Visual Plant Disease Detection

using Deep Learning, Machine Learning & eXplainble AI techniques

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01
INTRODUCTION

Introduction

Plant diseases classification is an important task in agriculture since there is a big variety of plants and their diseases. Some diseases can not be cured, and the only solution is to cut the diseased plant otherwise the whole plantation can be destroyed. Early detection of these diseases is crucial to prevent their spread and minimize the damage.

02

DATASET
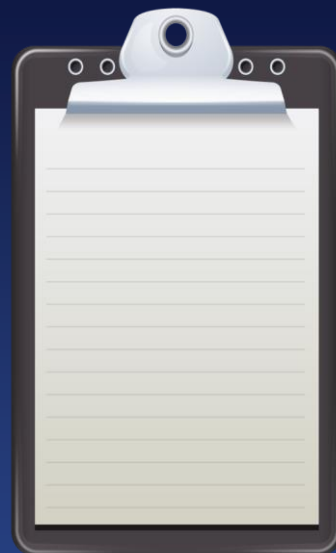
New Plant Diseases Dataset

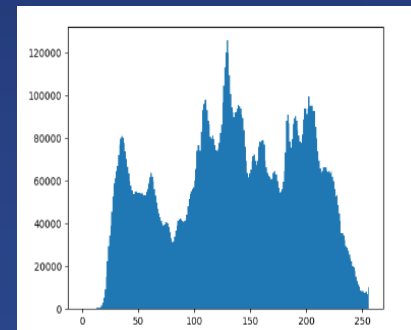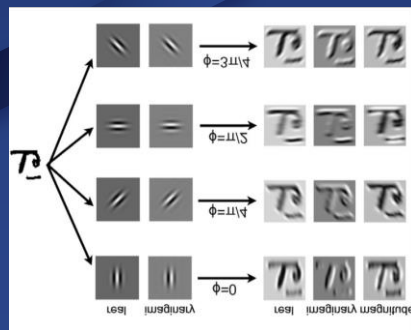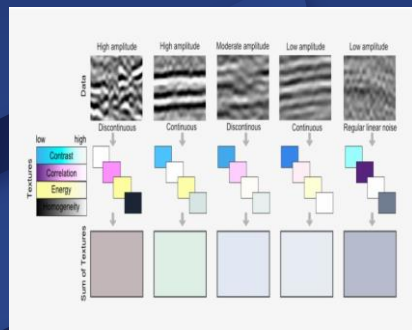- 54.305 samples
- 38 classes
- Imbalanced distribution

Imbalanced learn

03
MACHINE LEARNING

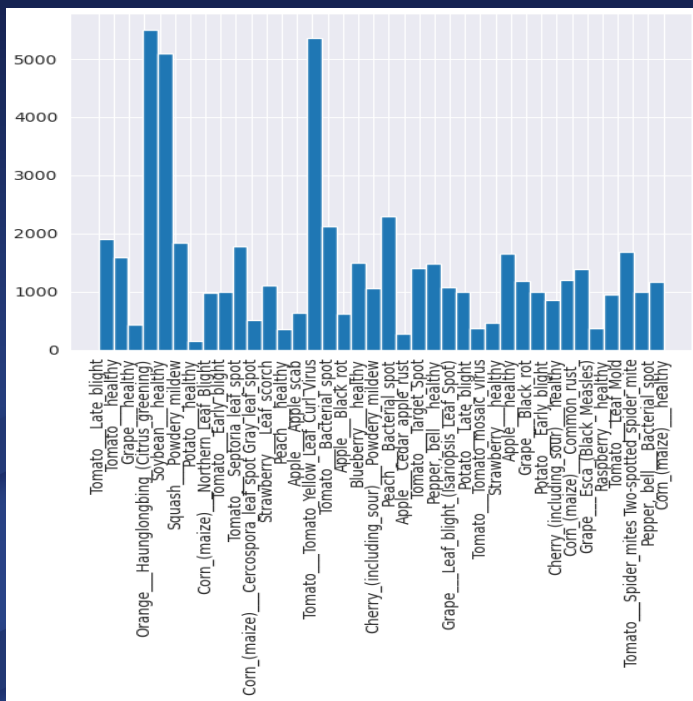# Features Extraction

Haralick Texture Features

Gabor Features

Shape Features

Color Features

Data Exploration

Dataset shape = (54304, 564)

