was conducted under investigation for COVID-19 presenting to this institution. Using well-documented COVID-19 imaging patterns, the two experienced radiologists classified each chest radiograph as typical, nonspecific, or negative in appearance for COVID-19[10]. The efficacy of chest radiography in detecting COVID-19 was determined by comparing classification of chest radiographs with RT-PCR results.

Real-life Covid-19 use-cases are used to demonstrate the differences between binary classification and hypothesis testing[11].

Machine Learning vs. Statistical Hypothesis Testing Distinctions and Guidelines panel for Binary Classification Jingyi JessicaLi1XinTong2[12].We learn about data in relation to binary decisions in this paper. Dandi Yang, Lara Visua, Cristhian Martinez, Chintan Bhatt and Hardev Khandhar used deep learning algorithms to detect and analyse COVID-19 in medical photos[13]. The major goal of this study is to look into and compare different deep learning enhanced strategies for detecting COVID-19 in CT-scan and X-ray medical images.

Main contribution of the paper is as follows:

1. The 3 well-known CT-scan and X-ray image datasets were used to test the efficiency of algorithms employing the suggested framework..

2. Binary and multiclass classification were done using SVM. Because there are no publicly available covid 19 data sets, we created a dataset with 3662 chest X-rays of covid 19 and non-covid patients.

3. The suggested Fast AI system was compared against earlier work in respect of f1-score, accuracy, recall, and precision, among other performance criteria. All of the indicators have greatly improved.

4. We observed that the proposed VGG16 deep transfer-learning-model works very well on binary and multi-class classification tasks, with the top model's accuracy reaching 99 percent, when evaluating the suggested model.

Experimental setup:- The experiment part of VGG16 model was done in 3 parts. First, we classify model with datasets of covid patients and normal people identified in COVID -19. Second part, a model was developed to identify Covid-19 from other disease like pneumonia (viral pneumonia and bacterial pneumonia) with deviating X-ray and CT-scan images. The third and part, multi-class of X-ray image datasets of pneumonia and normal for COVID-19 was taken.

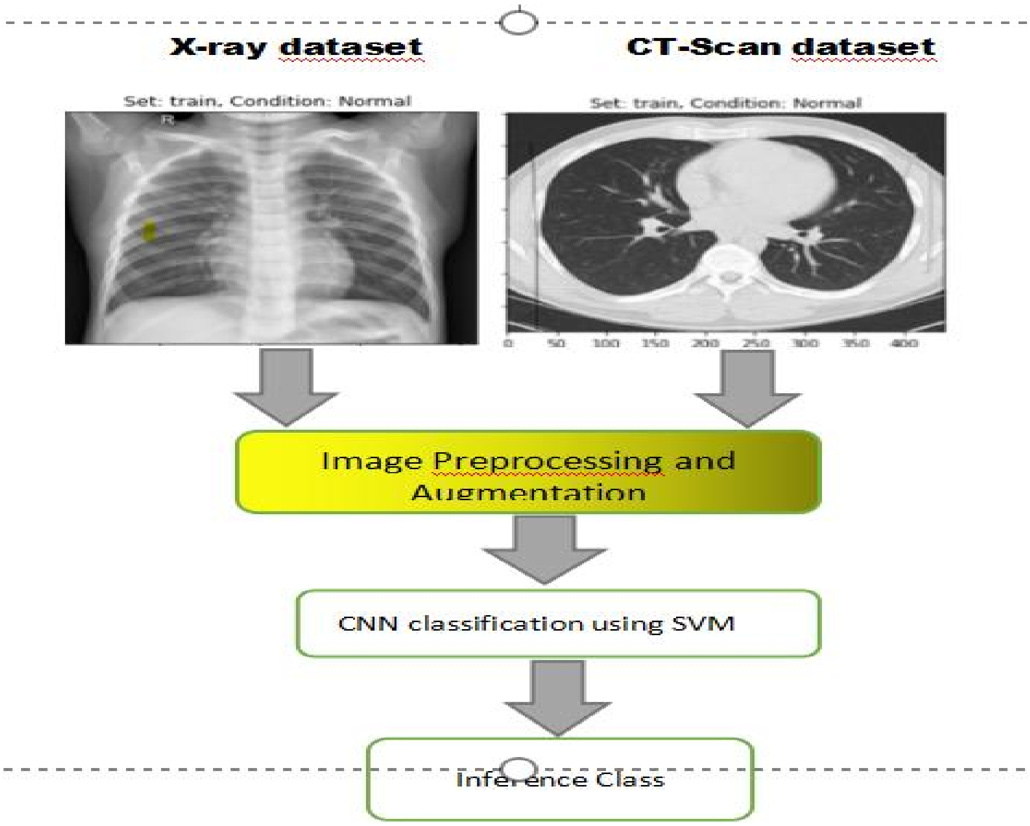


Figure 1 : Experimental set up

CHAPTER 3

METHOD OF DETECTION

3.1 CONVOLUTIONAL NEURAL NETWORK

Artificial Intelligence is making significant progress in closing the gap between human and computer capabilities. Researchers and amateurs alike work on a variety of facets of the field in order to make really excellent things happen in the future.
The domain of computer vision is just one of many such topics. The goal of this field is to train machines to perceive the world in the same way that humans do, to comprehend it in the same way that humans do, and to apply that knowledge to a wide range of tasks such as Image Analysis, Image & Video Recognition & Classification, Media Recreation, Recommendation Systems, tongue method, and so on. The improvements in computer vision using Deep Learning have been shaped over time, principally by a single rule the Convolutional neural network[14].

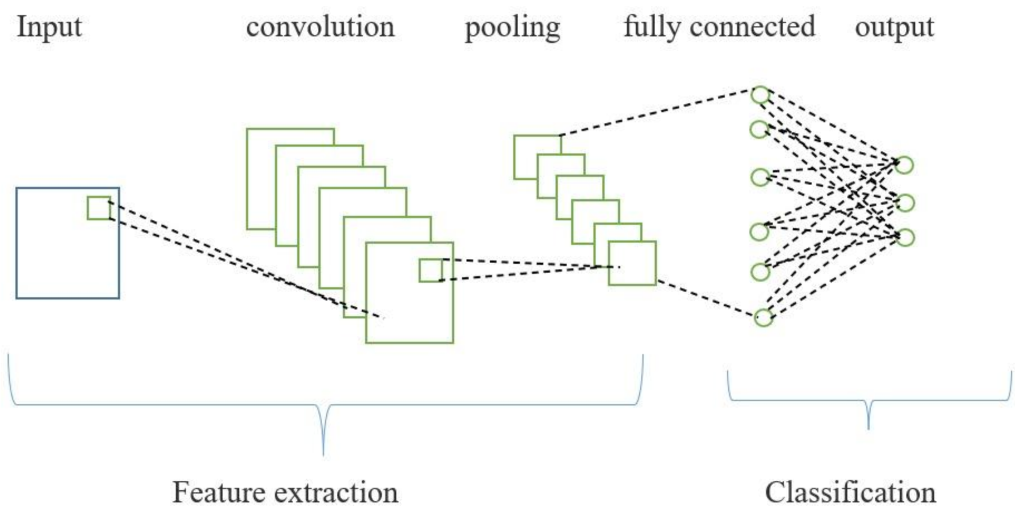


Figure 2: Basic CNN Architecture

The basic premise of CNN is that for increasingly complicated qualities, a leading figure may be retrieved from high layer inputs and conveyed to lower layers. Convolutional layers, pooling, and totally connected layers are all included in CNN (FC).

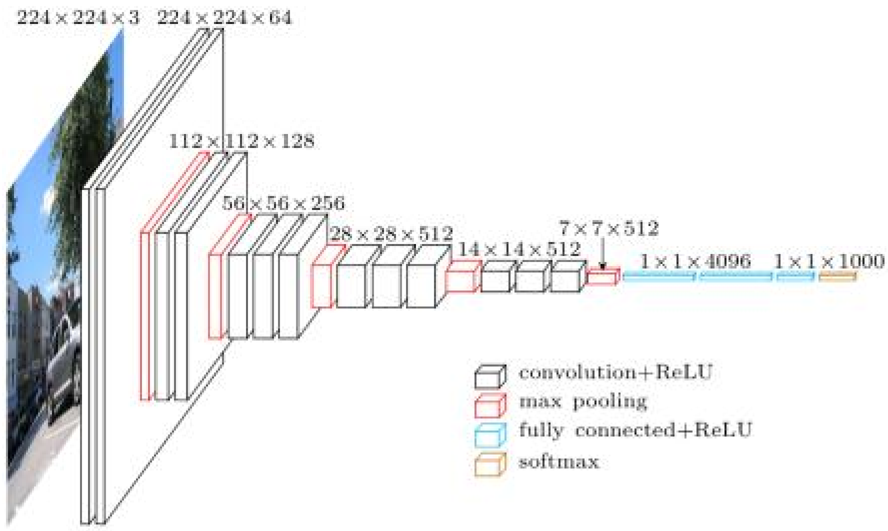
Multi-layer perceptrons are regularised variants of CNNs. Multi-layer perceptrons refer to completely connected networks, in which each somatic cell in one layer is connected to all or any neurons in the following layer[15]. Because of their "full connectedness," the networks are vulnerable to over-fitting information. Regularization, or preventing over-fitting, can be accomplished in a variety of ways, including penalising parameters throughout coaching (such as weight decay) or cutting property (skipped connections, dropout, etc.)

The design of a ConvNet is similar to that of the property pattern of Neurons gifted within the Human Brain, which was influenced by the cortical area's organization. Individual neurons respond to stimuli only in a small area of the field of view known as the Receptive Field. A group of such fields overlap one another to obscure the entire cortical region and deep learning, a convolutional neural network (CNN, or ConvNet) is a type of deep neural network used to study visual representational processes. Shift invariant or area invariant artificial neural networks (SIANN) are artificial neural networks with shared-weight convolution kernels that shift over input alternatives and provide translation equivariant outputs. Surprisingly, most convolutional neural networks are only equivariant to translation, as crucial invariants[16].

Among the applications covered are image and video recognition, medical image analysis, linguistic communication, brain-computer interfaces, recommender systems, image classification, image segmentation, and monetary statistics.

