#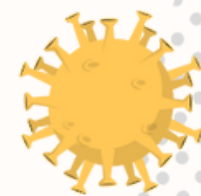 An ensemble learning-based approach to autonomous COVID19 detection using transfer learning with the help of pre-trained Deep Neural Network models

A PRESENTATION FOR PAPER ID:64

01

Our Team

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The Contents

Introduction

- COVID-19 has left a catastrophic and horrifying effect on our lives in every way and the aftermath is hard to undo

- Our Motivation of this paper arose from the need to assist doctors by easing out their burdensome task

Motivation

- Slow and Inaccurate Results

- High cost and unavailability of medical kits

- Too much workload

- Absence of trained staff

- Human Prone Errors and Risk Factors

Summary of Related Works

Paper Number	Dataset	Methodology	Result
[3]	NIH dataset & images from different websites	CNN- LSTM, CNN	Accuracy:99.4%, Specificity : 99.2%, Sensitivity :99.3%, F1-score : 98.9%.
[4]	Covid-19 image data collection.	DeTraC -CNN	Accuracy : 95.12%, Sensitivity : 97.91%, Specificity : 91.87%, Precision : 93.36%.
[5]	Covid-19 image data collection.	ResNet50V2, InceptionV3, Vgg16, VGG19, DenseNet, DeepCNN	Accuracy : 96.03%, Precision : 96.15%, F1-score : 96%.
[6]	Kaggle , Github Repository by Dr.Joseph Cohen,Latest Covid-19 Information,	AlexNet, DenseNet201, GoogleNet, InceptionV3, ResNet18, ResNet50, ResNet101, VGG16, VGG19, XceptionNet, Inceptionresnetv2	Accuracy:95.38%, Specificity : 93.47%, Sensitivity :92.29%, F1-score : 95.52%.
[7]	Github Repository by Dr.Joseph Cohen, ChestX-ray8 database by Wang	Dark Covid Net	Accuracy:87.02% Specificity : 92.18%, Sensitivity :85.35%, F1-score : 87.37%, Precision : 89.96%.
[8]	CXR images	Ensemble Deep Learning, Covid-Net	Accuracy:95%, Sensitivity :96%, Precision : 94.1%.

|			
[9]	COVIDx Dataset,	COVID-ResNet, Covid-Net	Accuracy : 96.23%, Sensitivity : 100%, F1-score : 100%, Precision : 100%.
[10]	Covid Chest X-ray dataset	ResNet 152, DenseNet121, ResNet152+DenseNet121, Vgg19, DeTrac, Resnet50, Xception+Resnet50	Accuracy:98.43% Specificity : 99.23%, Sensitivity :98.71%.
[14]	Covid-19 Image data Collection, ChestX-Ray8, Chest X-ray Images(Pneumonia)	ResNet50, InceptionV3, Inception-ResNetV2, ResNet101, ResNet152	Accuracy : 99.7%, Recall : 99.7%, Specificity : 99.9%, Precision : 98.9%.
[15]	COVID-19 Image Data Collection, COVID-19 Chest X-ray dataset,ActualMed COVID-19 Chest X-ray, RSNA Pneumonia Detection Challenge dataset, COVID-19 radiography database	COVID-Net, VGG-19, ResNet-50	Accuracy : 99.3%, Sensitivity : 91.0%, Precision : 98.9%.
[16]	Dr. Joseph Cohen's Github repository, Chest X-Ray Pneumonia Dataset, COVID19 XRay Dataset	VGG16, VGG19, MobileNetV2, InceptionV3 Xception, Densenet201, InceptionResNetV2, ResNet152V2, NASNetLArge	Accuracy:95.88% Specificity : 98%, Sensitivity :96%, F1-score : 96%, Precision : 96%.
[18]	covid-19 Image Data Collection , Covid Data Save Lives (COVIDDSL) and PadChest-covid Dataset	Novel Deep Learning	Accuracy:97.6% Specificity : 95.2%, Sensitivity :98.1%, F1-score : 93.5%, AUC-score : 98.6%.

Methodology

Methodology

Datasets Collection

- Dataset Used : *COVID19_Pneumonia_Normal_Chest_Xray_PA_Dataset*

	COVID + IMAGES	PNEUMONIA	NORMAL	TOTAL
Data	2313	2313	2313	6939

- Training : 80%
  - ↳ Validating : 20%
- Testing : 20%

Methodology

- Image Preprocessing and Augmentation
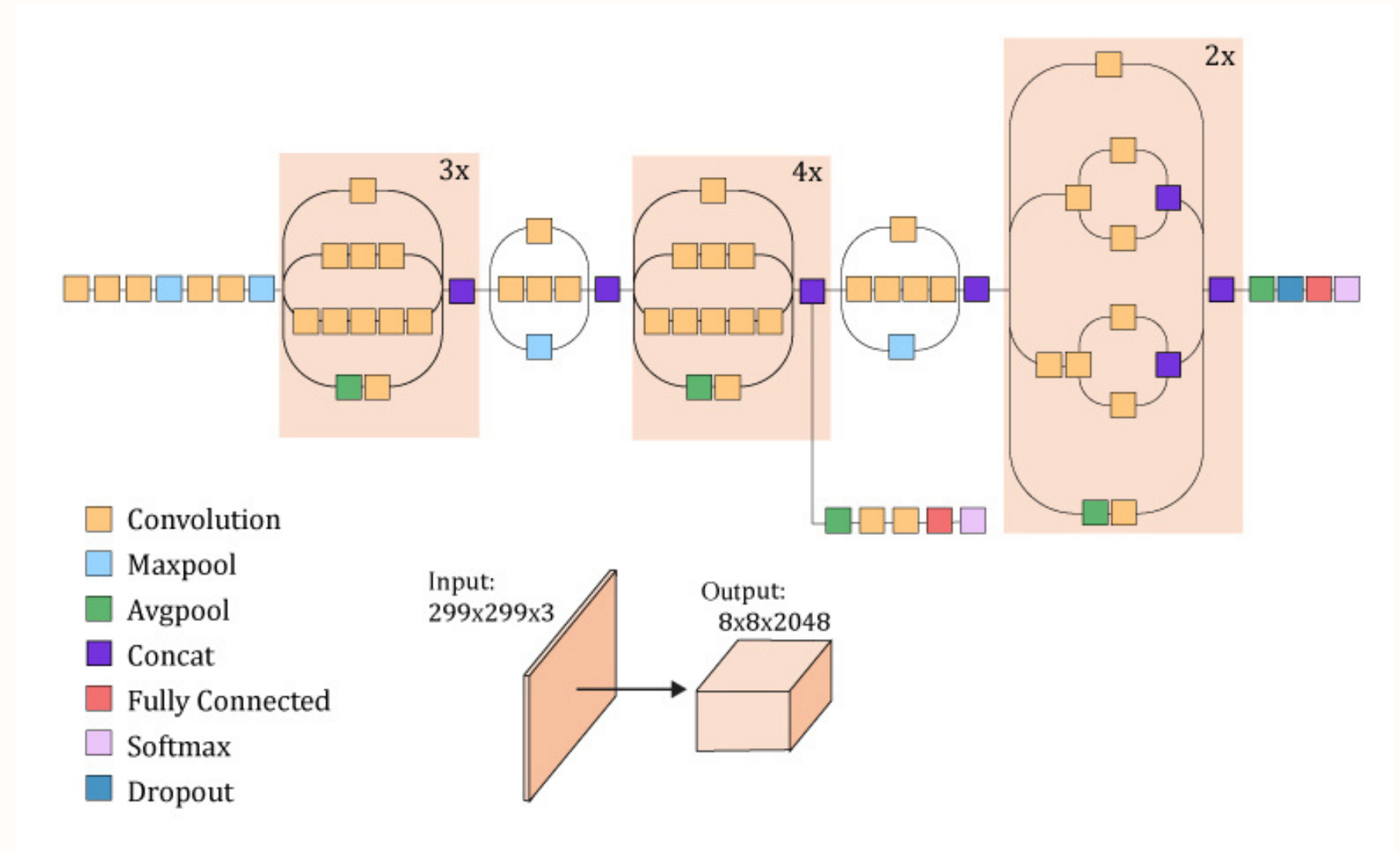
- Convolutional Neural Network (CNN)
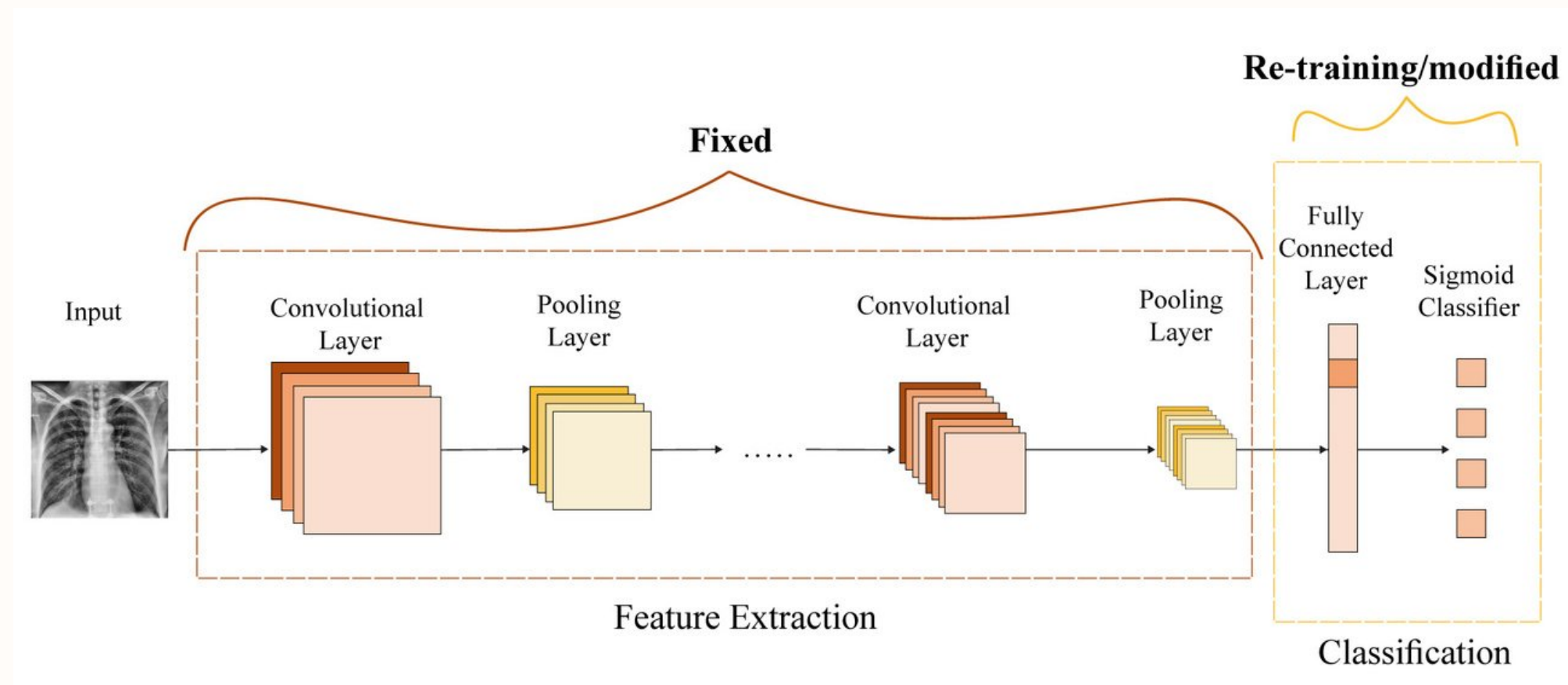
- Transfer Learning