Orange___Haunglongbing_(Citrus_greening)	5507
Tomato___Tomato_Yellow_Leaf_Curl_Virus	5357
Soybean___healthy	5090
Peach___Bacterial_spot	2297
Tomato___Bacterial_spot	2127
Tomato___Late_blight	1909
Squash___Powdery_mildew	1835
Tomato___Septoria_leaf_spot	1771
Tomato___Spider_mites Two-spotted_spider_mite	1676
Apple___healthy	1645
Tomato___healthy	1591
Blueberry___healthy	1502
Pepper,_bell___healthy	1478
Tomato___Target_Spot	1404
Grape___Esca_(Black_Measles)	1383
Corn_(maize)___Common_rust_	1192
Grape___Black_rot	1180
Corn_(maize)___healthy	1162
Strawberry___Leaf_scorch	1109
Grape___Leaf_blight_(Isariopsis_Leaf_Spot)	1076
Cherry_(including_sour)___Powdery_mildew	1052
Tomato___Early_blight	1000
Potato___Late_blight	1000
Potato___Early_blight	1000
Pepper,_bell___Bacterial_spot	997
Corn_(maize)___Northern_Leaf_Blight	985
Tomato___Leaf_Mold	952
Cherry_(including_sour)___healthy	854
Apple___Apple_scab	630
Apple___Black_rot	621
Corn_(maize)___Cercospora_leaf_spot Gray_leaf_spot	513
Strawberry___healthy	456
Grape___healthy	423
Tomato___Tomato_mosaic_virus	373
Raspberry___healthy	371
Peach___healthy	360
Apple___Cedar_apple_rust	275
Potato___healthy	152

Data Preprocessing

Data Scaling

Over – Sampling

Under - Sampling

	Before SMOTE	After SMOTE	UNDERSAMPLING
Orange___Haunglongbing_(Citrus_greening)	4390	4390	1000
Tomato___Tomato_Yellow_Leaf_Curl_Virus	4318	4390	1000
Soybean___healthy	4064	4390	1000
Peach___Bacterial_spot	1870	4390	1000
Tomato___Bacterial_spot	1705	4390	1000
Tomato___Late_blight	1534	4390	1000
Squash___Powdery_mildew	1479	4390	1000
Tomato___Septoria_leaf_spot	1387	4390	1000
Tomato___Spider_mites Two-spotted_spider_mite	1344	4390	1000
Tomato___healthy	1313	4390	1000
Apple___healthy	1271	4390	1000
Blueberry___healthy	1214	4390	1000
Pepper,_bell___healthy	1199	4390	1000
Tomato___Target_Spot	1115	4390	1000
Grape___Esca_(Black_Measles)	1096	4390	1000
Grape___Black_rot	956	4390	1000
Corn_(maize)___Common_rust_	944	4390	1000
Corn_(maize)___healthy	931	4390	1000
Strawberry___Leaf_scorch	875	4390	1000
Grape___Leaf_blight_(Isariopsis_Leaf_Spot)	867	4390	1000
Cherry_(including_sour)___Powdery_mildew	842	4390	1000
Potato___Late_blight	816	4390	1000
Pepper,_bell___Bacterial_spot	800	4390	1000
Tomato___Early_blight	793	4390	1000
Corn_(maize)___Northern_Leaf_Blight	791	4390	1000
Potato___Early_blight	791	4390	1000
Tomato___Leaf_Mold	744	4390	1000
Cherry_(including_sour)___healthy	676	4390	1000
Apple___Black_rot	504	4390	1000
Apple___Apple_scab	502	4390	1000
Corn_(maize)___Cercospora_leaf_spot Gray_leaf_spot	399	4390	1000
Strawberry___healthy	366	4390	1000
Grape___healthy	342	4390	1000
Raspberry___healthy	293	4390	1000
Tomato___Tomato_mosaic_virus	290	4390	1000
Peach___healthy	280	4390	1000
Apple___Cedar_apple_rust	223	4390	1000
Potato___healthy	119	4390	1000