CNNs adopt a unique method to regularization: they take advantage of the hierarchical pattern present in data and use simpler and less sophisticated patterns brocaded in their filters to assemble patterns of increasing quality. As a result, CNNs rank towards the bottom of the quality and property scale.

In our study, we used CNN models such as Vgg16, Vgg19, and Resnet50.Vgg16 Model-VGG16 is a convolutional_neural_network (CNN) architecture that won the 2014 ILSVR(Imagenet) competition. It is regarded as one of the best vision model architectures ever created. VGG16 has 3x3 filter convolution layers with a stride 1 and utilising the maxpool layer (2x2 filter) stride 2. which is of same padding. In the design , convolution and max pool layers are arranged in the same way. It features two FC which are connected layers in the end. It is then followed by a softmax for output. VGG16 contains 16 layers of different weights. This network is rather huge, with around 178 million parameters[17].



.

Figure 3: VGG 16 Neural Network Architecture

The ImageNet datasets contain datasets of images which has fixed size that is 224*224 and have RGB channels. A tensor of [224, 224, 3] is used as the initial input. This model processes the input images and outputs of the vector that of 1000 values[18].

(A) This is a vector representation to classification probability for the corresponding class.

$$\hat{y} = \begin{bmatrix} \hat{y_0} \\ \hat{y_1} \\ \hat{y_2} \\ \hat{y_3} \\ . \\ . \\ . \\ . \\ .\,\hat{y_{999}} \end{bmatrix}$$

(B) To ensure that these probabilities sum up to *1*, we use softmax function which is defined as :

$$P(y=j \mid \theta^{(i)}) = \frac{e^{\theta^{(i)}}}{\sum_{j=0}^{k} e^{\theta_k^{(i)}}}$$

Softmax function

where $\theta = w_0x_0 + w_1x_1 + \dots + w_kx_k = \sum_{i=0}^{k} w_ix_i = w^Tx$

Then we take the 5 most plausible candidates into vector.

$$C = \begin{bmatrix} 780 \\ 0 \\ 1 \\ 2 \\ 999 \end{bmatrix}$$

and the ground truth[T] vector is given as follows:

$$G = \begin{bmatrix} G_0 \\ G_1 \\ G_2 \end{bmatrix} = \begin{bmatrix} 780 \\ 2 \\ 999 \end{bmatrix}$$

Then Error function has to be defined as follows:

$E = \frac{1}{n} \sum_k min_i d(c_i, G_k)$

$where\, d = 0\, if\, c_i = G_k\, else\, d = 1$

3.2 Architecture of Vgg16

A two-dimensional picture is fed into the network (224, 224, 3). The padding on the first two levels is the same, and there are 64 channels of 3*3 filter size on the first two layers. Then, after a stride (2, 2) max pool layer, two layers of 256 filter size and filter size convolution layers (3, 3). A stride (2, 2) max pooling layer follows, which is identical to the preceding layer. Then there are two convolution layers with 3 and 3 filter sizes and a 256 filter. There are two sets of 3 convolution layers and a max pool layer, after that. Layers contains 512 filters and padding of the same size (3, 3). Following that, the picture is passed into a two-layer convolution stack. Here 3*3 filters is used instead of 11*11 in AlexNet and 7*7 in ZF-Net. In some of the layers, 1*1 pixels are used to alter the number of input channels. A 1-pixel same padding is placed after each convolutional layers to hinder the image's spatial information from being lost[19].

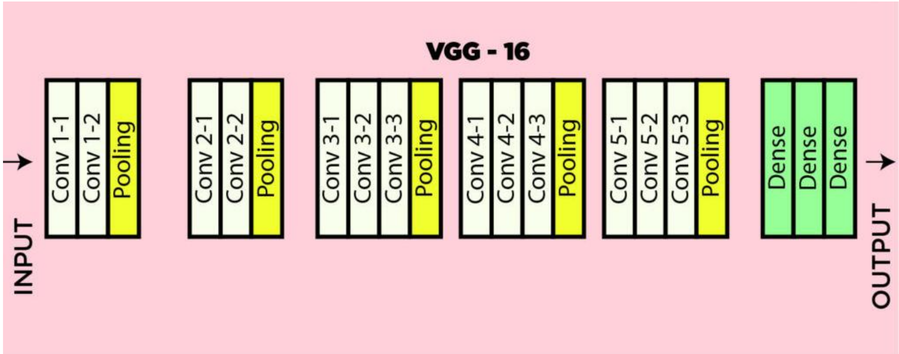


Figure 4: VGG 16 Architecture

After stacking the convolution and max-pooling layers, we got a (7, 7, 512) feature map. To produce a (1, 25088) feature vector, this output is flattened. Following that, there are 3 fully connected layers: the 1st takes the last feature vector as input and outputs a (1, 4096) vector, the 2nd layer also outputs a (1, 4096) vector, but the 3rd layer outputs 1000 channels for 1000 ILSVRC challenge classes, and the output of the third fully connected layer is passed to the softmax layer to normalise the classification vector. Following the categorization vector output, review the top five categories. The ReLU function is used to activate all hidden layers.Because it speeds up learning and minimises the risk of a vanishing gradient issue, ReLU is more computationally efficient[19].

VGG 16 Difficulties:

VGG-16's trained imageNet are 528 MB in size.As a result, it eats up a many storage space and bandwidth, rendering it useless.

The model achieves almost ninety three percent top-five test accuracy up on the ImageNet datasets, which comprises 14(Fourteen) million pictures from 1000 classifications.

Vgg19 model:- The VGG-19 is an upgrade to the VGG-16 model. It's a 19-layer convolutional neural network model. It is constructed by stacking convolutions together, however the depth of the model is limited due to a phenomenon known as diminishing gradient. Deep convolutional networks are difficult to train because of this issue. The model, like the rest of the models examined, was trained on ImageNet to classify 1000 different types of objects.

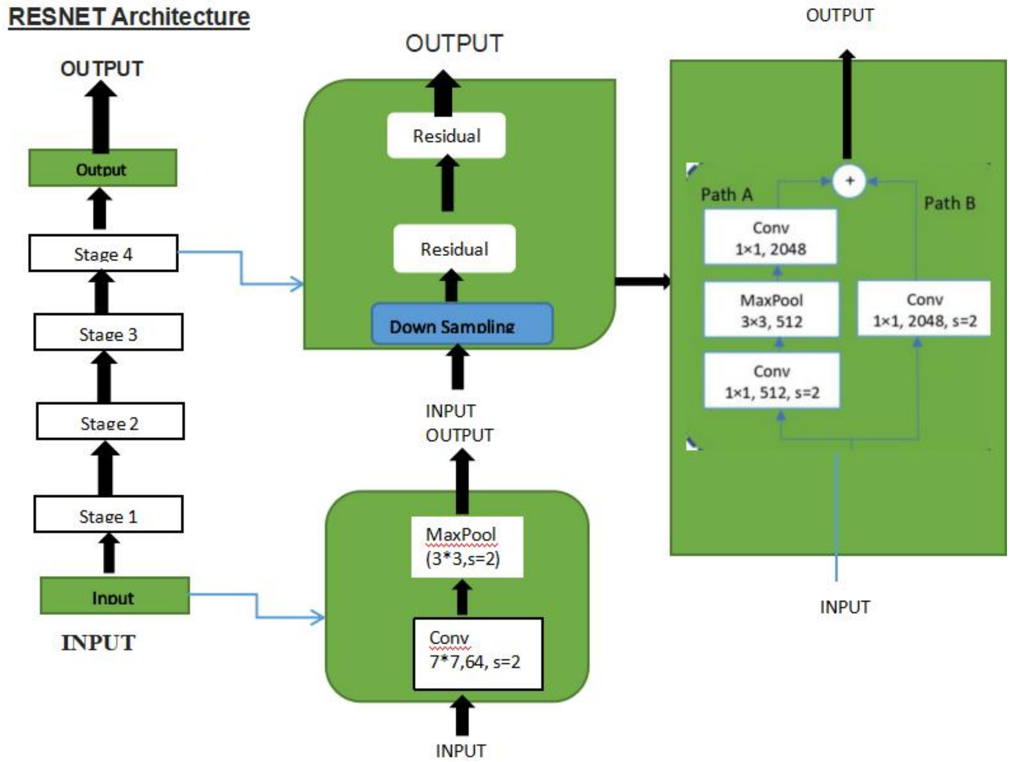


Figure 5: RESNET Architecture

Resnet50 model

To overcome the problem of diminishing gradient, the Resnet model was proposed. The goal is to bypass the link and transmit the residual to the next layer, allowing the model to keep training. CNN models can get deeper and deeper using Resnet models. Resnet models come in a variety of shapes and sizes, and we chose Resnet50 because it was featured in Kaggle's lesson and we were familiar with it. Resnet 50 produces the greatest results when almost 40% of all parameters are re-trained.

Confusion Matrix:-

A confusion matrix is a table that describes a classifier's performance in a collection of test datasets for which the true values are previously known. Every confusion matrix26 has four primary terms linked with it. (i) [TP] True Positives: This is case where it predicted "yes" and the patient actually has the condition.(ii) [TN] True Negatives : It predicted "no," and patients are not infected.
(iii) [FP] False Positives : It predict "yes" for a condition, but the patient does not have it. This is referred to as the Type I mistake. (iv) [FN] False Negatives : Although our model predicts "no," patients nonetheless have the condition. Type II errors are what they're called. It is used to depict essential prediction statistics, making it easier to analyse and obtain useful experiment trends.

Accuracy (ACCURACY), Recall (R), Precision (P) and F1-score are four metrics that are used to asses models (F1).

$$ACCURACY = (TN+TP) / (TP+FN+FP+TN)$$

$$P = TP/(FP+TP)$$

$$R = TP/(FN+TP)$$

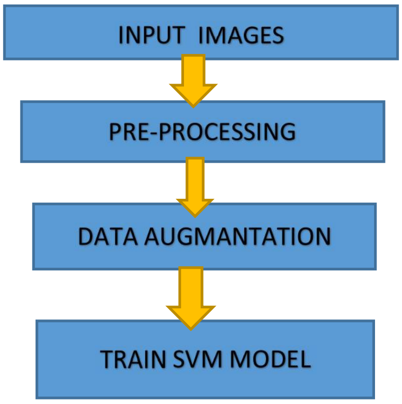
$$F1 = [(R \times P)/(R+P)] \times 2$$

CHAPTER 4
COVID DETECTION USING SVM

Batista et al suggested that multiple machine learning algorithms such as neural networks, gradient boosting trees, random forests, support vector machines(SVM) and logistic regression be used to train the sample data in order to forecast the threat of a positive COVID-19 diagnosis.