Methodology

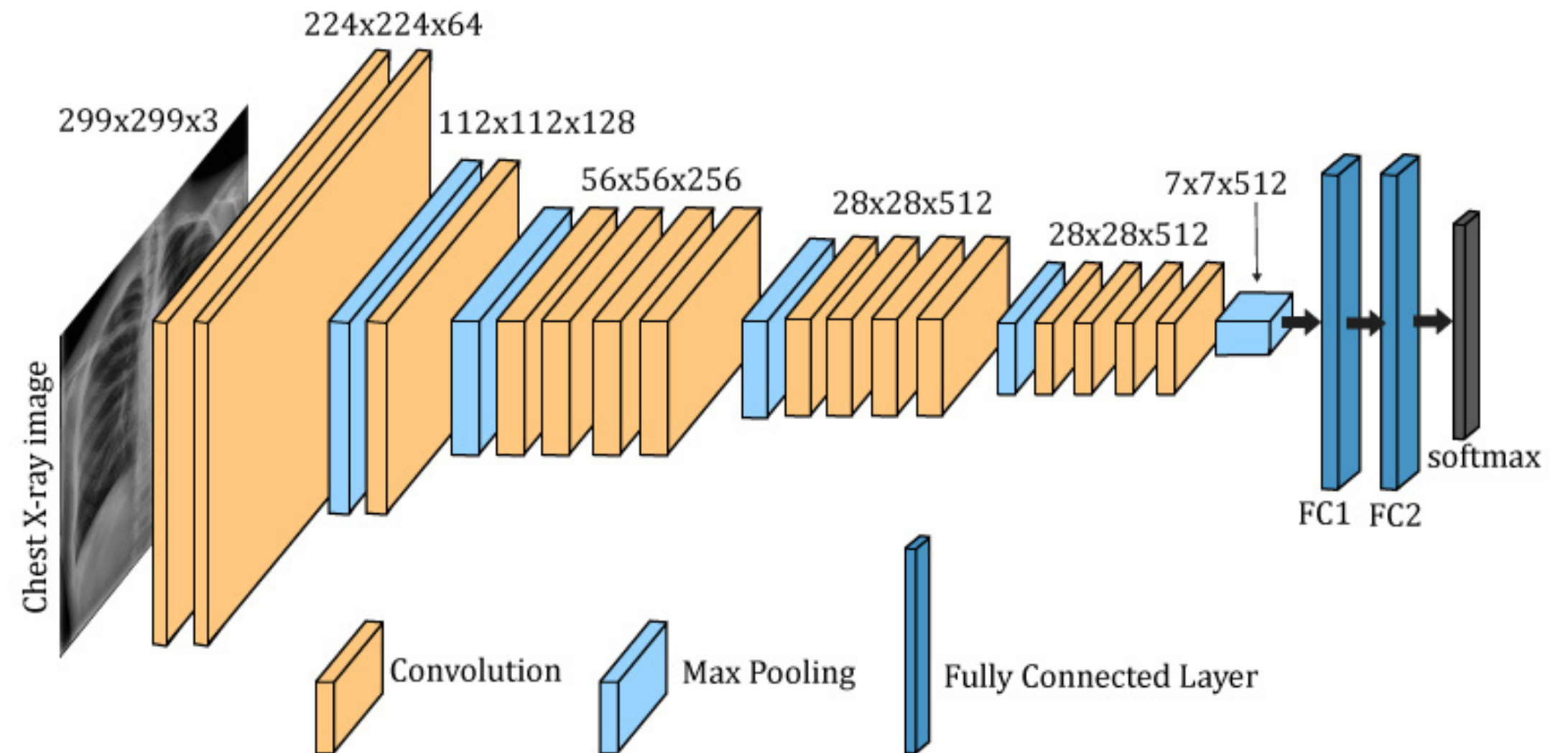● Reference CNN models for transfer learning

01 Inceptionv3

Methodology

Reference CNN models for transfer learning

02 VGG19

299x299x3

224x224x64

112x112x128

56x56x256

28x28x512

28x28x512

7x7x512

Chest X-ray image

FC1 FC2

softmax

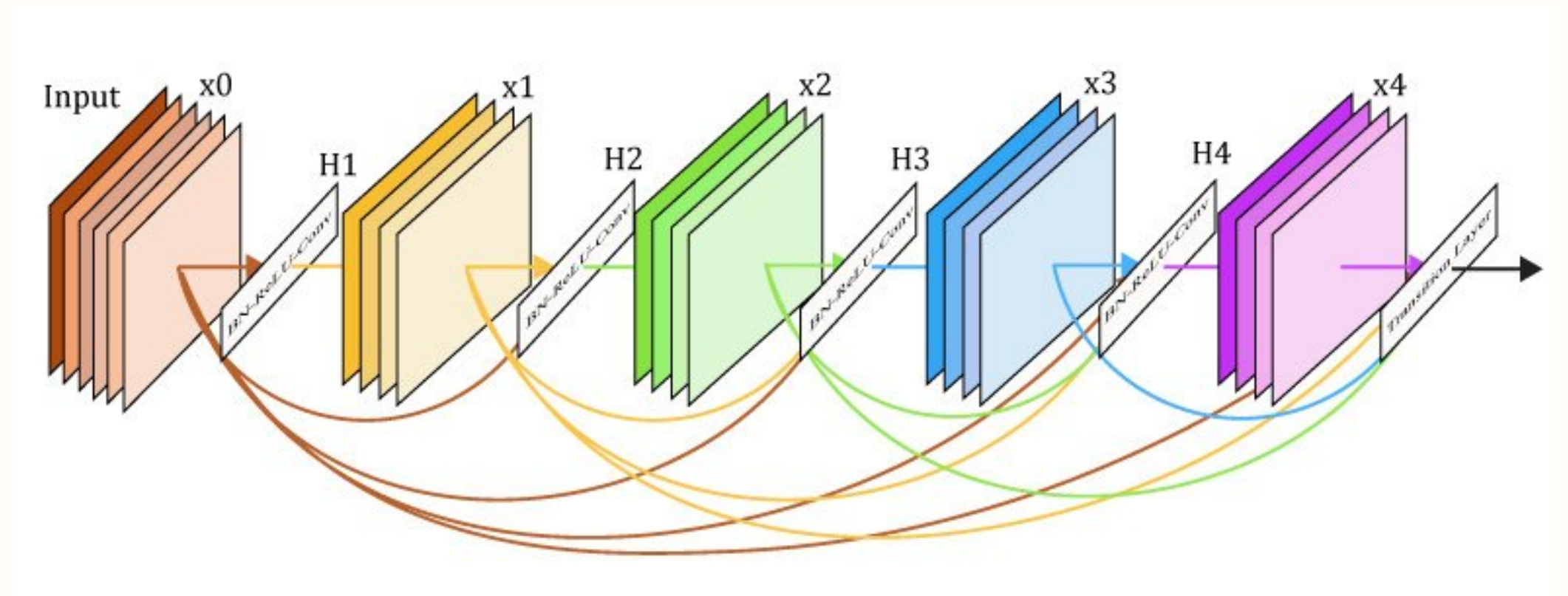Convolution   Max Pooling   Fully Connected Layer

Methodology

● **Reference CNN models for transfer learning**

03 **Densenet201**

04 **Ensembled**

Tools Used

- Google Colab platform - used for training and testing

- GPU - Tesla K80

- Keras library of TensorFlow version 2.2.0 and python 3.8 - for model formation

Methodology

Evaluation metrics

Time needed for training
of the models

Model Name	Number of epochs needed	Time needed per epoch (sec)	Total training time (hours)
InceptionV3	50	115	1.59
VGG19	50	567	7.87
Densenet201	50	127	1.76

Methodology

Evaluation metrics

Hyperparameter settings for the models

| Parameters	Model Name		
	InceptionV3	VGG19	Densenet201
Learning Rate	0.0001	0.0001	0.0001
Number of epochs	50	50	50
Training batch size	64	64	16
Validation batch size	64	64	16
Total number of parameters	25M	58M	38M
Optimizer	Adam	Adam	Adam