Classification Reports without SMOTE

Classification Reports with SMOTE

	Random Forest			KNN			SVM		
	precision	recall	f1-score	precision	recall	f1-score	precision	recall	f1-score
Apple___Apple_scab	0.82	0.81	0.82	0.67	0.6	0.63	0.66	0.84	0.74
Apple___Black_rot	0.93	0.93	0.93	0.71	0.84	0.77	0.89	0.96	0.92
Apple___Cedar_apple_rust	0.84	0.94	0.89	0.4	0.67	0.5	0.66	0.94	0.78
Apple___healthy	0.9	0.91	0.91	0.91	0.83	0.87	0.91	0.88	0.89
Blueberry___healthy	0.87	0.96	0.91	0.92	0.95	0.93	0.92	0.96	0.94
Cherry_(including_sour)___Powdery_mildew	0.89	0.96	0.92	0.77	0.84	0.8	0.82	0.91	0.86
Cherry_(including_sour)___healthy	0.88	0.95	0.92	0.8	0.89	0.84	0.95	0.99	0.97
Corn_(maize)___Cercospora_leaf_spot Gray_leaf_spot	0.76	0.71	0.73	0.62	0.76	0.68	0.63	0.87	0.73
Corn_(maize)___Common_rust_	1	0.99	0.99	0.99	0.98	0.98	1	0.99	0.99
Corn_(maize)___Northern_Leaf_Blight	0.84	0.87	0.85	0.86	0.67	0.75	0.92	0.79	0.85
Corn_(maize)___healthy	0.96	1	0.98	0.99	0.94	0.96	0.97	0.97	0.97
Grape___Black_rot	0.89	0.89	0.89	0.73	0.82	0.77	0.83	0.89	0.86
Grape___Esca_(Black_Measles)	0.99	0.95	0.97	0.95	0.93	0.94	0.95	0.94	0.95
Grape___Leaf_blight_(Isariopsis_Leaf_Spot)	0.91	0.95	0.93	0.85	0.98	0.91	0.94	0.96	0.95
Grape___healthy	0.77	0.93	0.84	0.52	0.91	0.67	0.75	0.99	0.85
Orange___Haunglongbing_(Citrus_greening)	0.96	0.96	0.96	0.98	0.85	0.91	0.97	0.92	0.95
Peach___Bacterial_spot	0.94	0.86	0.9	0.9	0.88	0.89	0.9	0.9	0.9
Peach___healthy	0.95	0.97	0.96	0.85	0.95	0.9	0.99	0.95	0.97
Pepper,_bell___Bacterial_spot	0.93	0.94	0.93	0.74	0.83	0.78	0.86	0.91	0.88
Pepper,_bell___healthy	0.82	0.89	0.85	0.73	0.75	0.74	0.86	0.88	0.87
Potato___Early_blight	0.93	0.93	0.93	0.9	0.92	0.91	0.95	0.97	0.96
Potato___Late_blight	0.77	0.93	0.84	0.76	0.89	0.82	0.81	0.83	0.82
Potato___healthy	0.81	0.79	0.8	0.51	0.82	0.63	0.76	0.85	0.8
Raspberry___healthy	0.79	0.94	0.86	0.73	0.9	0.8	0.97	0.94	0.95
Soybean___healthy	0.96	0.92	0.94	0.98	0.86	0.92	0.98	0.93	0.96
Squash___Powdery_mildew	0.97	0.98	0.97	0.96	0.92	0.94	0.97	0.98	0.97
Strawberry___Leaf_scorch	1	0.97	0.99	0.95	0.91	0.93	0.97	0.97	0.97
Strawberry___healthy	0.94	0.93	0.94	0.77	0.94	0.85	0.97	0.94	0.96
Tomato___Bacterial_spot	0.88	0.91	0.9	0.82	0.9	0.86	0.9	0.93	0.91
Tomato___Early_blight	0.84	0.82	0.83	0.72	0.82	0.76	0.78	0.84	0.81
Tomato___Late_blight	0.92	0.82	0.87	0.88	0.8	0.84	0.87	0.81	0.84
Tomato___Leaf_Mold	0.96	0.95	0.95	0.83	0.93	0.88	0.93	0.89	0.91
Tomato___Septoria_leaf_spot	0.95	0.82	0.88	0.91	0.79	0.84	0.91	0.85	0.88
Tomato___Spider_mites Two-spotted_spider_mite	0.92	0.9	0.91	0.87	0.92	0.89	0.9	0.89	0.9
Tomato___Target_Spot	0.87	0.91	0.89	0.89	0.91	0.9	0.91	0.87	0.89
Tomato___Tomato_Yellow_Leaf_Curl_Virus	0.96	0.93	0.95	0.93	0.9	0.91	0.96	0.91	0.93
Tomato___Tomato_mosaic_virus	0.82	0.99	0.9	0.75	1	0.86	0.85	0.99	0.91
Tomato___healthy	0.98	1	0.99	0.98	1	0.99	0.99	1	0.99
accuracy			0.92			0.87			0.91
macro avg	0.9	0.92	0.91	0.82	0.87	0.84	0.89	0.92	0.9
weighted avg	0.92	0.92	0.92	0.88	0.87	0.87	0.92	0.91	0.92