With sensitivity and AUC, the support vector machine(svm) algorithm outperforms. SVM is a strong tool for regression data and categorization . It outperforms other machine learning algorithms in a variety of real-world applications, like medical picture analysis. It was used in the analysis and classification of COVID-19 because of its superior performance.

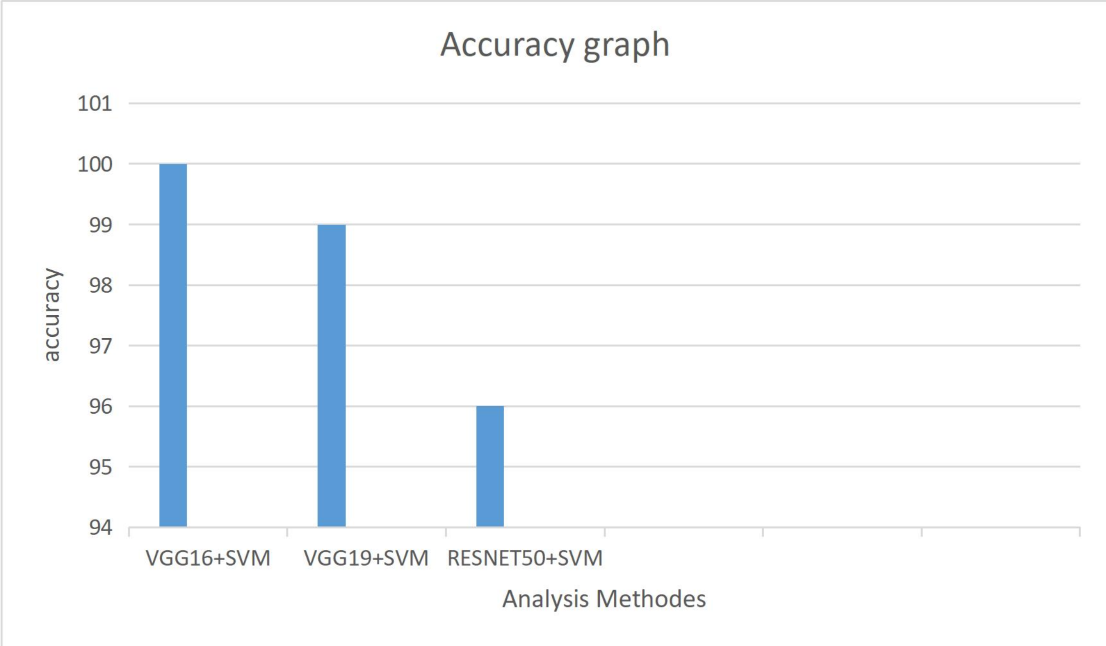
In order to test the suggested approach, a datasets of 3662 chest X-ray pictures was used and 7485 images used for the CT-scan datasets, on these both datasets we used the 80% to 20% of testing and training images. We done Pre-processing methods such as the image sizes on X-ray images include image filtering with a median filter, and Data Augmentation like expanding dimension. Data Augmentation algorithms can increase accuracy of the machine learning models.



TRANINIG THE SVM MODEL

3662 images are used where 80% of total image is used to train and 20% for testing.That is we used 2930 images for training and 732 images for testing. the SVM model and the best curve fit with 5- fold cross validation is found to classify the COVID19 against normal images. Here is the graph used to show the our results of accuracy.

Accuracy graph of the X-ray datasets



Accuracy graph of the CT-scan datasets

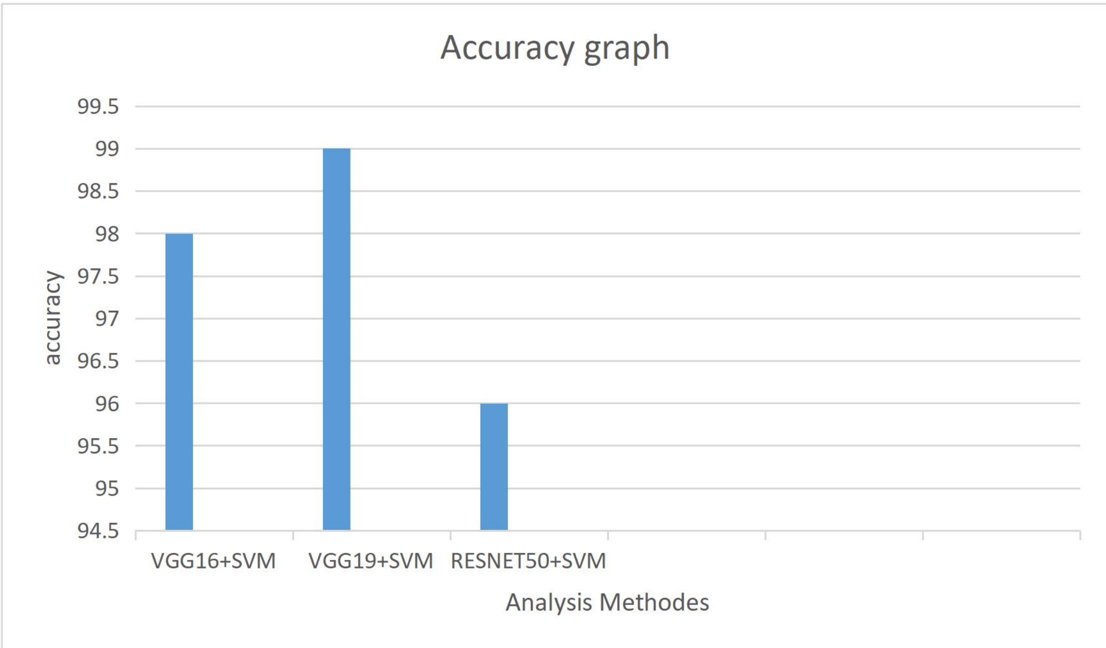


Figure 6: Accuracy Bar graph

Here we have done classification using 2 methods -binary class classification and multiclass classification on the x-ray and ct-scan datasets.

4.1 BINARY CLASS CLASSIFICATION

It refers to classification problems with two labels for each class. In most binary classification problems, one class represents the the aberrant state and the other represents normal state.

For binary classification the following algorithms can be used:

- Logistic Regression
- K Nearest Neighbors
- Decision Trees
- Support Vector Machine
- Naive Bayes

We have SVM(Support Vector Machine) algorithm in our project.

4.2 MULTICLASS CLASSIFICATION

It is used to describe classification problems with more than two class labels. Multi class classification, unlike binary classification, does not distinguish between healthy and ill outcomes, Instead, instances are categorized into one of several pre defined groups. Multi-class problems can be solved using binary classification algorithms that have been adapted. This entails fitting multiple binary classification models for each class vs. all other classes (known as one-vs rest) or a single model for each pair of classes (called one vs ane). Fit one binary classification model for each class vs the rest all other classes. Fit one binary classification model for each pair of classes using the one vs one method. These methodologies can be used for multi class classification via binary classification algorithms such as:

- Logistic Regression
- Support Vector Machine

CHAPTER 5

EXPERIMENTAL RESULTS

5.1 BINARY CLASS CLASSIFACTION USING X-ray datasets

X-ray images of Normal and Covid patients are taken for classification

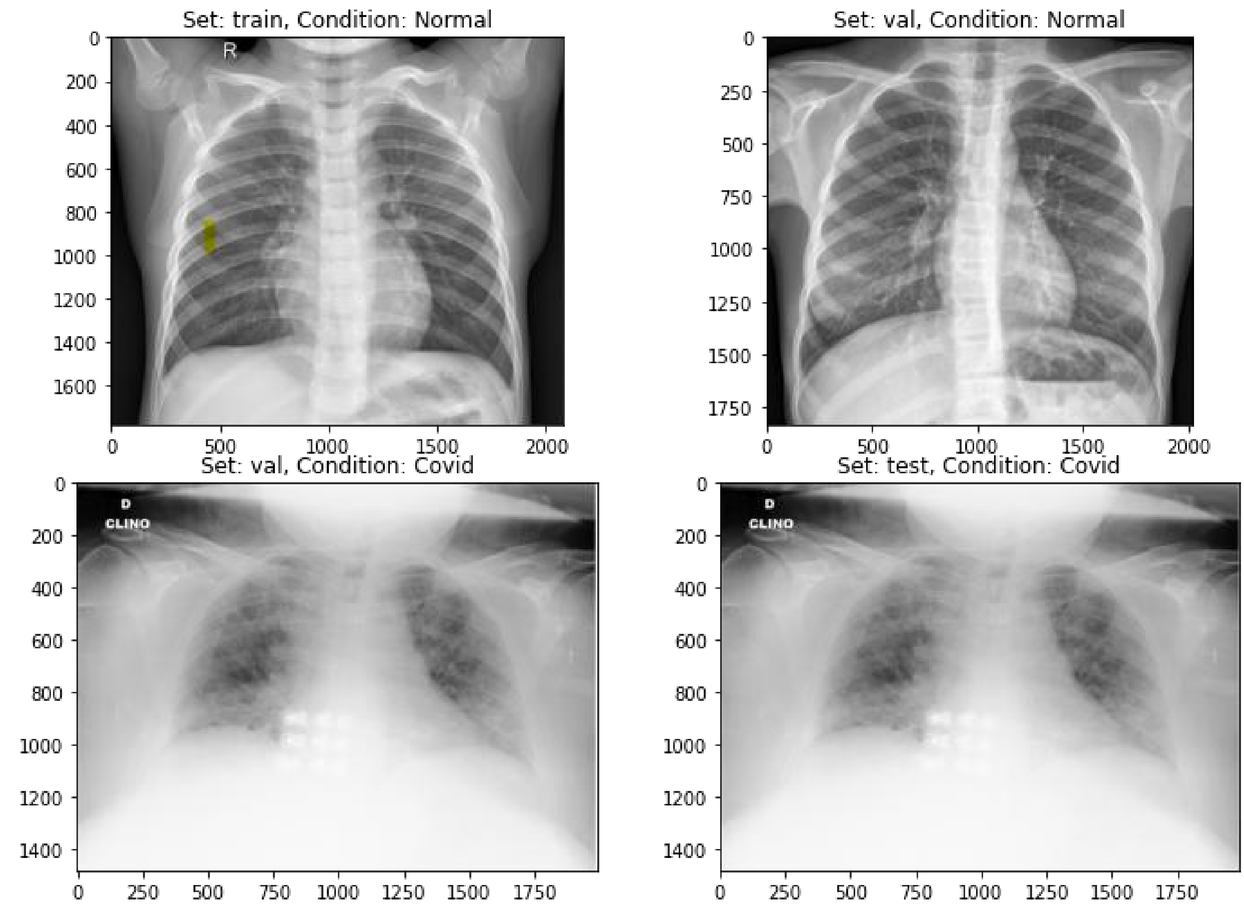


Figure 7: Normal and covid image

5.1.2 Vgg16+SVM under binary class classification

(A) ROC curve of our model

```
Accuracy: 1.0%
Precision: 100.0%
Recall: 100.0%
F1-score: 100.0
```