Result Analysis

Result Analysis

InceptionV3

- x = number of epochs
  y_{left} = accuracy
  y_{right} = loss
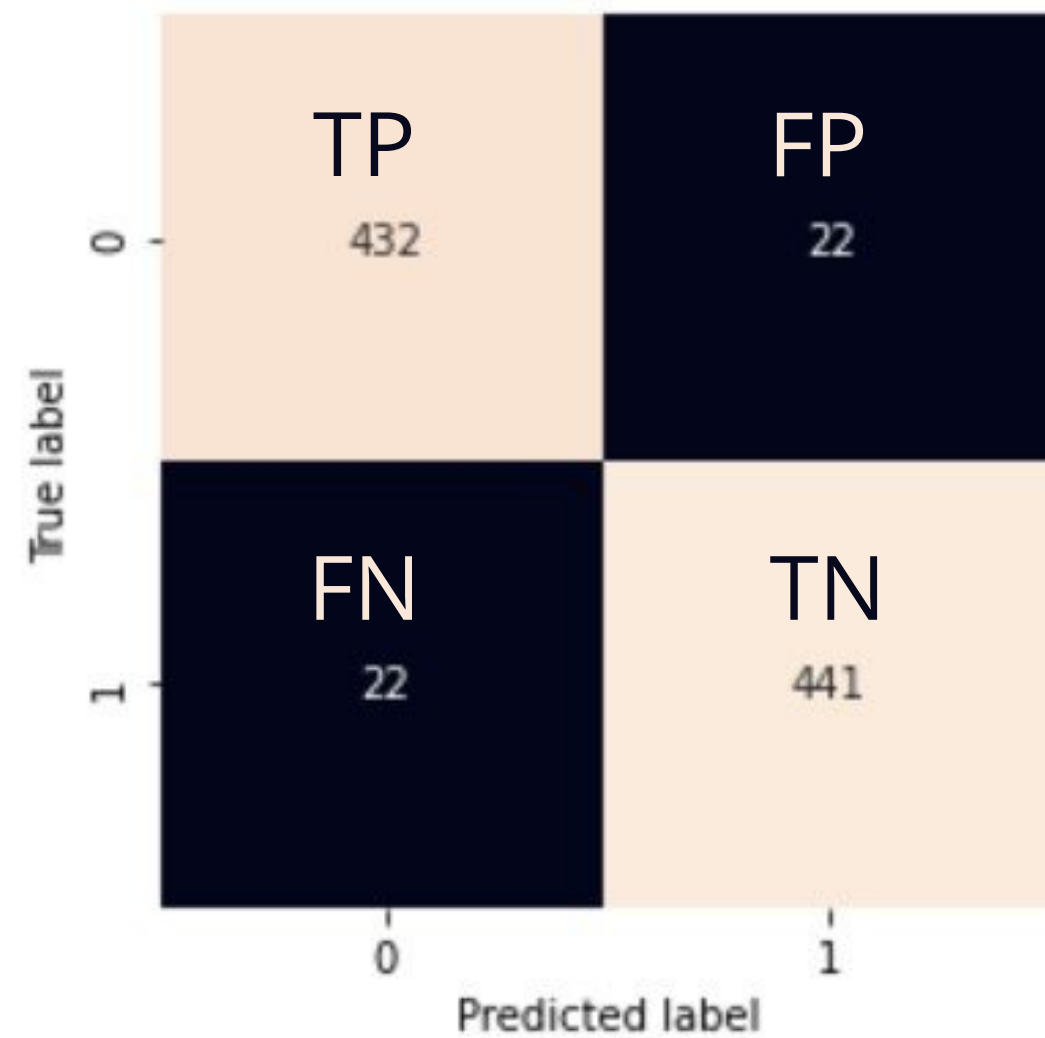
- Training and validation accuracy of InceptionV3
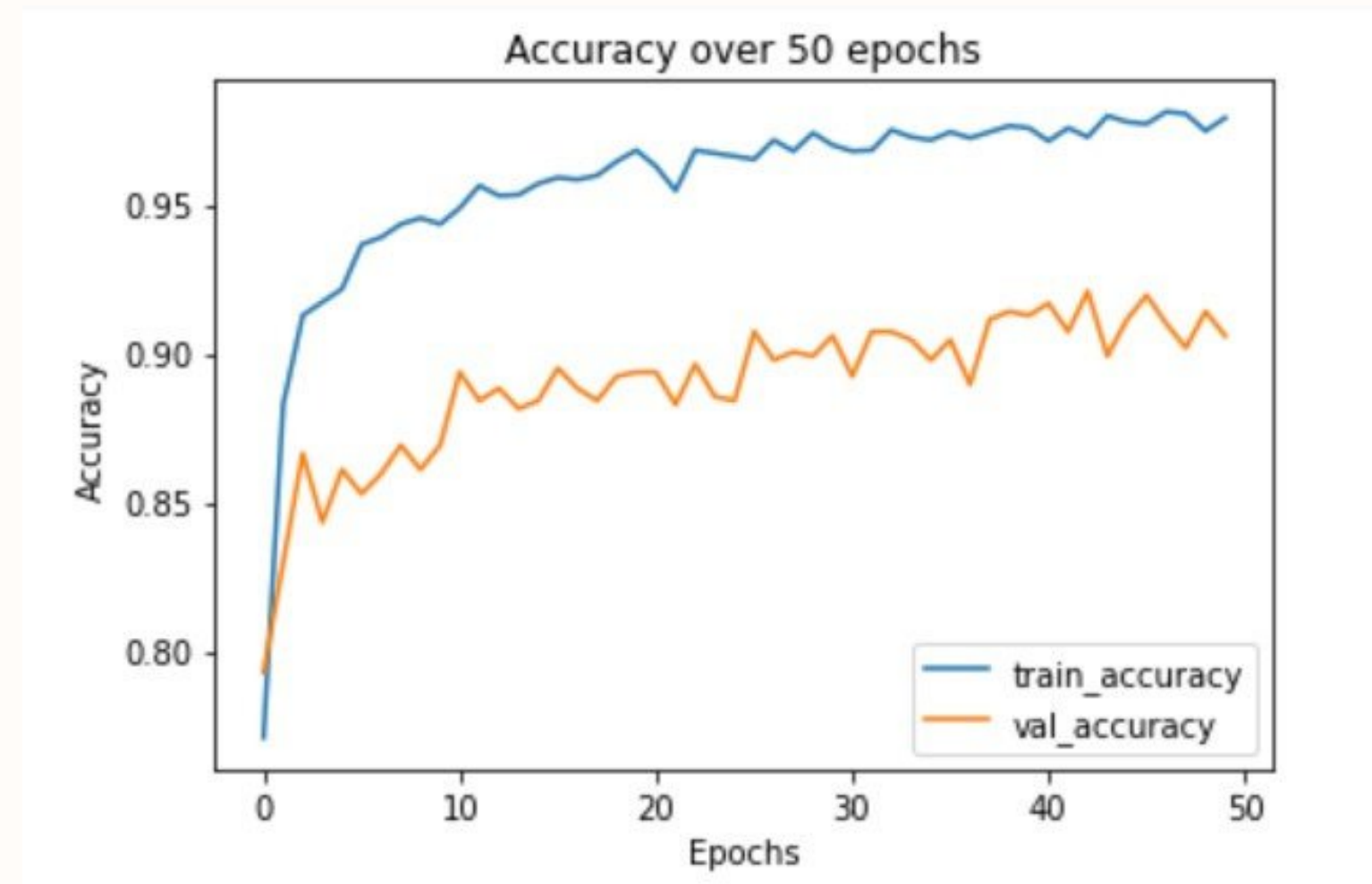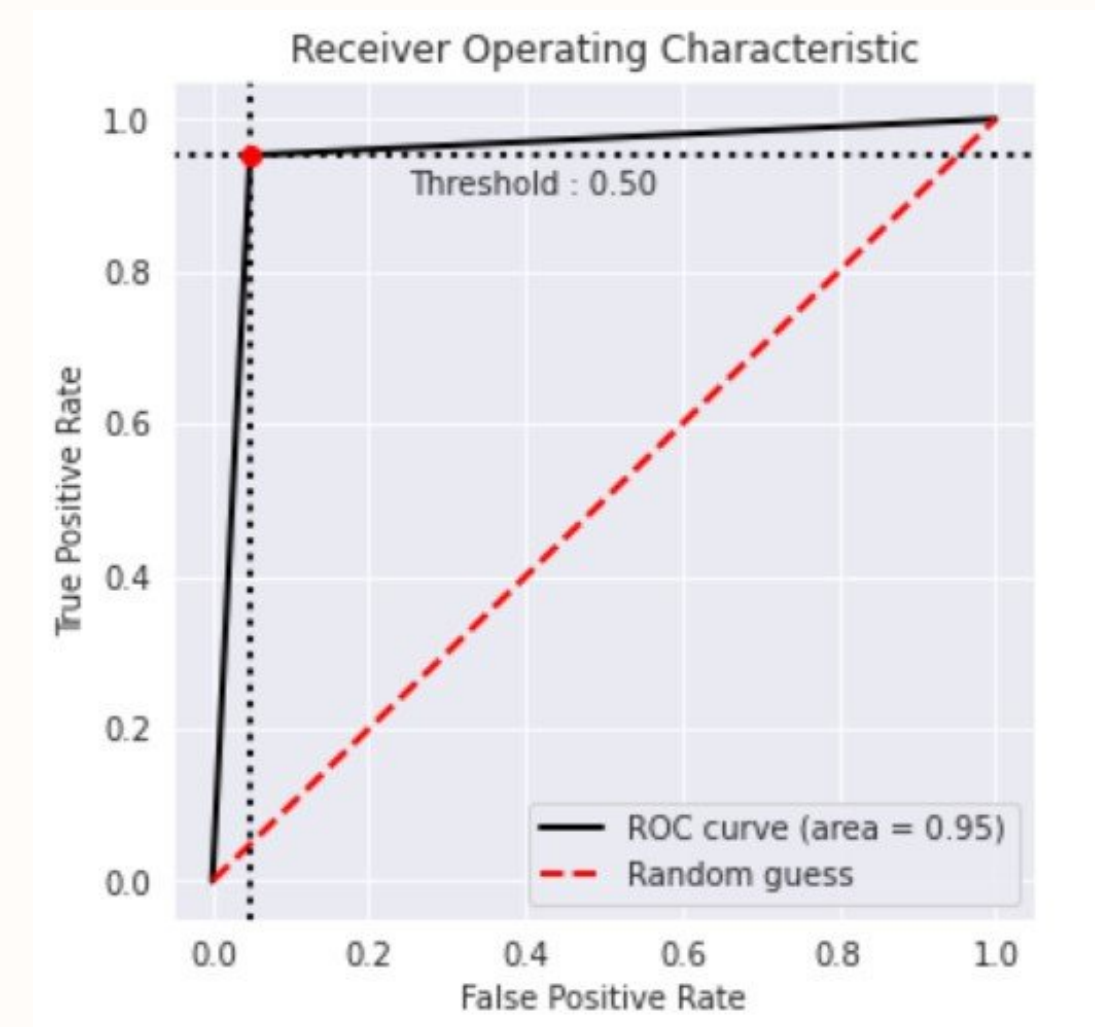
- Training and validation loss of InceptionV3
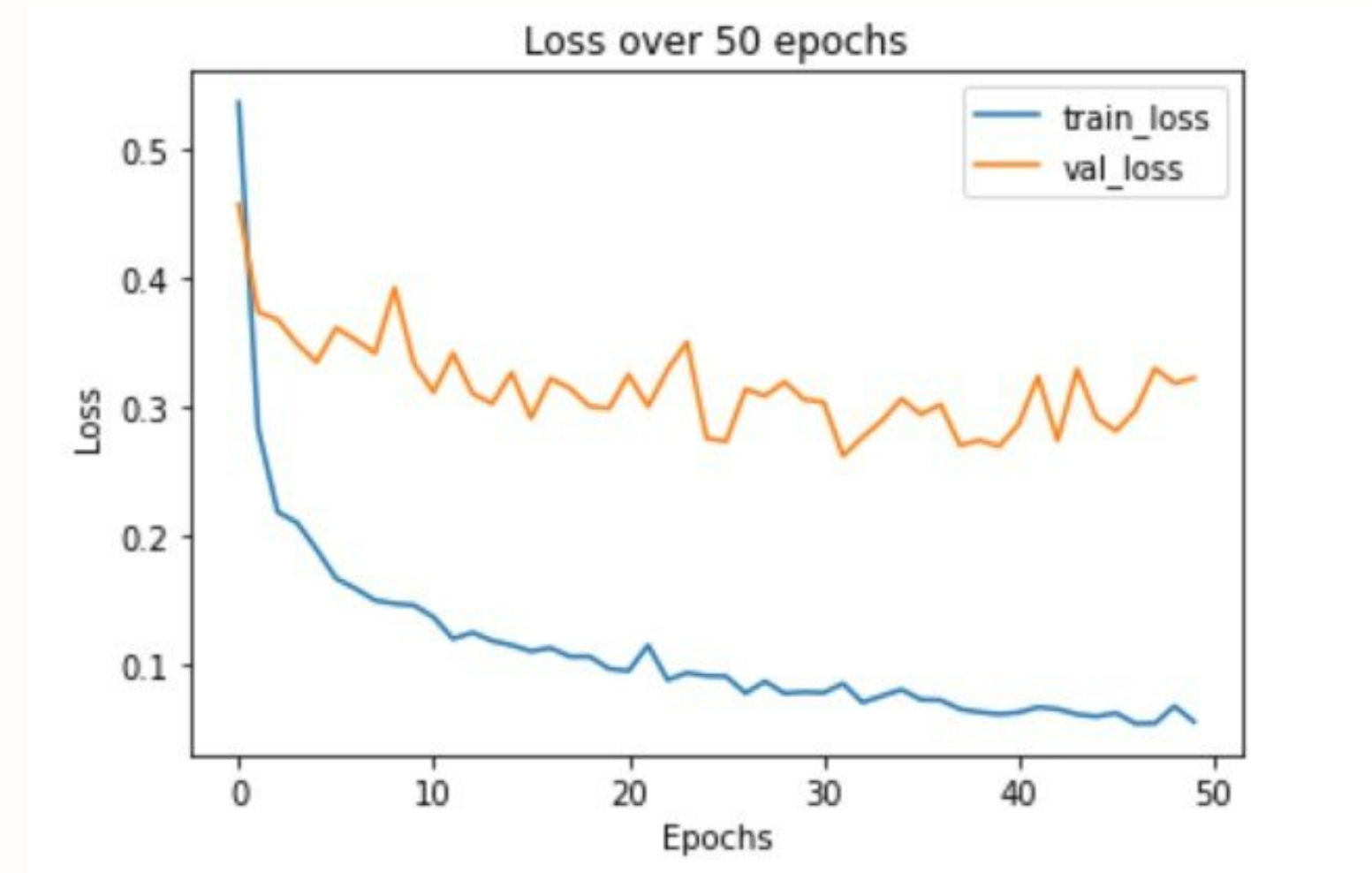
Result Analysis