Random Forest Confusion Matrix
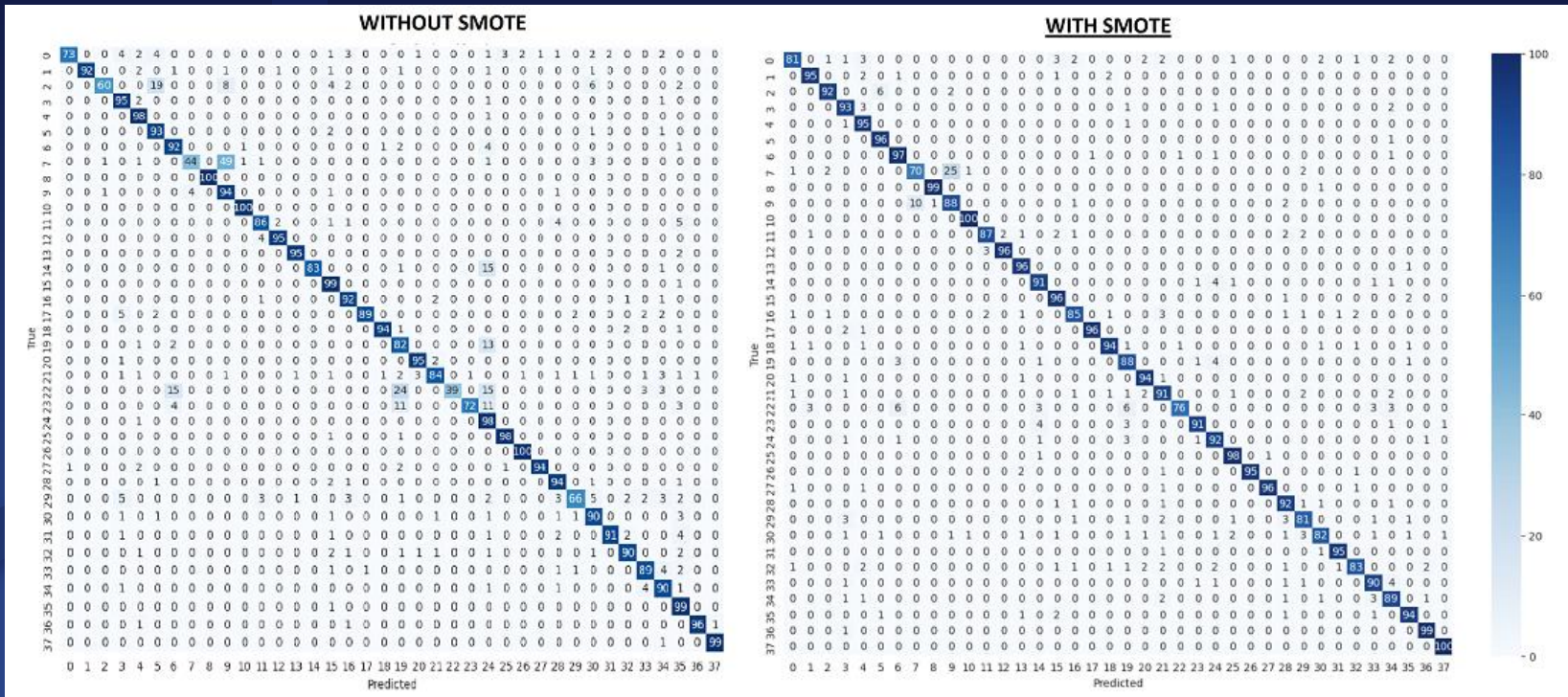
04

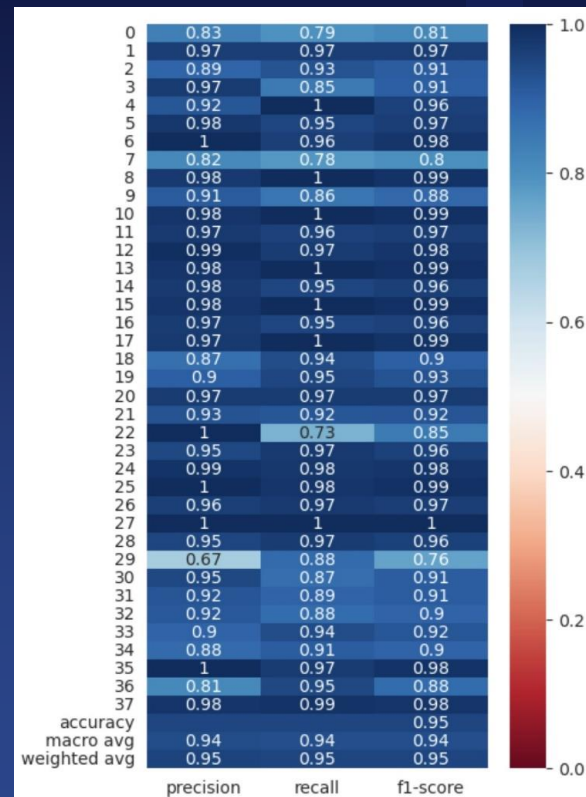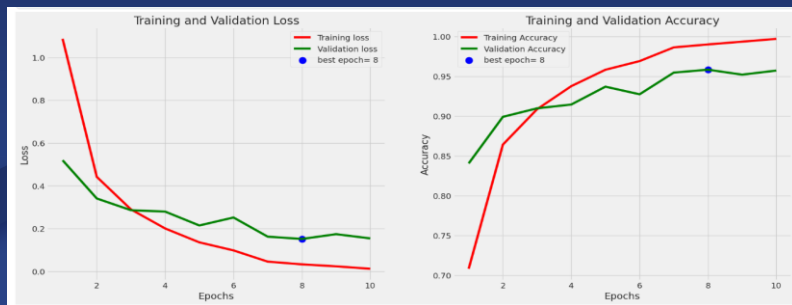# DEEP LEARNING