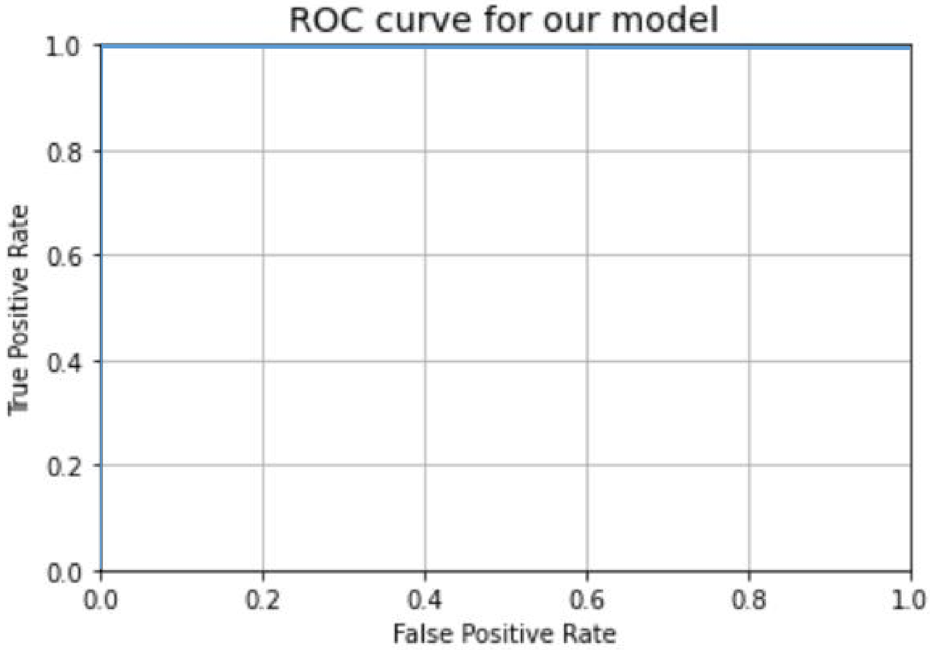


Figure 8: VGG 16 ROC curve

Confusion Matrix

```
Confusion Matrix without Normalization
```

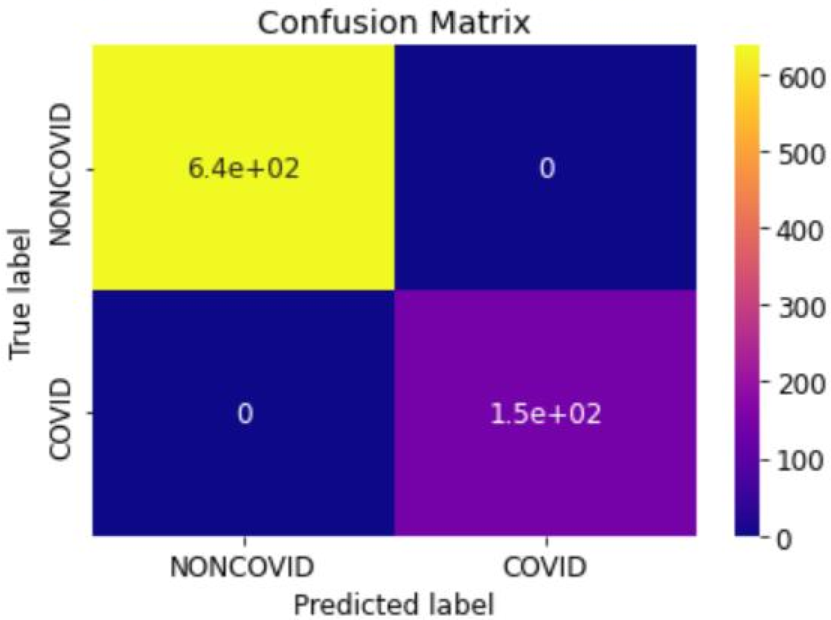


Figure 9 : Confusion matrix without normalization

Confusion Matrix with Normalized Values

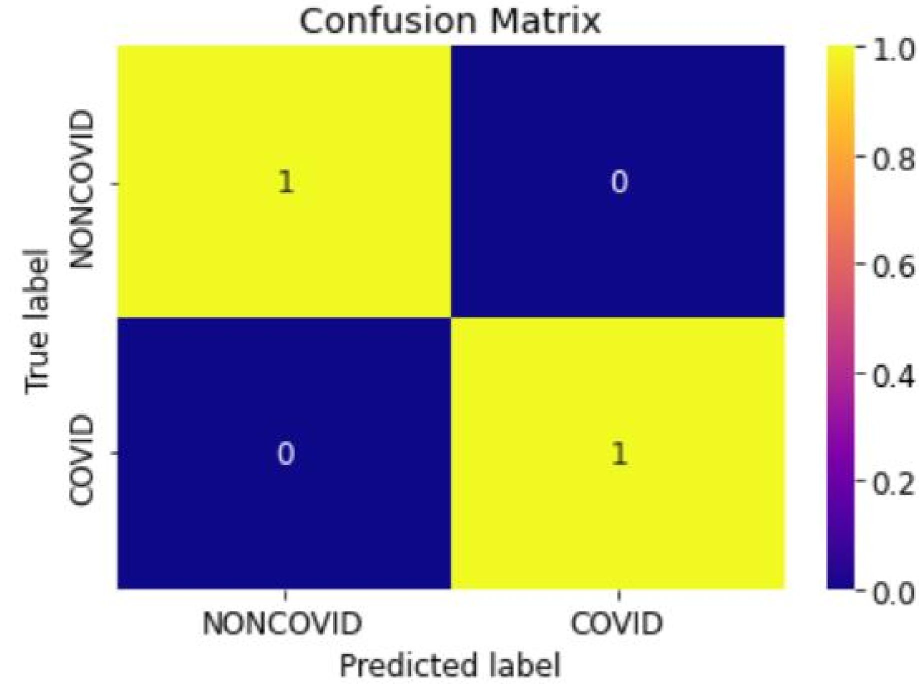


Figure 10 : confusion matrix with normalization

5.1.3 Vgg19+SVM under binary class classification

```
TEST METRICS ----------------------
Accuracy: 0.9961636828644501%
Precision: 99.3103448275862%
Recall: 98.63013698630137%
F1-score: 98.96907216494844
```