InceptionV3

● Confusion Matrix

● ROC curve of InceptionV3

Result Analysis

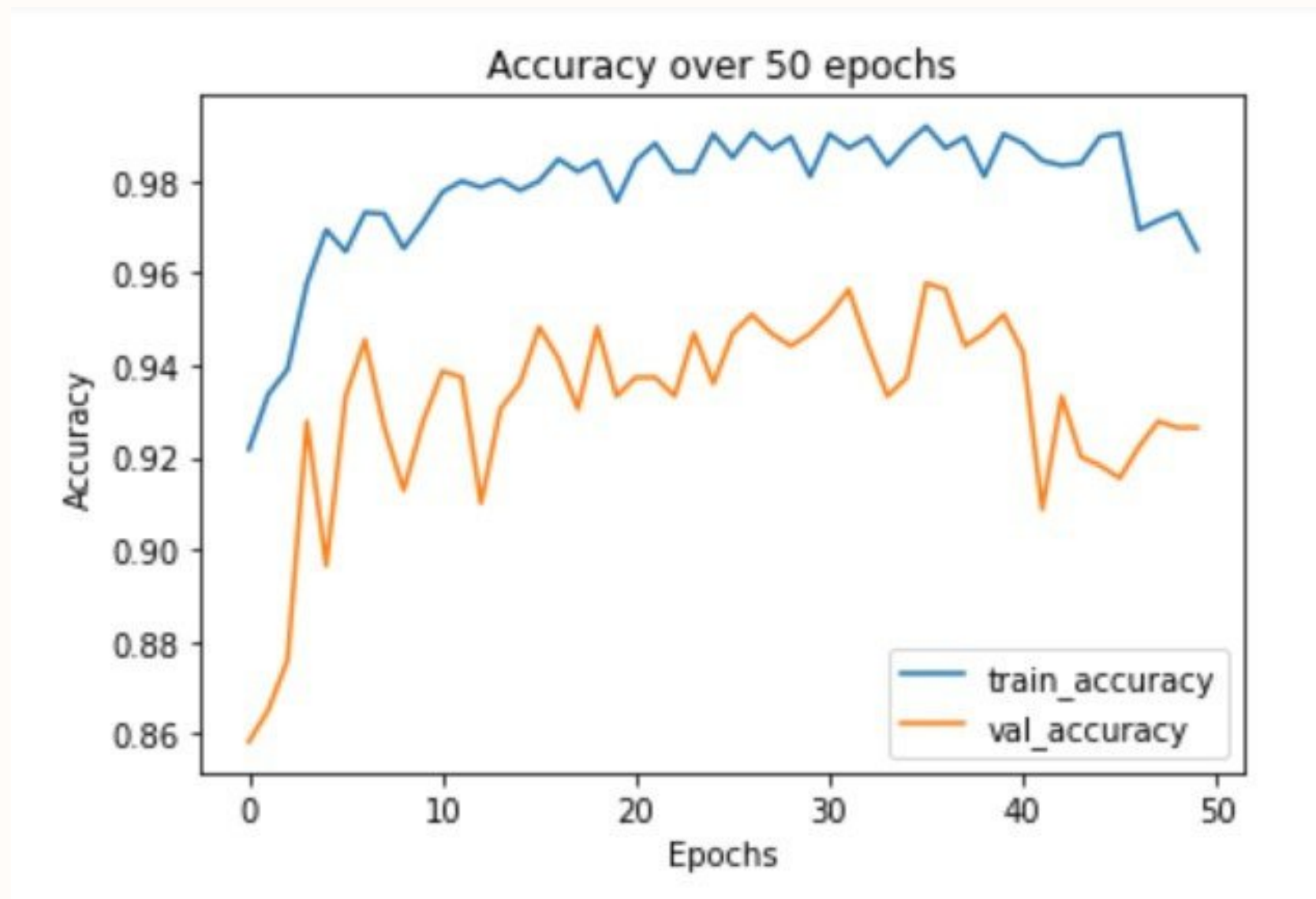## *InceptionV3*

● Classification report of InceptionV3

	precision	recall	f1-score	support
0	0.95	0.95	0.95	454
1	0.95	0.95	0.95	463
accuracy			0.95	917
macro avg	0.95	0.95	0.95	917
weighted avg	0.95	0.95	0.95	917