Data Preprocessing

❑ Data Augmentation

- ✓ Flipping
- ✓ Rotating
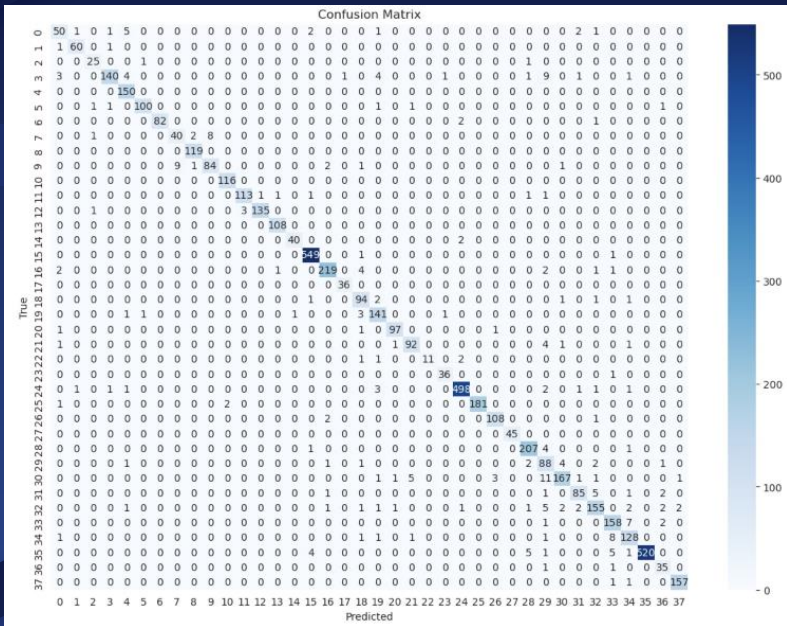- ✓ RGB Shift
- ✓ Channel Shuffle
- ✓ Gray-Scale
- ✓ Segmentation

CNN's Results

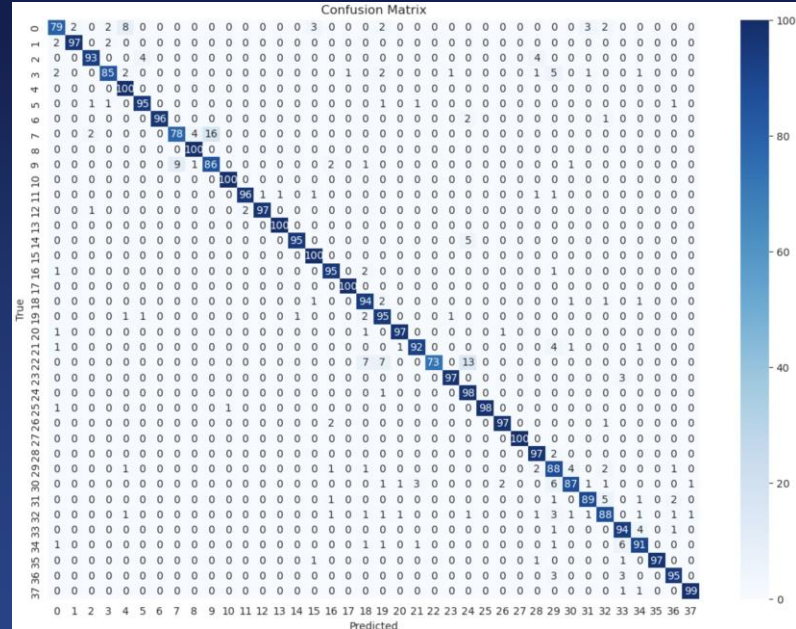| Model	Validation Accuracy	Validation Loss	Test Accuracy	Test Loss
CNN	95.83%	0.151	96.28%	0.146