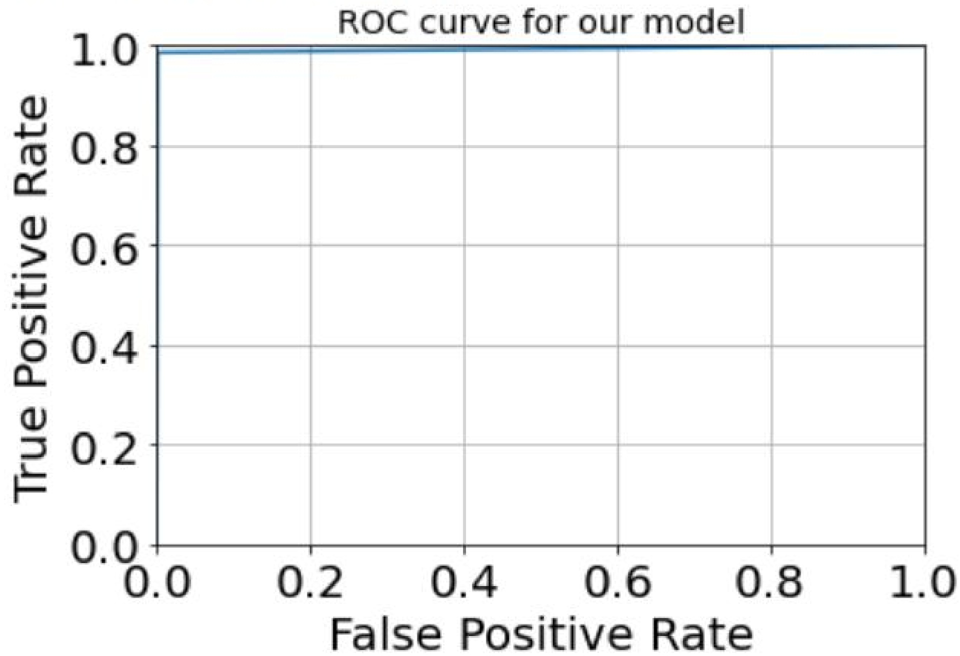


Figure 11 : VGG19 ROC curve

Confusion Matrix without Normalization

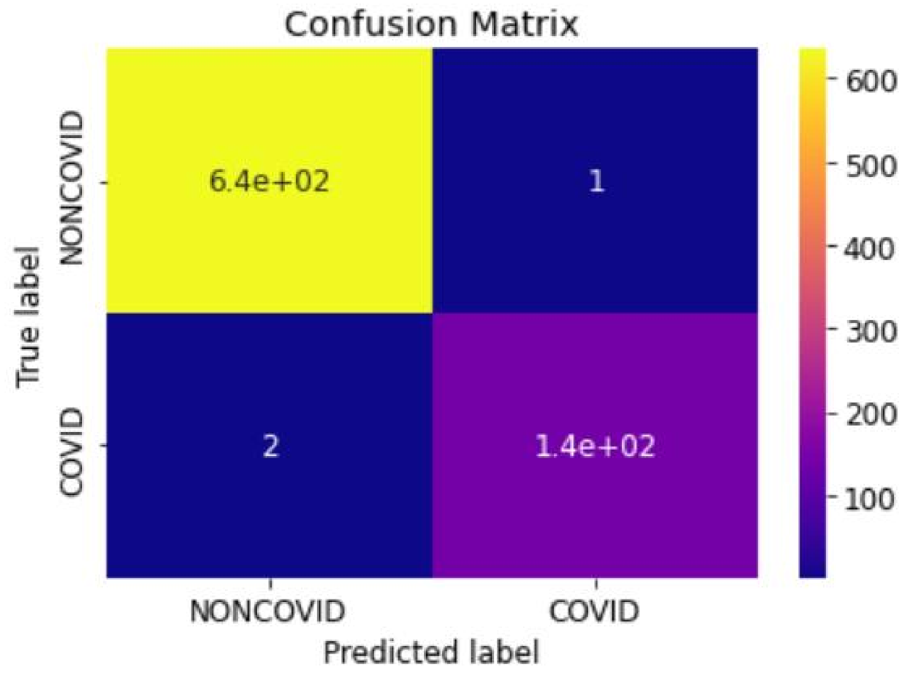


Figure 12: confusion matrix without normalization

Confusion Matrix with Normalized Values

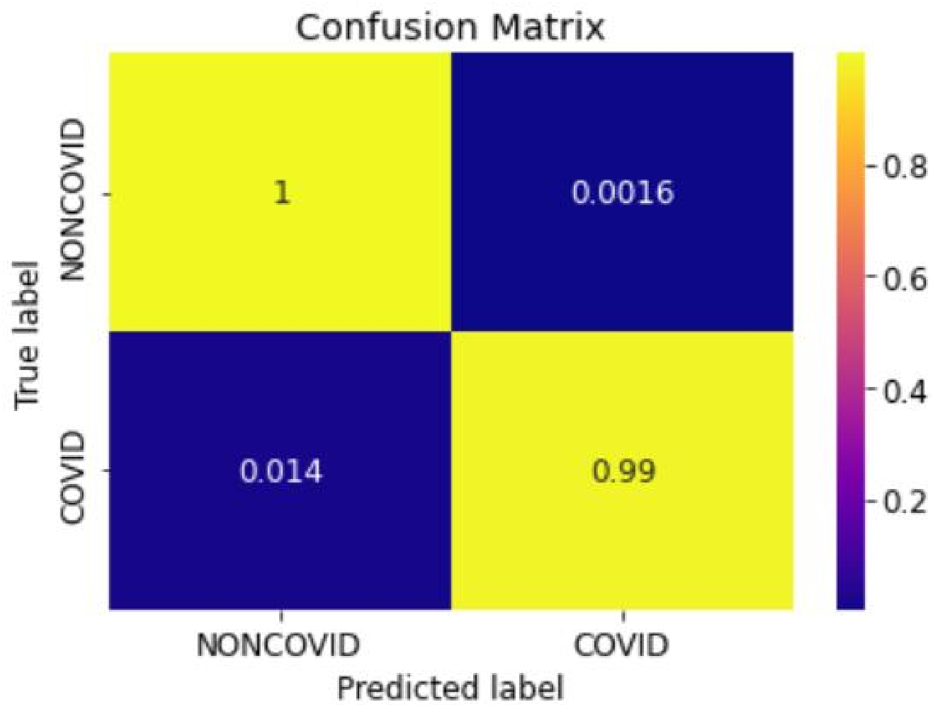


Figure 13: confusion matrix with normalization

5.1.4 Resnet50+SVM under binary class classification

```
TEST METRICS ----------------------
Accuracy: 0.9680306905370843%
Precision: 99.1869918699187%
Recall: 83.56164383561644%
F1-score: 90.70631970260223
```

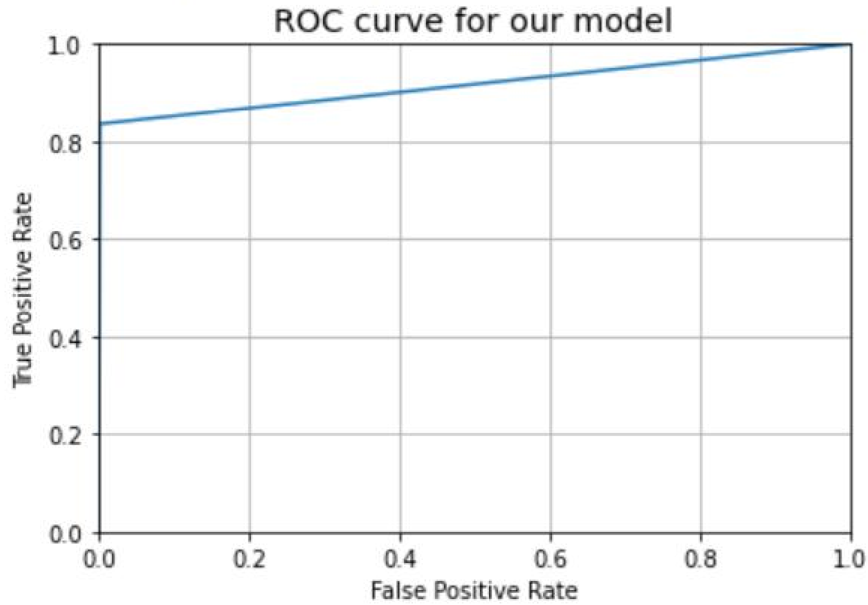


Figure 14: RESNET 50 ROC curve

```
Confusion Matrix without Normalization
```

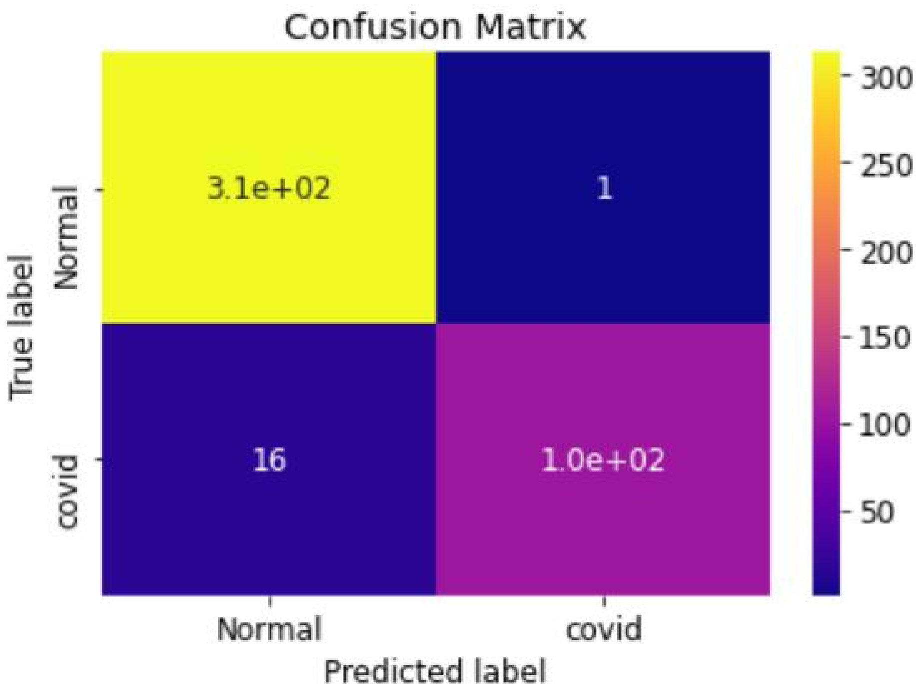


Figure 15: confusion matrix without normalization

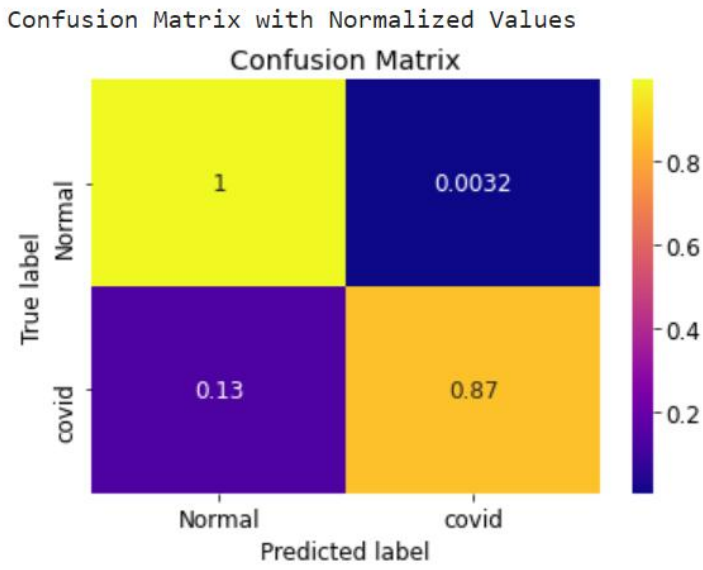


Figure 16 : confusion matrix with normalization

5.2 BINARY CLASS CLASSIFACTION USING CT-SCAN datasets

CT-SCAN images of normal and covid patients are taken for binary classification.