Result Analysis

VGG19

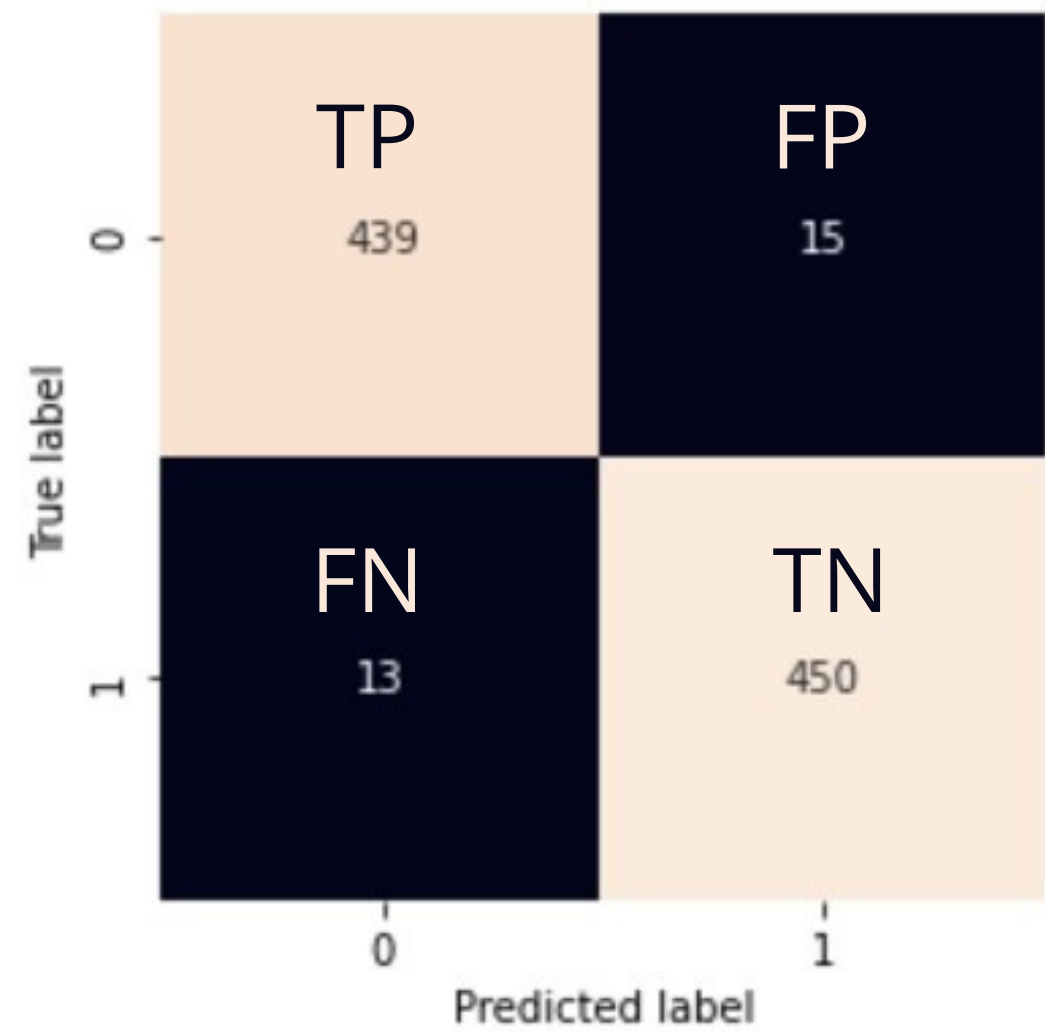- Training and Validation accuracy of VGG19

- Training and validation loss of VGG19
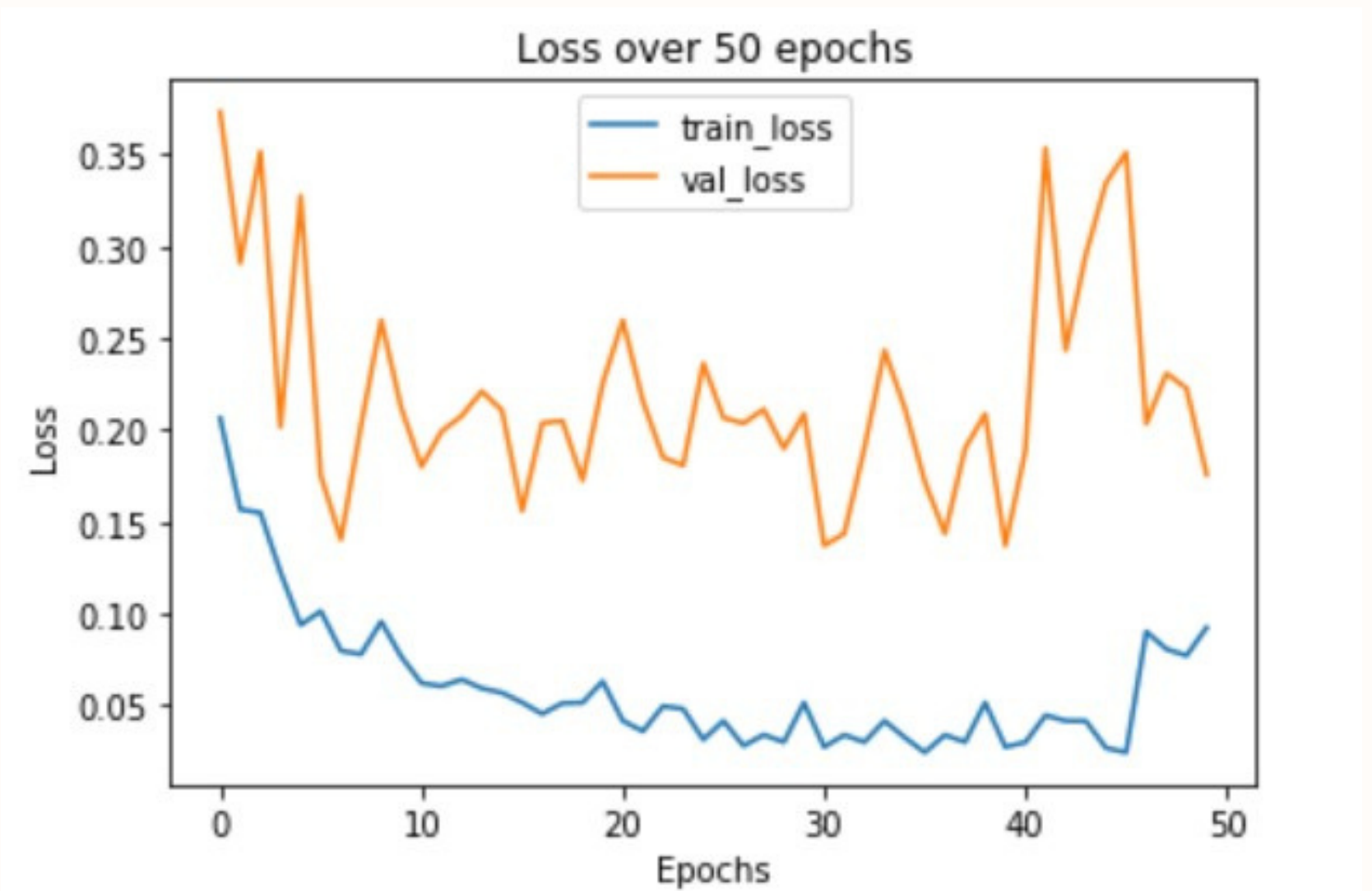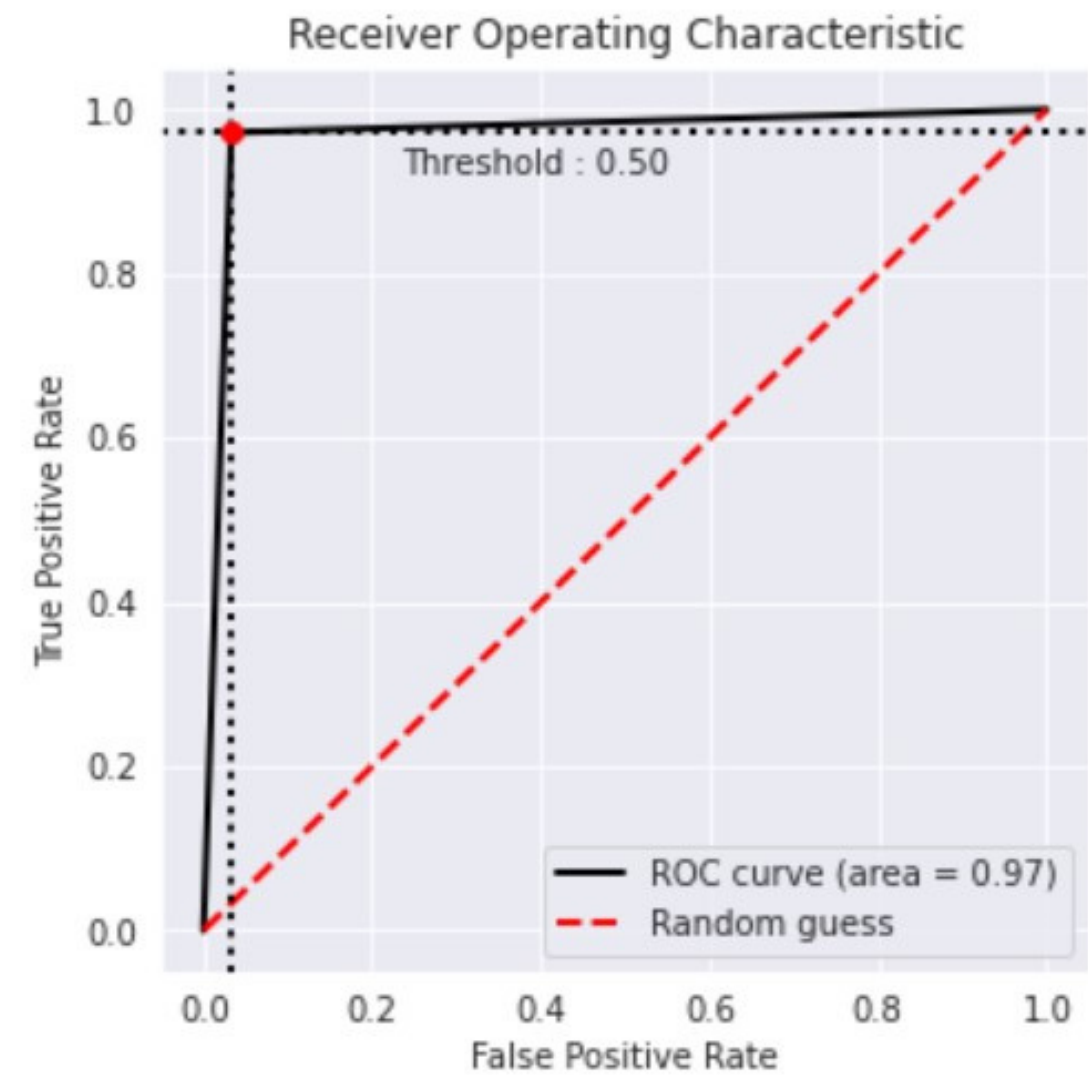
Result Analysis

VGG19

● Confusion Matrix

● ROC curve of VGG19

21

Result Analysis

VGG19

- Classification report of VGG19

	precision	recall	f1-score	support
0	0.97	0.97	0.97	454
1	0.97	0.97	0.97	463
accuracy			0.97	917
macro avg	0.97	0.97	0.97	917
weighted avg	0.97	0.97	0.97	917