CNN's Confusion Matrix
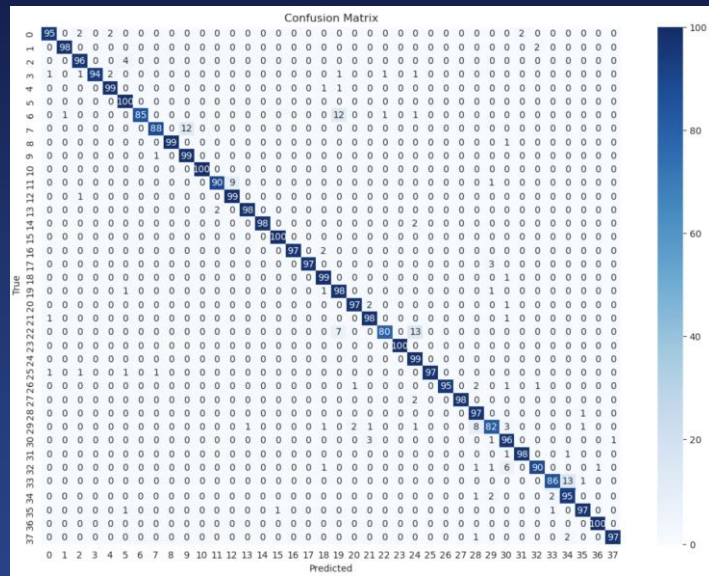

After Normalization

ResNet50's Performance

Model	Validation Accuracy	Validation Loss	Test Accuracy	Test Loss
ResNet50	98.60%	0.048	99.06%	0.050
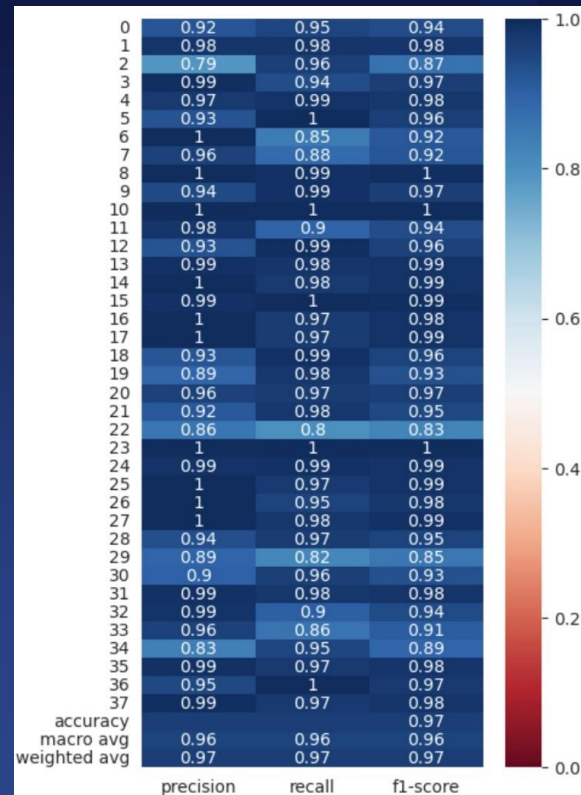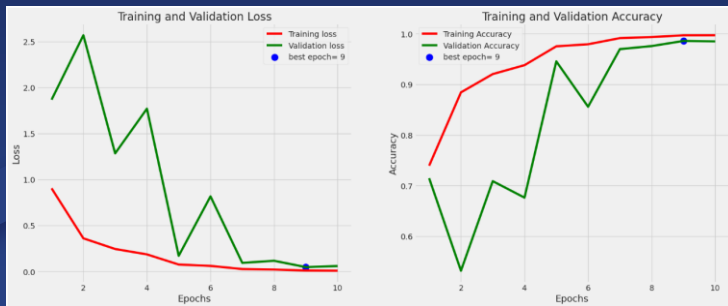
ResNet50's Confusion Matrix
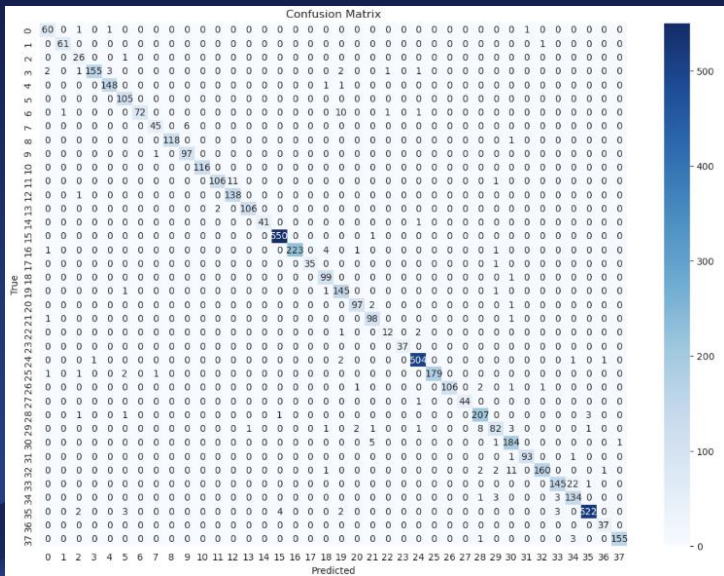
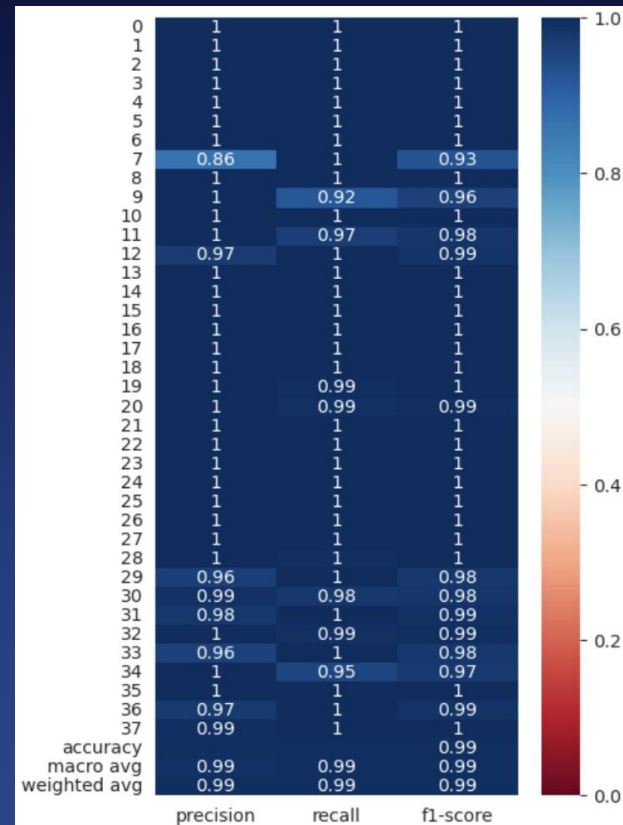After Normalization