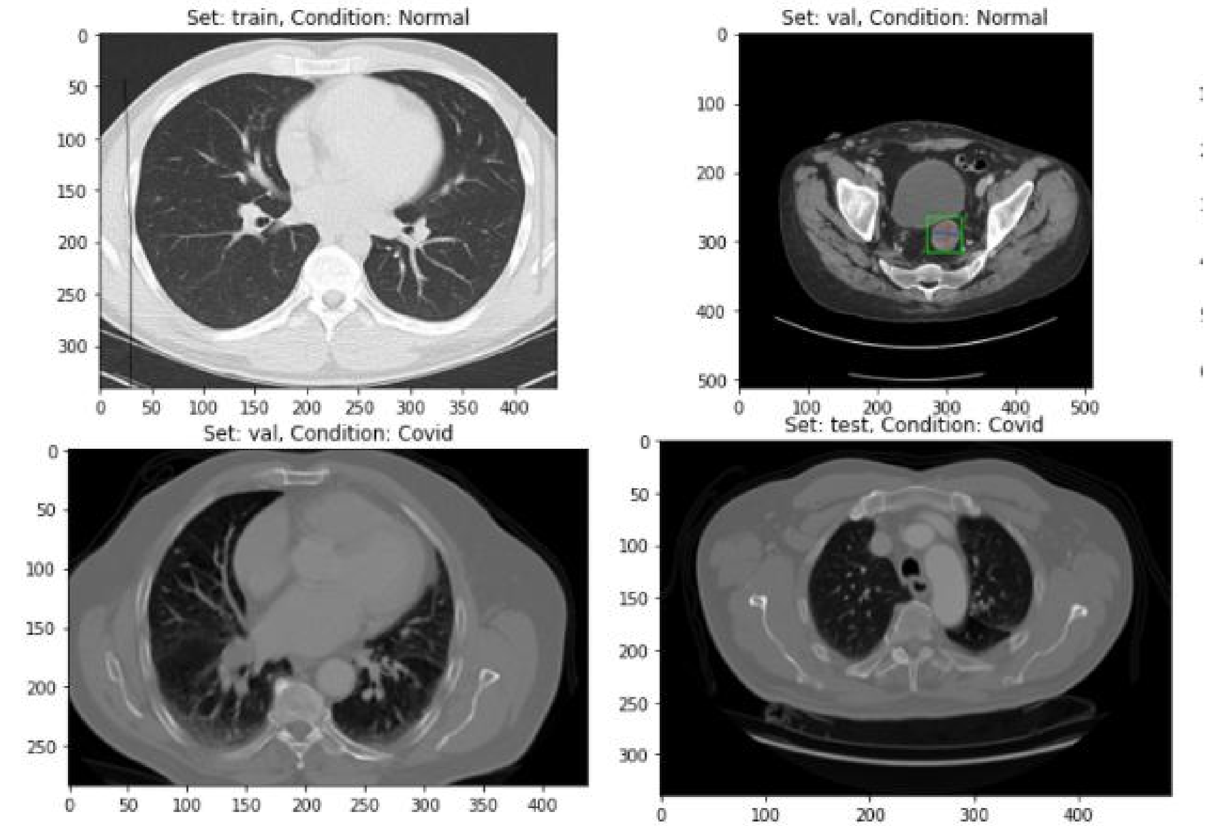


Figure 17 : normal and covid images of ct-scan

5.2.1 Vgg19+SVM under binary class classification

```
Accuracy: 0.9910714285714286%
Precision: 100.0%
Recall: 98.27586206896551%
F1-score: 99.13043478260869
```