Result Analysis

Densenet201

● Training and Validation accuracy of Densenet201
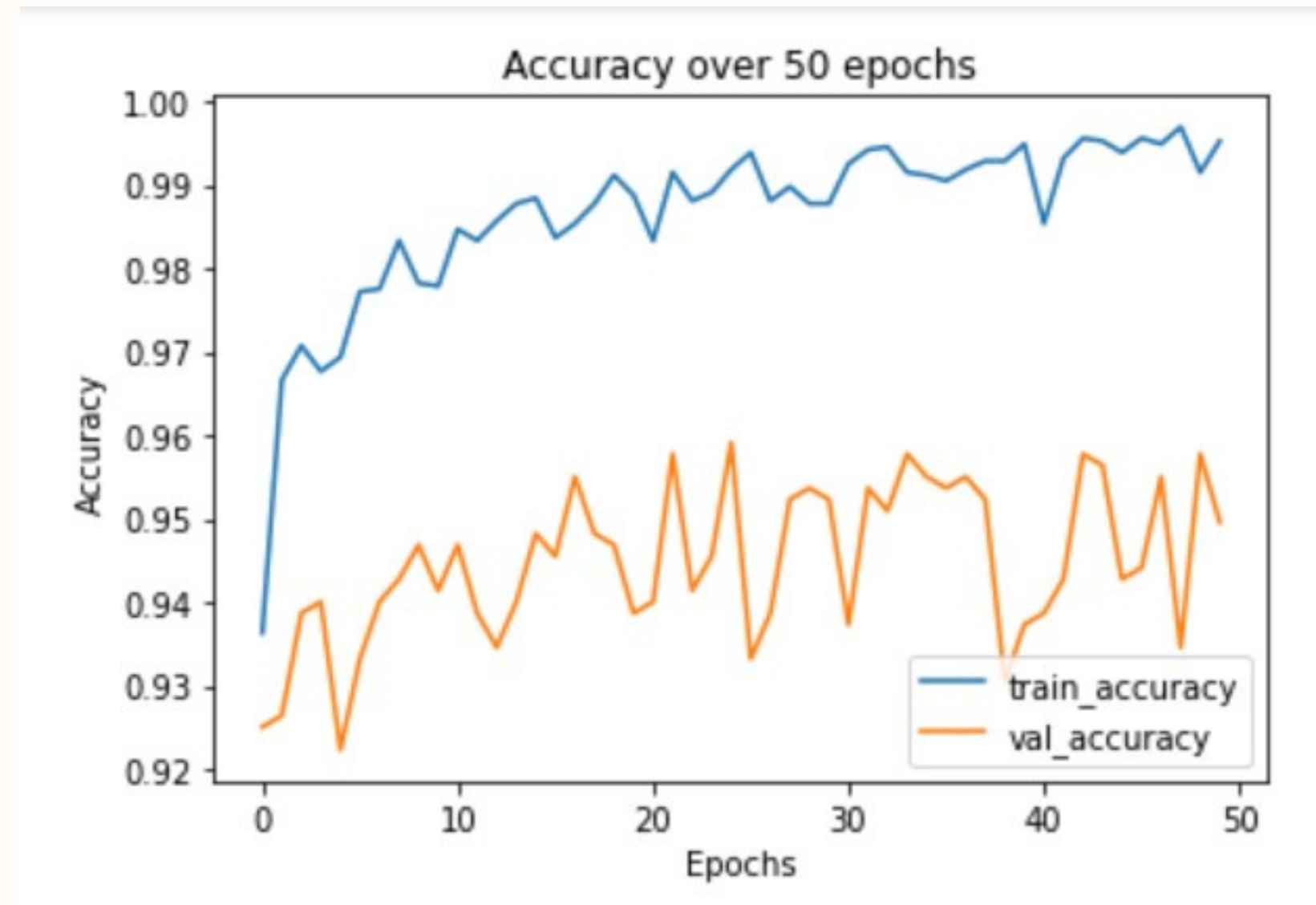
● Training and validation loss of Densenet201
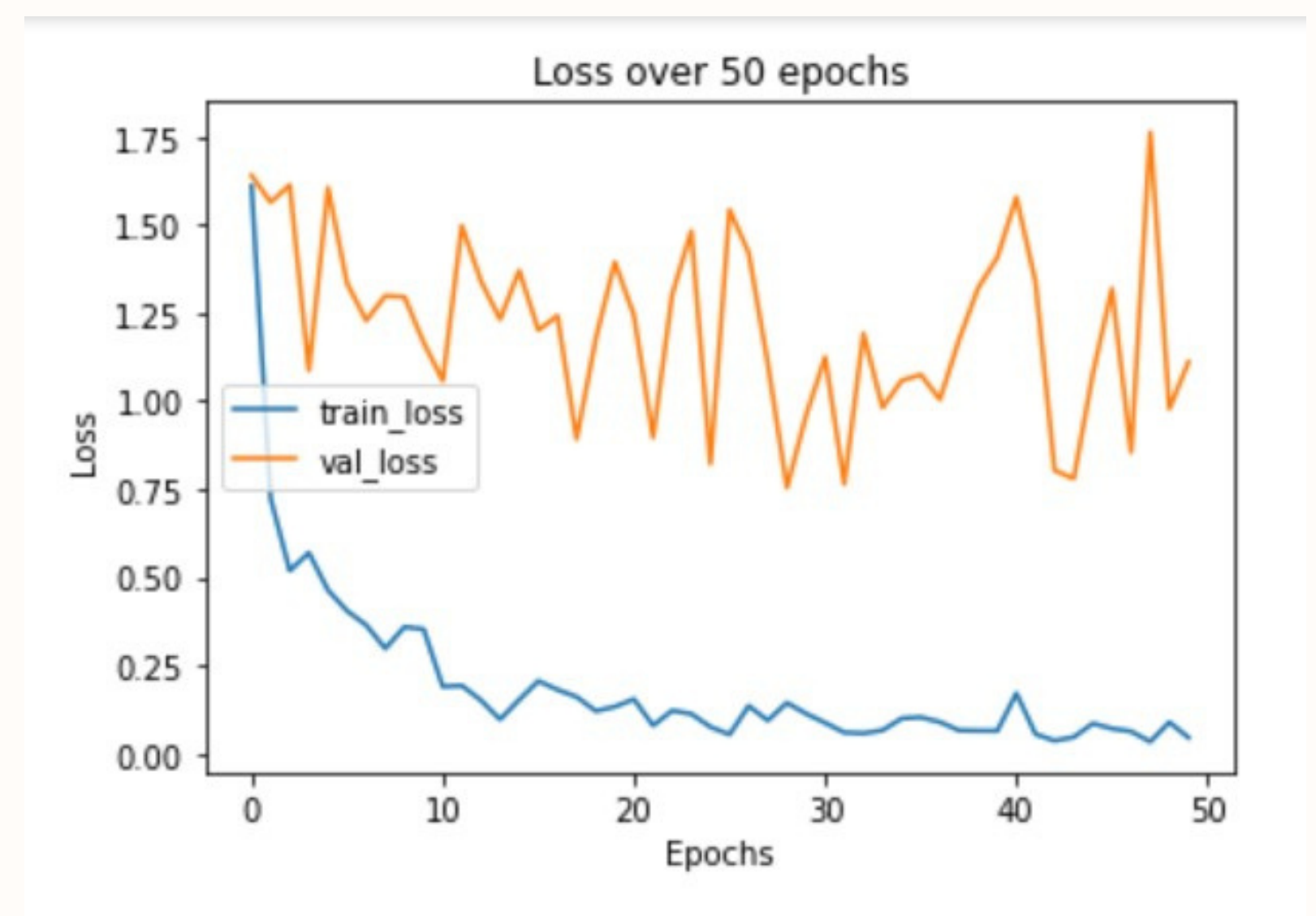
Result Analysis