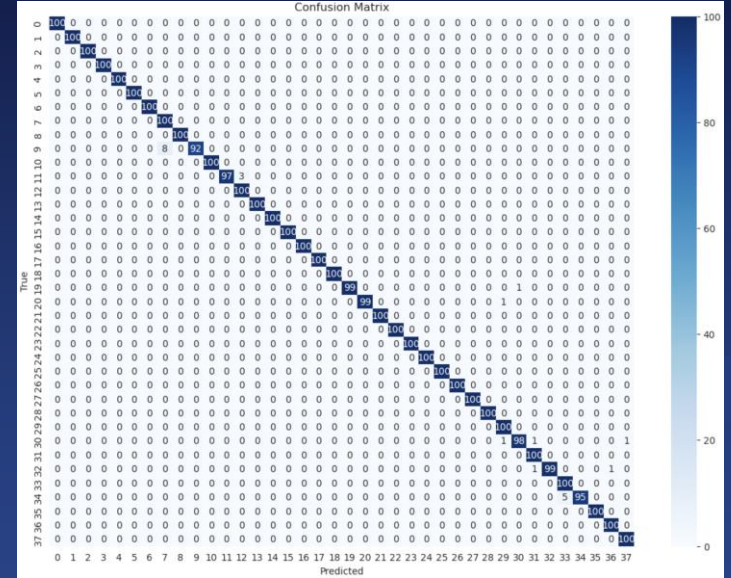# EfficientNet's Performance

Model	Validation Accuracy	Validation Loss	Test Accuracy	Test Loss
EfficientNet	99.74%	0.129	99.79%	0.125
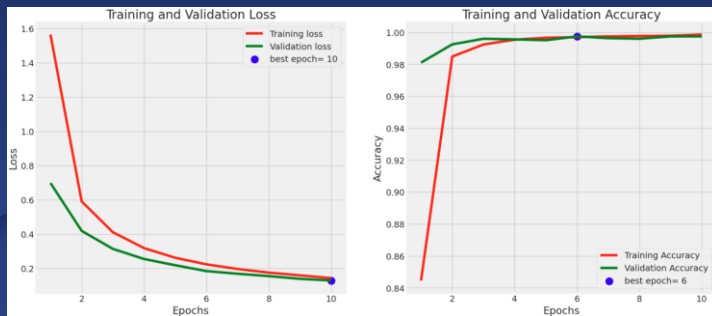
EfficientNet Confusion Matrix
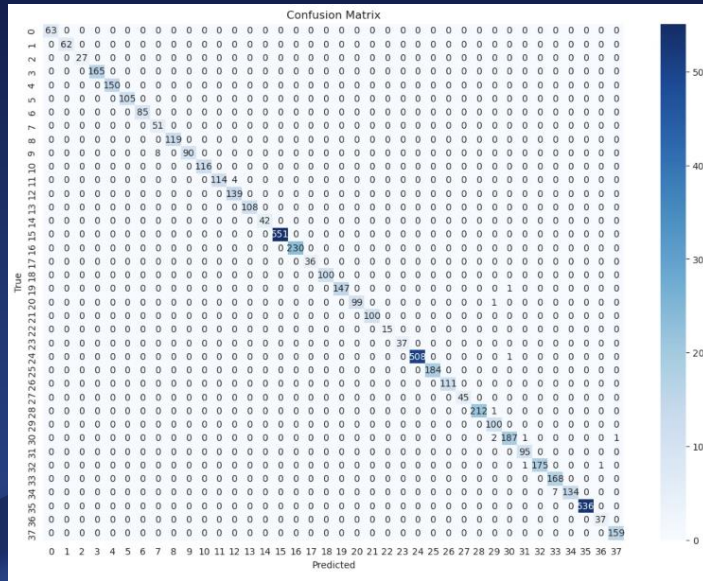
After Normalization