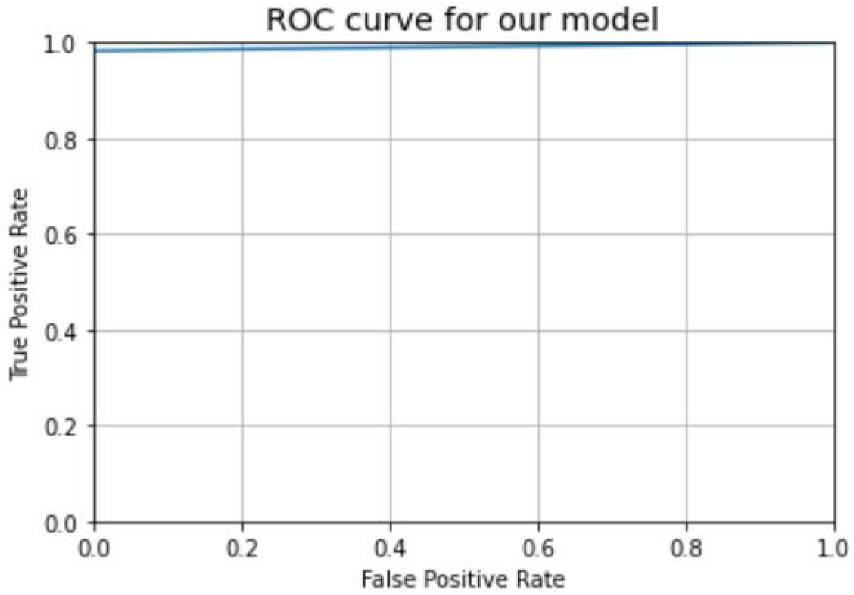


Figure 18: VGG19 ROC curve

```
Confusion Matrix without Normalization
```

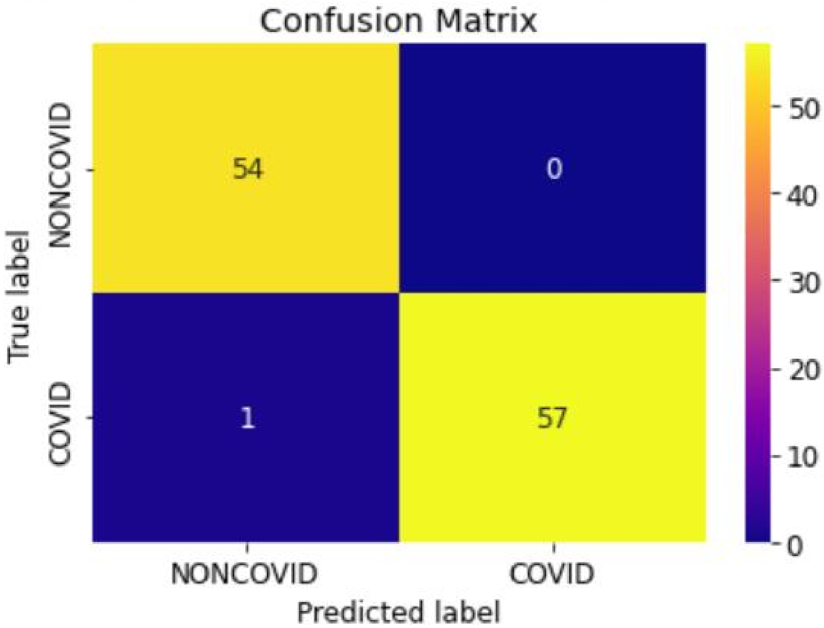


Figure 19: VGG19 confusion matrix without normalization

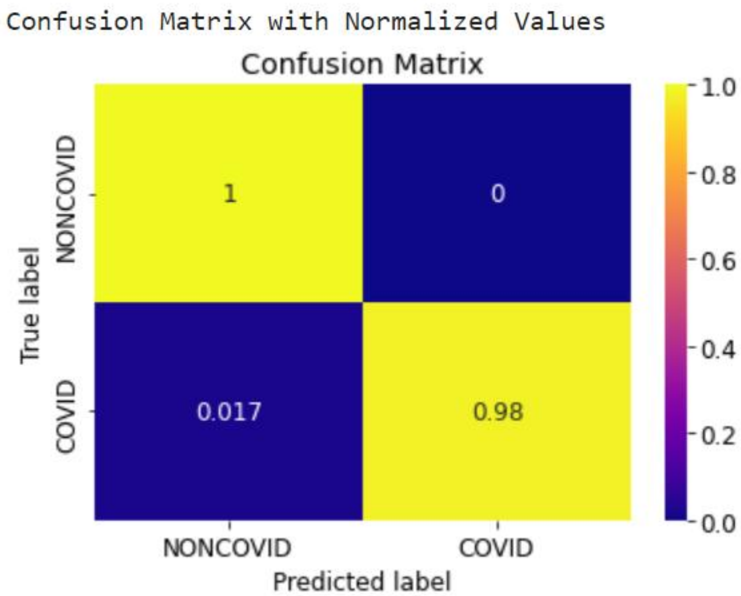


Figure 20 :VGG19 Confusion matrix with normalization

5.2.2 Resnet50+SVM under binary class classification

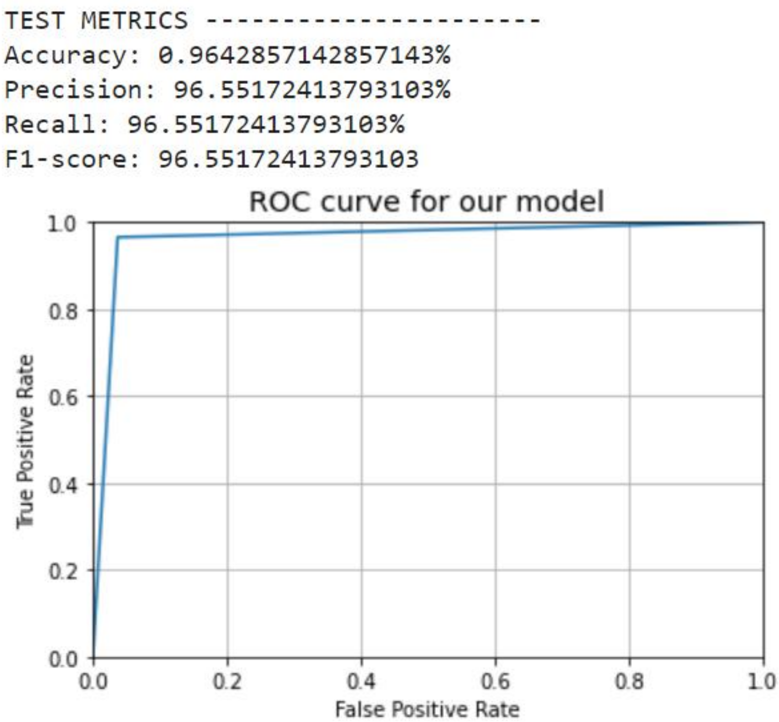


Figure 21 : RESNET50 ROC curve

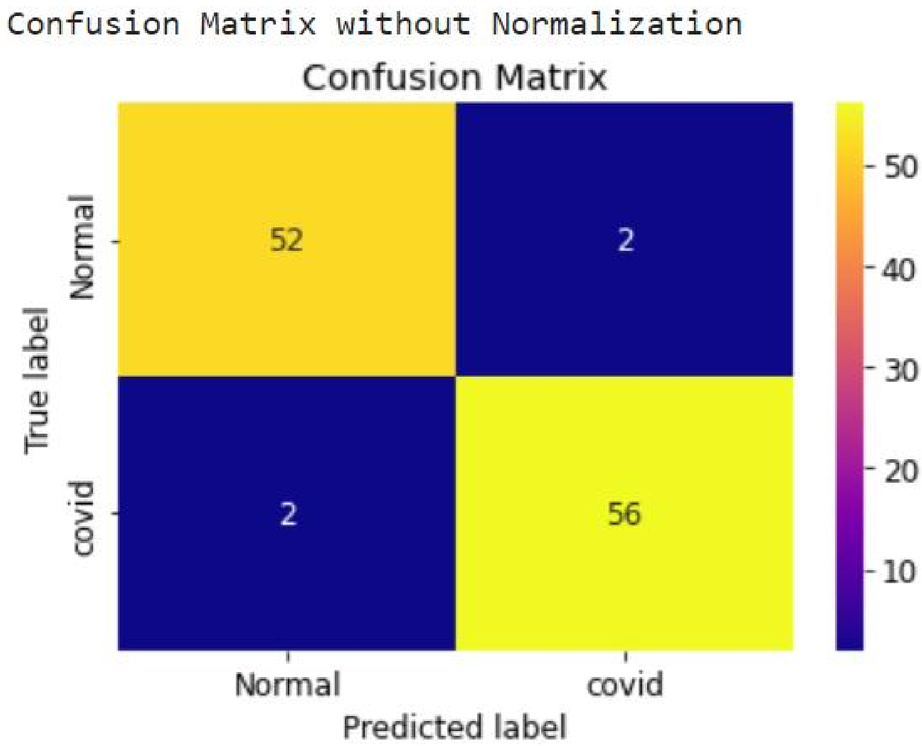


Figure 22: RESNET50 confusion matrix without normalization

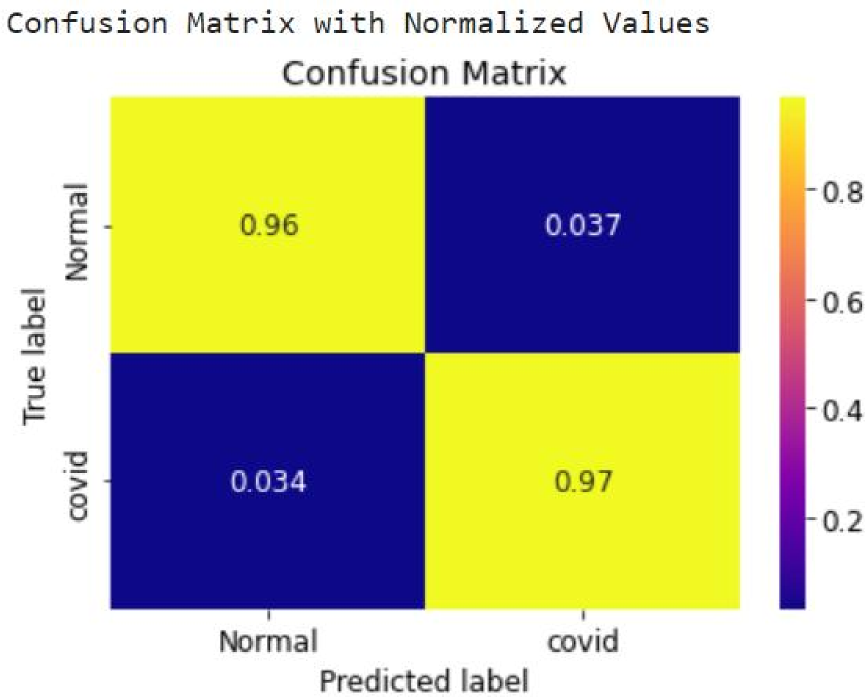


Figure 23: RESNET50 confusion matrix with normalization

5.2.3 Vgg16+SVM under binary class Classification

```
TEST METRICS ----------------------
Accuracy: 0.9847634322373697%
Precision: 97.85478547854785%
Recall: 98.9983305509182%
F1-score: 98.42323651452283
```

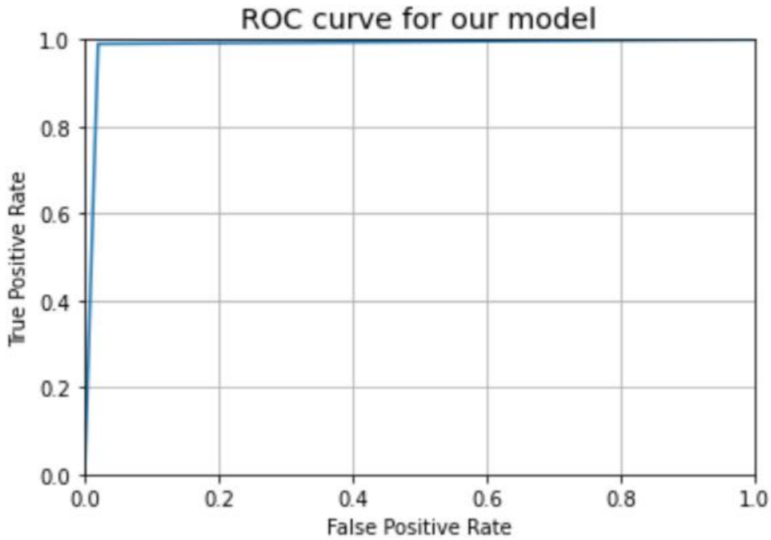


Figure 24 : VGG16 ROC curve

```
Confusion Matrix without Normalization
```

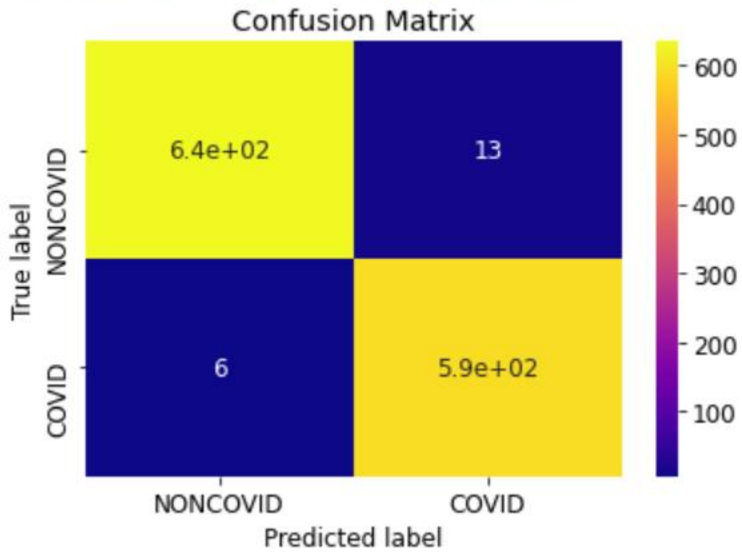


Figure 25 : VGG16 confusion matrix without normalization

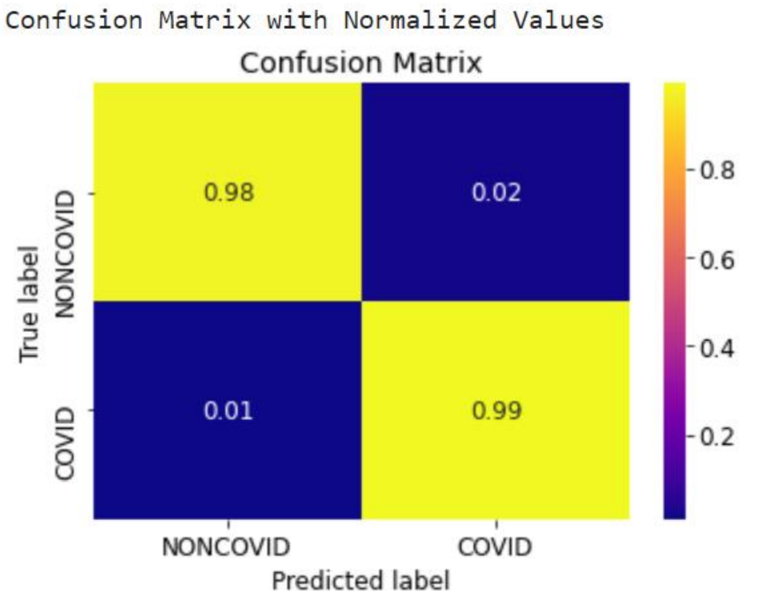


Figure 26: VGG16 confusion matrix with normalization

SUMMARY

CLASSIFICATION REPORT

The precision, accuracy F1-score and recall of all the models are-

MODELS	DATASET	ACCURACY	PRECISION	RECALL	F1-score
VGG-16+SVM	X-RAY	1.0%	100.0%	100.0%	100.0
VGG-16+SVM	CT-SCAN	0.984%	97.854%	98.998%	98.423
VGG-19+SVM	X-RAY	0.996%	99.310%	98.630%	98.969
VGG-19+SVM	CT-SCAN	0.991%	100.0%	98.275%	99.130
RESNET50+SVM	X-RAY	0.9680%	99.186%	83.561%	90.706
RESNET50+SVM	CT-SCAN	0.964%	96.551%	96.551%	96.551

CHAPTER 6

CONCLUSION

The major aim of this study was not only to look at but also describe several Deep_learning methods for diagnosing COVID-19 using medical images.We developed various datasets from public repositories for binary class and multi-class classifications task, including CT-Scan and X-Ray images.The classification of COVID-19 CT-scan and chest X-ray pictures using ResNet and VGG16 deep learning structures models has also been proven.

The accuracy of improved CNN models are all the time over ninety eight(98) percent, and the confusion matrices for binary classification of X-ray images reveal very few false occurrences, allowing us to tweak the models to achieve a higher level of accuracy than previous studies. The findings suggest that we may combine characteristics learned from improved deep learning models into our work to develop a useful model.

One of the paper's main conclusions is that data fusion models might increase descriptive and prognostic performance even further by merging more bibliographic databases.The other is that our models might help virologists detect COVID-19 and radiologists battle COVID-19 epidemics by delivering essential patient diagnoses in some minutes, which might be crucial in the treatment process.

As a future research line, we are currently working on multi-criteria classifications in order to distinguish image(s) from pile datasets comprising persons with lung difficulties owing to a range of illnesses, including TB, AIDS, COVID-19, and others. We also couldn't find any datasets containing metadata detailing illness phases that may be utilised to estimate the severity of symptoms.