Densenet201

● Confusion Matrix
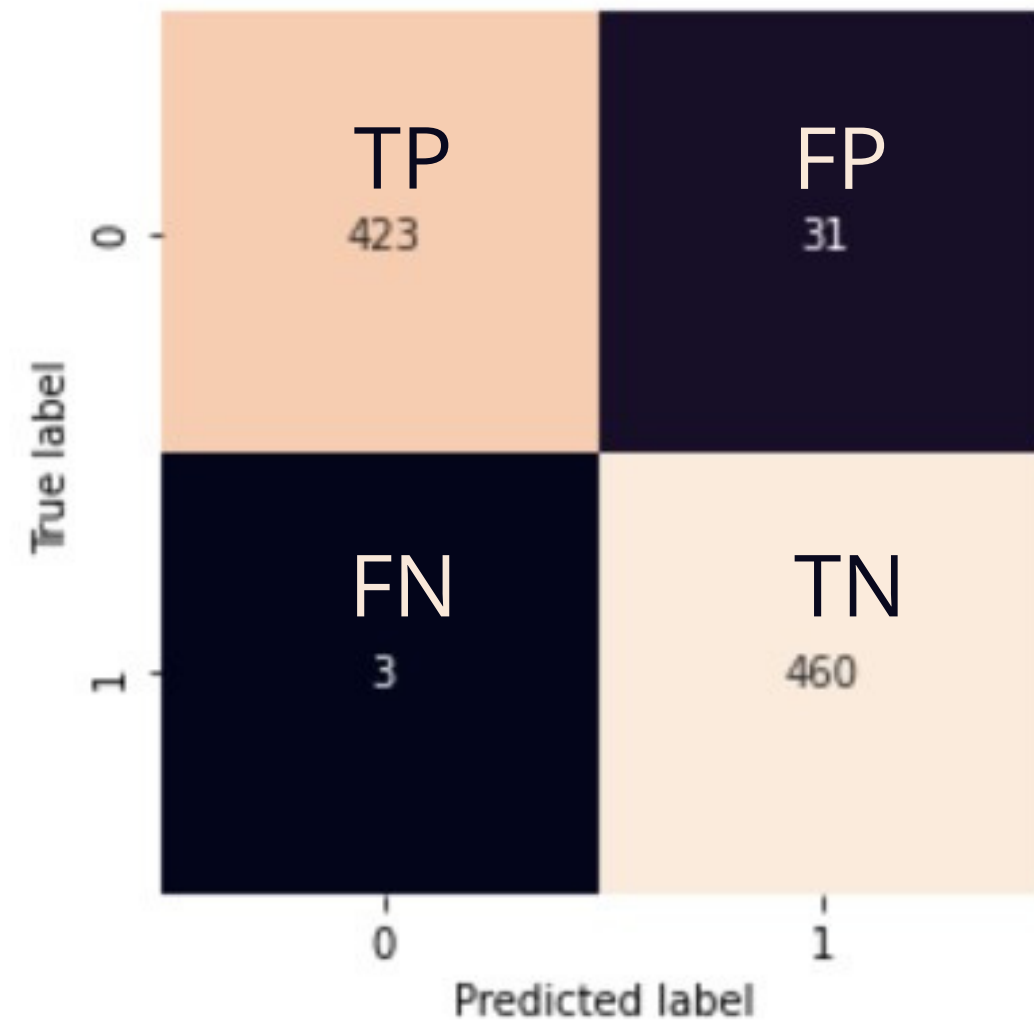
● ROC curve of Densenet201
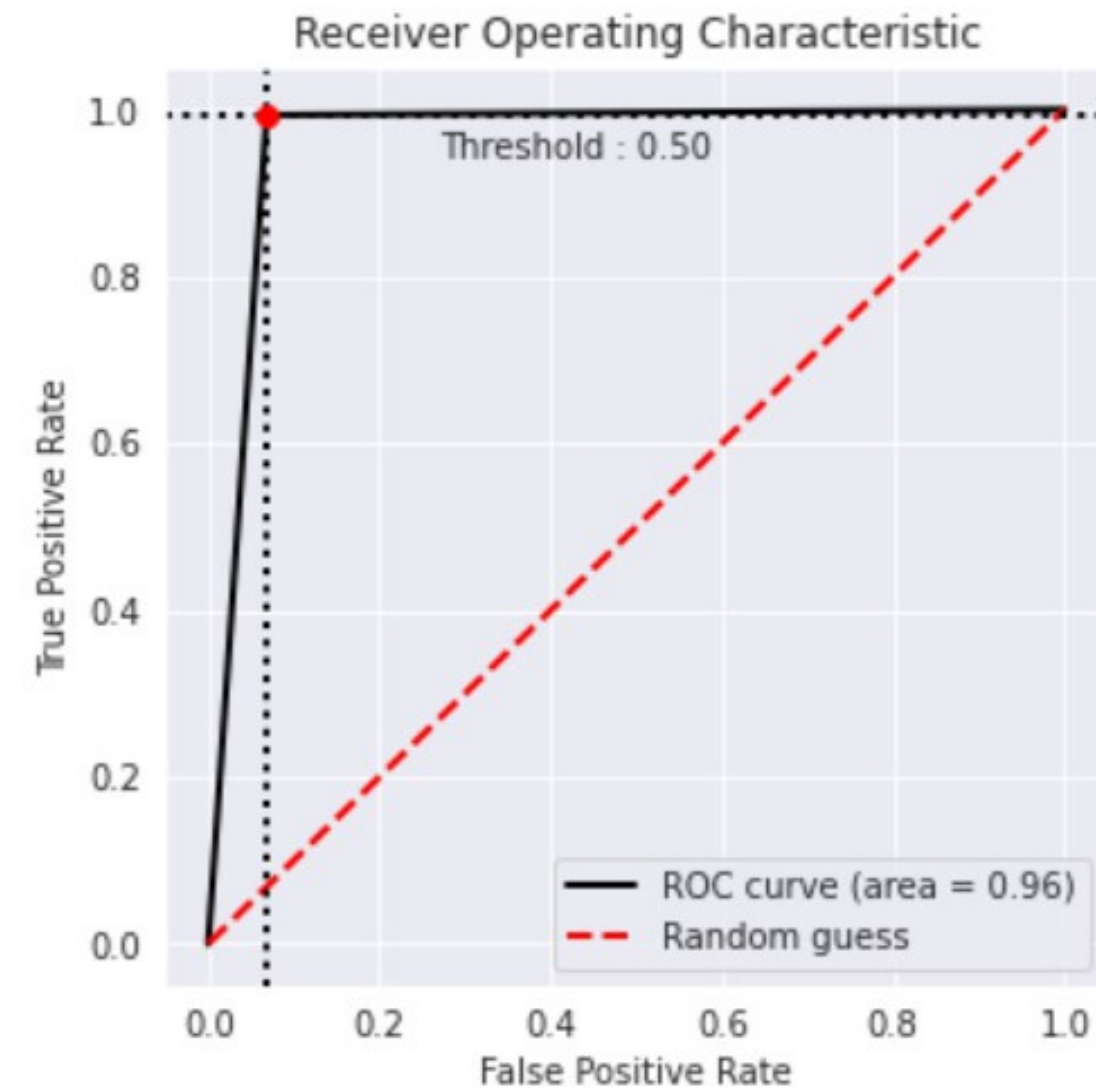
Result Analysis

Densenet201

● Classification report of Densenet201

	precision	recall	f1-score	support
0	0.99	0.93	0.96	454
1	0.94	0.99	0.96	463
accuracy			0.96	917
macro avg	0.96	0.96	0.96	917
weighted avg	0.96	0.96	0.96	917

Result Analysis

Ensemble of InceptionV3, VGG19, Densenet201

● Confusion Matrix
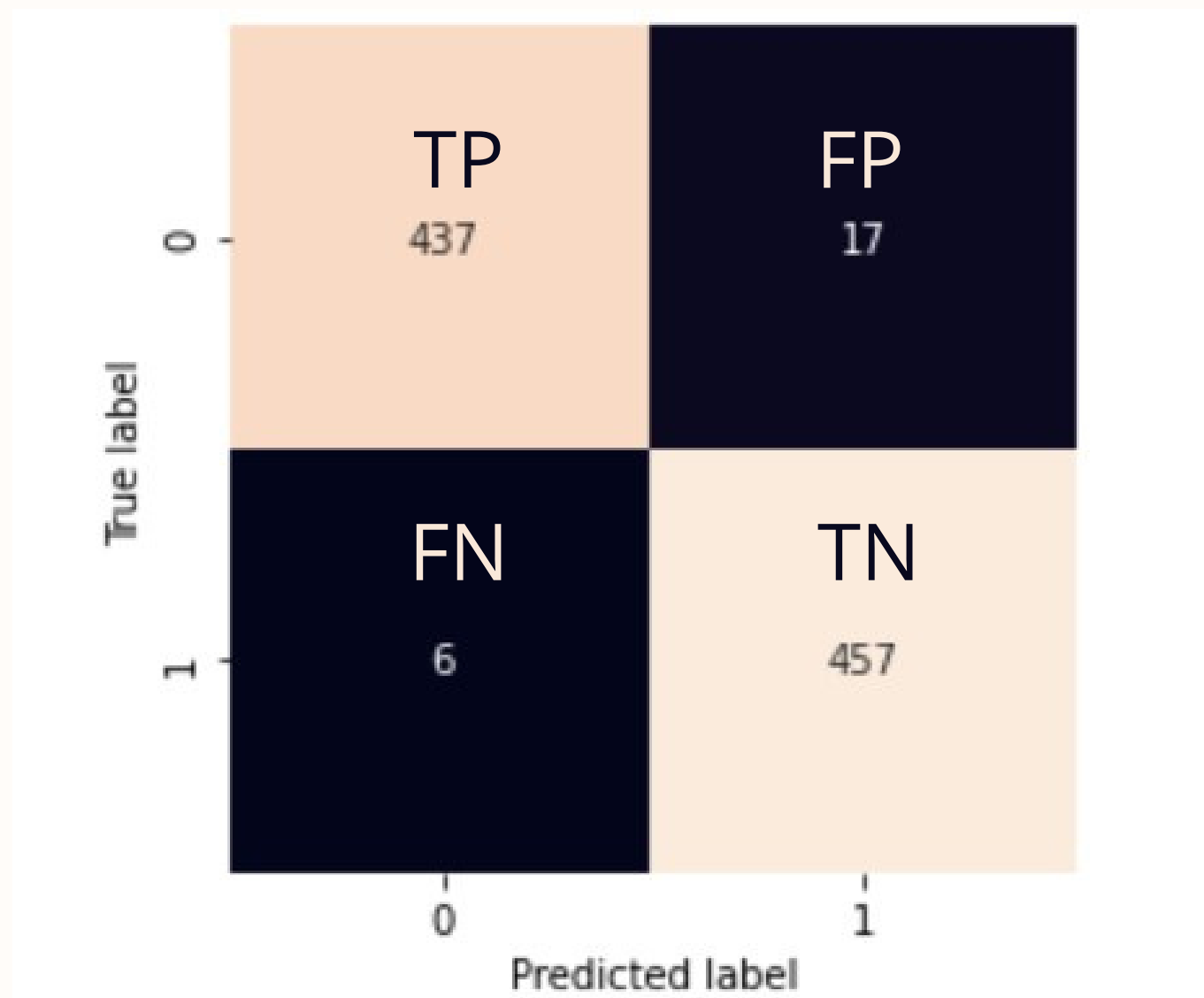
● ROC curve of Ensemble learning method
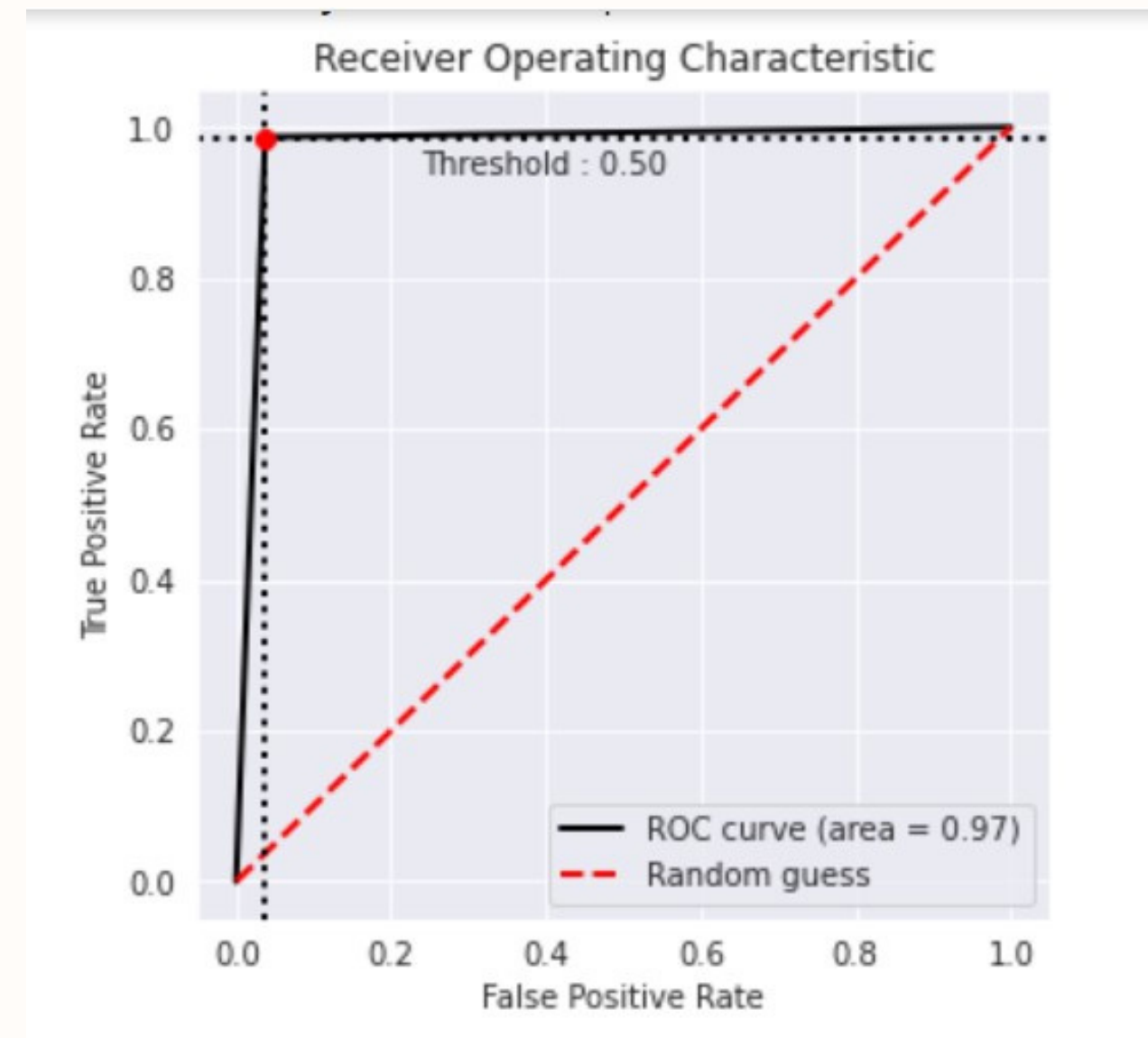
Result Analysis