Side-By-Side Comparison

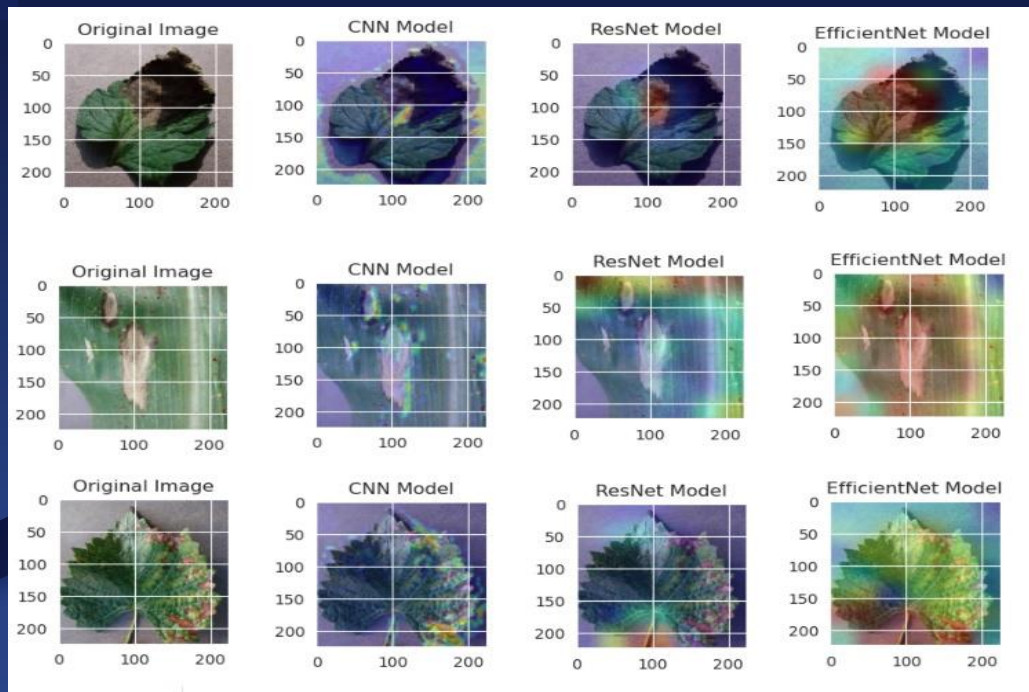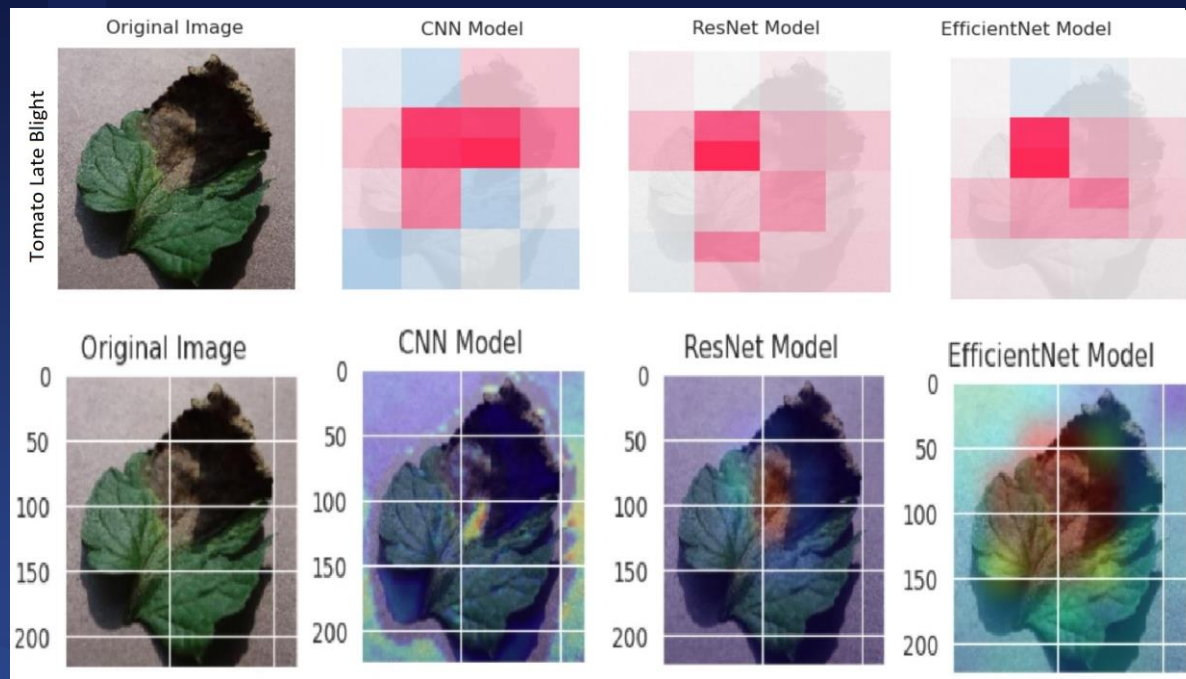| Model	Validation Accuracy	Validation Loss	Test Accuracy	Test Loss
CNN	95.83%	0.151	96.28%	0.146
ResNet50	98.60%	0.048	99.06%	0.050
EfficientNet	99.74%	0.129	99.79%	0.125

05

EXPLAINABLE AI

SHAP

Grad-CAM

COMPARISON OF XAI TECHNIQUES

THANK YOU FOR YOUR TIME!!!