We plan to collaborate on this with doctors from a few Madrid hospitals.

PLANNING AND PROJECT MANAGEMENT

Table 6.1 Showing details about project planning and management

Activity	Starting week	Number of days
Literature review	1st week	4
Finalising problem	2nd week	14
Implementing of codes for Vgg16+SVM with CT scan	3rd week	21
Implementing of codes for Vgg16+SVM with X-ray	2 week	14
Implementing of codes for Vgg19+SVM with CT scan	1 week	7
Implementing of codes for Vgg19+SVM with X-ray	1 week	7
Implementing of codes for Resnet50+SVM with CT scan	3 week	21
Implementing of codes for Resnet50+SVM with X-ray	2 week	14
Implementing of codes for MULTI CLASS Vgg16+SVM with X-ray	4 weeks	28
Preparing project	1 week	7
Finalizing all the work	1 week	7

The Gantt chart is shown below.

	Week 1 & 2	Week 3	Week 4, 5 & 6	Week 7,8, 9 & 10	Week 11	Week 12
Literature review						
Presentation						
Modification and Presentation						
Coding implementation						
Preparation of project report						
Preparation of presentation						

REFERENCES

[1] . Swapna rekha Hanumanthu. "Role of Intelligent Computing in COVID-19 Prognosis: A State-of-the-Art Review", Chaos, Solitons & Fractals, 2020

[2]. American College of Radiology , the Society of Thoracic Radiology, and the american Society of Emergency Radiology Imaging approach to COVID-19 associated pulmonary embolism Lukas M. Trunz,Patrick Lee,Steven M. Lange,Corbin L. Pomeranz,Laurence Needleman,Robert W. Ford,Ajit Karambelkar,Baskaran Sundaram

[3] A Characteristic Chest Radiographic Pattern in the Setting of the COVID-19 Pandemic. David L Smith [1], John-Paul Grenier [1], Catherine Batte [1], Bradley Spieler [1]
A retrospective study was performed under investigation for COVID-19 presenting to this institution during the exponential growth phase of the COVID-19 outbreak in New Orleans (March 13–25, 2020).

[4]. Woo PCY, Lau SKP, Lam CSF, Lau CCY, Tsang AKL, Lau JHN, et al. . Discovery of Seven Novel Mammalian and Avian Coronaviruses in the Genus Deltacoronavirus Supports Bat Coronaviruses as the Gene Source of Alphacoronavirus and Betacoronavirus and Avian Coronaviruses as the Gene Source of Gammacoronavirus and Deltacoronavirus. J Virol (2012) 86(7):3995–4008. doi:10.1128/JVI.06540-11 - DOI - PMC - PubMed.

[5]. Greenhalgh T, Jimenez JL, Prather KA, Tufekci Z, Fisman D, Schooley R. Ten Scientific Reasons in Support of Airborne Transmission of SARS-CoV-2. Lancet (2021) 397(10285):1603–5. doi: 10.1016/S0140-6736(21)00869-2 - DOI - PMC - PubMed.

[6]. JHU, COVID-19 Dashboard by the Center for Systems Science and Engineering (CSSE) at Johns Hopkins University (JHU),
(2020). https://coronavirus.jhu.edu/map.html.

[7]. Li Y., Xia L., Coronavirus disease (COVID-19): role of chest CT in diagnosis and management, American Journal of Roentgenology (2020), 1–7.

[8] Ulhaq et-al[1] The existing literature of deep learning computer vision algorithms relating to diagnosis, prevention and control of COVID 19.

[9] Shi et-al A qualitative study on the psychological experience of caregivers of COVID-19 patients.

[10] . WHO Director-General's opening remarks at the media briefing on COVID-19 - 11 March World Health Organization,
(2020). https://www.who.int/dg/speeches/detail/who-director-general-s-opening-re.

[11]. Shen L., Sun H., Li X., Liu Y., Fang H., Su J., Zhang L., A Robust Filtering Method for X-Ray Pulsar Navigation in the Situation of Strong Noises and Large State Model Errors, IEEE Access 7(1) (2019), 161141–161151.

[12]. Statistical Hypothesis Testing versus Machine Learning Binary Classification: Distinctions and Guidelines panelJingyi JessicaLi[1]XinTong[2].

[13]. Dandi Yang, Cristhian Martinez, Lara Visuña, Hardev Khandhar, Chintan Bhatt, Jesus Carretero. "Detection and analysis of COVID-19 in medical images using deep learningtechniques", Scientific Reports, 2021

[14]. F.M. Javed Mehedi Shamrat, Sovon Chakraborty, Md. Masum Billah, Md. Al Jubair,Md Saidul Islam, Rumesh Ranjan. "Face Mask Detection using Convolutional Neural Network (CNN) to reduce the spread of Covid-19", 2021 5th International Conference onTrends in Electronics and Informatics (ICOEI),2021

[15]. Mormont R., Geurts P., Marée R., Comparison of deep transfer learning strategies for digital pathology, in: Proceedings of the IEEE Conference on Computer Vision and Pattern Recognition Workshops (2018), pp. 2262–2271

[16]. M. Rahimzadeh and A. Attar, “A modified deep convolutional neural network for detecting COVID-19 and pneumonia from chest X-ray images based on the concatenation of Xception and ResNet50V2,” *Informatics in Medicine Unlocked*, vol. 19, 2020

[17]. H. Ko, H. Chung, W. S. Kang et al., “COVID-19 pneumonia diagnosis using a simple 2D deep learning framework with a single chest CT image: model development and validation,” *Journal of Medical Internet Research*, vol. 22, no. 6, Article ID e19569, 2020.

[18]. Farooq M., Hafeez A., Covid-resnet: A deep learning framework for screening of covid19 from radiographs, arXiv preprint arXiv:2003.14395 (2020).

[19]. Hemdan E.E.-D., Shouman M.A., Karar M.E., Covidx-net: A framework of deep learning classifiers to diagnose covid-19 in x-ray images, arXiv preprint arXiv:2003.11055 (2020).

[20] Q. Ni, Z. Y. Sun, L. Qi et al., “A deep learning approach to characterize 2019 coronavirus sisease (COVID-19) pneumonia in chest CT images,” *European Radiology*, vol. 30, no. 12, 2020.

[21] T. Ozturk, M. Talo, E. A. Yildirim, U. B. Baloglu, O. Yildirim, and U. Rajendra Acharya, “Automated detection of COVID-19 cases using deep neural networks with X-ray images,” *Computers in Biology and Medicine*, vol. 121, 2020.

[22] I. D. Apostolopoulos, S. I. Aznaouridis, and M. A. Tzani, “Extracting possibly representative COVID-19 biomarkers from X-ray images with deep learning approach and image data related to pulmonary diseases,” *Journal of Medical and Biological Engineering*, vol. 40, no. 3, pp. 462–469, 2020.

[23] Sejuti Rahman, Sujan Sarker, Md Abdullah Al Miraj, Ragib Amin Nihal, A. K. M. Nadimul Haque, Abdullah Al Noman. "Deep Learning–Driven Automated Detection of COVID-19 from Radiography Images: a Comparative

Analysis", Cognitive Computation, 2021

[24] Y. Pathak, P. K. Shukla, A. Tiwari, S. Stalin, and S. Singh, “Deep transfer learning based classification model for COVID-19 disease,” *IRBM*, vol. 41, 2020.

[25] Deep-learning algorithms for the interpretation of chest radiographs to aid in the triage of COVID-19 patients: A multicenter retrospective study Se Bum JangJong Kun Kim, Jae Wan Cho, Jaekyung Cho, Ki Beom Kim, Byunggeon Park, Jongmin Park,Jae-Kwang Lin

[26] Hwang EJ, Kim H, Yoon SH, Goo JM, Park CM. Implementation of a Deep Learning-Based Computer-Aided Detection System for the Interpretation of Chest Radiographs in Patients Suspected for COVID-19. Korean J Radiol. 2020;21(10):1150–60. Epub 2020/07/31. pmid:32729263; PubMed Central PMCID: PMC7458860.

[27] Wong HYF, Lam HYS, Fong AH, Leung ST, Chin TW, Lo CSY, et al. Frequency and Distribution of Chest Radiographic Findings in Patients Positive for COVID-19. Radiology. 2020;296(2):E72–E8. Epub 2020/03/29. pmid:32216717; PubMed Central PMCID: PMC7233401.

[28] Kim JH, Kim JY, Kim GH, Kang D, Kim IJ, Seo J, et al. Clinical Validation of a Deep Learning Algorithm for Detection of Pneumonia on Chest Radiographs in Emergency Department Patients with Acute Febrile Respiratory Illness. Journal of Clinical Medicine. 2020;9(6). pmid:32599874

[29] He, K.; Zhang, X.; Ren, S.; Sun, J. Deep residual learning for image recognition. In Proceedings of the IEEE Conference on Computer Vision and Pattern Recognition, Las Vegas, NV, USA, 26 June–1 July 2016; pp. 770–778.

[30]. Xin Guo, Tuanjie Liu, Chenqi Xing, Yan Wang, Zhilei Shang, Luna Sun, Yanpu Jia, Lili Wu, Xiong Ni, Weizhi Liu. "Is Higher Subjective Fear Predictive of Post-

Traumatic Stress Symptoms in a Sample of the Chinese General Public?", Frontiers in Psychiatry, 2021

[31]. Sethy P.K., Behera S.K., Detection of coronavirus disease (covid-19) based on deep features, Preprints 00, (2020), 2020.

[32]. Loey M., Smarandache F., Khalifa N.E.M., Within the Lack of COVID-19 Benchmark Dataset: A Novel GAN with Deep Transfer Learning for Corona-virus Detection in Chest X-ray Images, (2020).

[33]. Howard A.G., Zhu M., Chen B., Kalenichenko D., Wang W., Weyand T., Andreetto M., Adam H., Mobilenets: Efficient convolutional neural networks for mobile vision applications, arXiv preprint arXiv:1704.04861 (2017).

[34]. Huang G., Liu Z., Van L., Der Maaten and K.Q. Weinberger, Densely connected convolutional networks, in: Proceedings of the IEEE conference on computer vision and pattern recognition (2017), pp. 4700–4708.