Ensemble of InceptionV3, VGG19, Densenet201

● Classification report of Ensemble learning method

	precision	recall	f1-score	support
0	0.99	0.96	0.97	454
1	0.96	0.99	0.98	463
accuracy			0.97	917
macro avg	0.98	0.97	0.97	917
weighted avg	0.98	0.97	0.97	917

Result Analysis

Comparative Results and Discussions

Model	Accuracy (%)	Precision (%)	Recall (%)	F1-score (%)
InceptionV3	95.2	95.2	95.2	95.2
VGG19	96.9	97.1	96.7	96.9
Densenet201	96.7	99.3	94	96.6
Ensemble	97.5	98.6	96.3	97.4
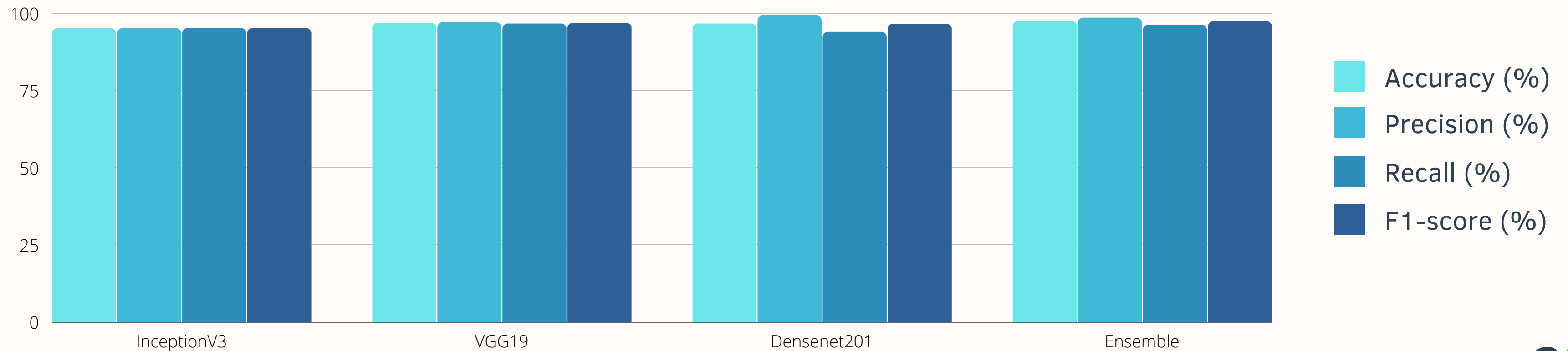
Result Analysis

Comparative Results and Discussions

Comparision with other papers

Studies	Methods	Accuracy(%)	Others(%)
[5]	ResNet50V2, InceptionV3, VGG16, VGG19, DenseNet, DeepCNN	96.03%	Precision : 96.15%, F1-score : 96.
[6]	AlexNet, DenseNet201, GoogleNet, InceptionV3, ResNet18, ResNet50, ResNet101, VGG16, VGG19, XceptionNet, Inceptionresnetv2	95.38%	Specificity : 93.47%, Sensitivity :92.29%, F1-score : 95.52,
[10]	ResNet 152, DenseNet121, ResNet152+DenseNet121, Vgg19, DeTrac, Resnet50, Xception+Resnet50	98.43%	Specificity : 99.23%, Sensitivity :98.71%.
[14]	ResNet50, InceptionV3, Inception-ResNetV2, ResNet101, ResNet152	99.7%	Recall : 99.7%, Specificity : 99.9%, Precision : 98.9%.
[15]	COVID-Net, VGG-19, ResNet-50	99.3%	Sensitivity : 91.0%, Precision : 98.9%.
[16]	VGG16, VGG19, MobileNetV2, InceptionV3 , Xception, Densenet201, InceptionResNetV2, ResNet152V2, NASNetLArge	95.88%	Specificity : 98%, Sensitivity :96%, F1-score : 96%, Precision : 96%.
This study	InceptionV3, Vgg19, Densenet201, InceptionV3+Vgg19+ DenseNet201	97.5%	Precision:99.3%, Recall:96.7% F1-Score:97.4%;

Future Works

- Collection of more data
- Improve the Recall rate and Precision
- Explore more pre-trained models
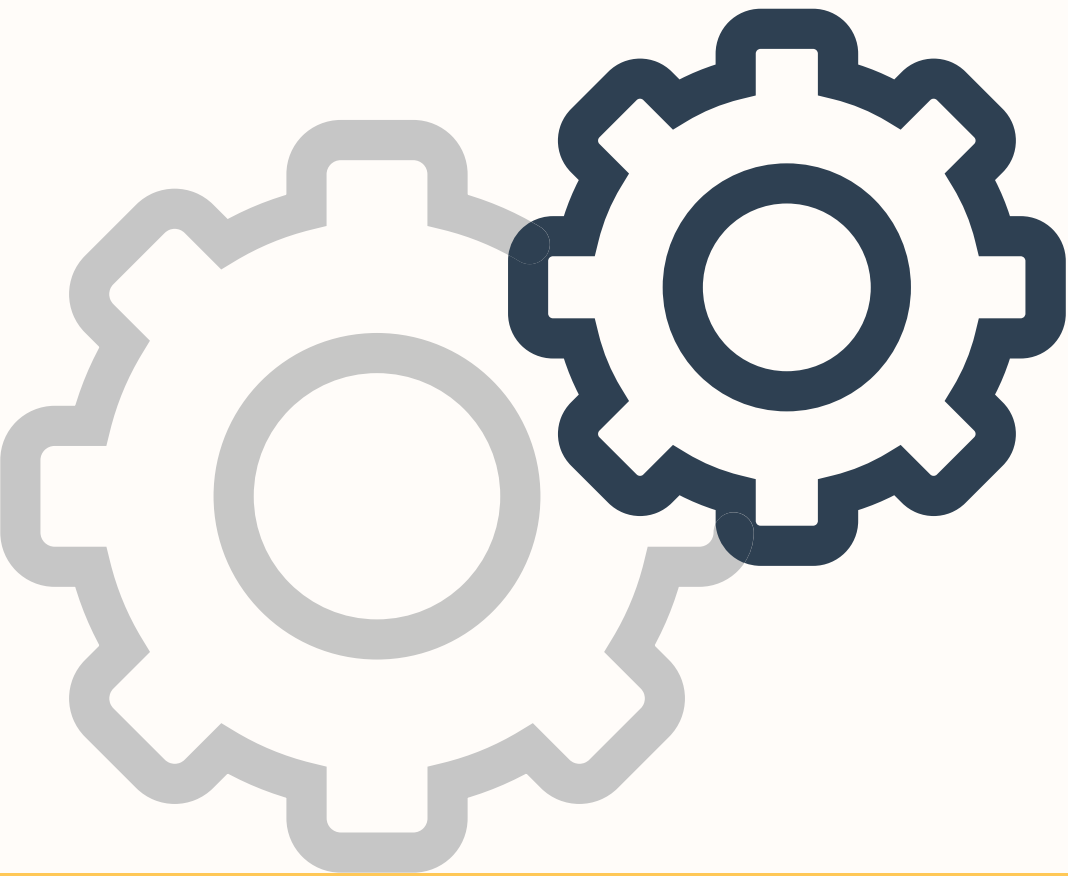
Conclusion

Taking all of the limitations and constraints in mind we have come up with the idea of our proposed system which is to detect covid19 using chest x ray images. We believe that our proposed system will go a long way in achieving this goal and will help doctors and medical personnel and will add a significant value to the medical field.

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Thank You