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**Program:** **BS-AI (VI-A)**

**Title:** **Project**

**Course:** **Computer Vision**

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# Plant Disease Detection

## 1. Introduction:

This project focuses on developing a robust AI-driven system for detecting and classifying plant leaf diseases. It integrates two powerful deep learning approaches: **YOLOv8** for leaf detection and **ResNet-based convolutional neural networks** for disease classification. The solution includes a **user-friendly web interface** that enables farmers and agricultural workers to upload images and receive instant feedback on plant health, thereby contributing to early diagnosis and improved crop management.

## 2. Goals:

The primary objectives of the project are:

- **Accurate Detection:** Identify leaf regions from images using object detection.
- **Disease Classification:** Classify the detected leaves into one of the predefined disease categories or as healthy.
- **Real-Time Accessibility:** Provide an interactive web-based platform for easy image uploads and instant diagnosis.
- **Generalization:** Train models that generalize well across different crop types and image conditions.

### 3. Structure of Data:

The dataset used in this project consists of annotated images of leaves categorized into **17 distinct classes**, including various diseases and healthy conditions for crops like Corn, Potato, Rice, Wheat, and Sugarcane.

The directory structure follows the YOLOv8 convention:

```
dataset/  
├─ train/  
│   ├─ images/  
│   └─ labels/  
├─ val/  
│   ├─ images/  
│   └─ labels/  
├─ test/  
│   ├─ images/  
│   └─ labels/  
└─ dataset.yaml
```

Each label file contains YOLO-style annotations representing bounding boxes and class IDs for the corresponding image.

### 4. Methodology:

The methodology combines two deep learning components:

## **A. Yolov8 For Object Detection:**

**Tool Used:** Ultralytics YOLOv8 (You Only Look Once)

### **Training Configuration:**

- **Model:** `YOLOv8m`
- **Epochs:** 25
- **Batch size:** 16
- **Image size:** 640x640
- **Optimizer:** SGD

### **Steps:**

1. Dataset verification and YAML configuration.
2. Model training with visualization of metrics.
3. Validation and prediction on sample test images.

## **B. ResNet for Disease Classification:**

**Model Used:** ResNet50 (pretrained)

### **Modifications:**

- Custom fully connected head for 17 classes.
- Data augmentation using `torchvision.transforms`

### **Training Process:**

1. Dynamic dataset parsing based on structure (labels or folder names).
2. Model trained for 15 epochs using cross-entropy loss.
3. Evaluation using accuracy, classification report, and confusion matrix.

## C. Web Interface:

**Frontend:** HTML/CSS with JavaScript

### Features:

- Upload image via button or drag & drop.
- Real-time status indicators for model readiness.
- Visualization of bounding boxes and classification results.






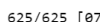


**Backend:** Flask API for YOLO and ResNet model inference.

## 5. Result:

### For Object Detection Using Yolov8:

#### ➤ Training For Epochs (25):

Starting training for 25 epochs...

Epoch	GPU_mem	box_loss	cls_loss	dfl_loss	Instances	Size
1/25	14.2G	0.2594	1.447	1.025	20	544: 100%  625/625 [06:42<00:00, 1.55it/s]
	Class	Images	Instances	Box(P	R	mAP50 mAP50-95): 100%  63/63 [00:49<00:00, 1.27it/s]
	all	1999	1999	0.724	0.896	0.868 0.867
Epoch	GPU_mem	box_loss	cls_loss	dfl_loss	Instances	Size
2/25	14.2G	0.1941	0.7081	0.9355	23	960: 100%  625/625 [07:15<00:00, 1.44it/s]
	Class	Images	Instances	Box(P	R	mAP50 mAP50-95): 100%  63/63 [00:48<00:00, 1.29it/s]
	all	1999	1999	0.689	0.876	0.863 0.862
Epoch	GPU_mem	box_loss	cls_loss	dfl_loss	Instances	Size
3/25	14.5G	0.2383	0.7492	0.9425	23	640: 100%  625/625 [07:13<00:00, 1.44it/s]
	Class	Images	Instances	Box(P	R	mAP50 mAP50-95): 100%  63/63 [00:48<00:00, 1.29it/s]
	all	1999	1999	0.675	0.847	0.842 0.83
Epoch	GPU_mem	box_loss	cls_loss	dfl_loss	Instances	Size
4/25	13.8G	0.2402	0.7716	0.9413	19	832: 100%  625/625 [07:20<00:00, 1.42it/s]
	Class	Images	Instances	Box(P	R	mAP50 mAP50-95): 100%  63/63 [00:47<00:00, 1.32it/s]
	all	1999	1999	0.669	0.837	0.843 0.836

Epoch	GPU_mem	box_loss	cls_loss	dfl_loss	Instances	Size
22/25	14.5G	0.04863	0.178	0.8701	7	544: 100% ██████████   625/625 [06:48<00:00, 1.53it/s]
	Class	Images	Instances	Box(P	R	mAP50 mAP50-95): 100% ██████████   63/63 [00:50<00:00, 1.26it/s]
	all	1999	1999	0.934	0.957	0.976 0.976

Epoch	GPU_mem	box_loss	cls_loss	dfl_loss	Instances	Size
23/25	13.5G	0.04528	0.1729	0.8651	7	608: 100% ██████████   625/625 [06:51<00:00, 1.52it/s]
	Class	Images	Instances	Box(P	R	mAP50 mAP50-95): 100% ██████████   63/63 [00:49<00:00, 1.27it/s]
	all	1999	1999	0.944	0.959	0.979 0.979

Epoch	GPU_mem	box_loss	cls_loss	dfl_loss	Instances	Size
24/25	14.5G	0.04269	0.1556	0.8648	7	448: 100% ██████████   625/625 [06:48<00:00, 1.53it/s]
	Class	Images	Instances	Box(P	R	mAP50 mAP50-95): 100% ██████████   63/63 [00:52<00:00, 1.20it/s]
	all	1999	1999	0.943	0.962	0.98 0.98

Epoch	GPU_mem	box_loss	cls_loss	dfl_loss	Instances	Size
25/25	14.2G	0.03904	0.1519	0.869	7	736: 100% ██████████   625/625 [06:50<00:00, 1.52it/s]
	Class	Images	Instances	Box(P	R	mAP50 mAP50-95): 100% ██████████   63/63 [00:50<00:00, 1.24it/s]
	all	1999	1999	0.958	0.949	0.98 0.98

Model Summary:

25 epochs completed in 3.364 hours.  
Optimizer stripped from plant\_disease\_detection\_colab/yolov8m\_plant\_disease\_25epochs/weights/last.pt, 52.0MB  
Optimizer stripped from plant\_disease\_detection\_colab/yolov8m\_plant\_disease\_25epochs/weights/best.pt, 52.0MB

Validating plant\_disease\_detection\_colab/yolov8m\_plant\_disease\_25epochs/weights/best.pt...

Ultralytics 8.3.146 Python-3.11.12 torch-2.6.0+cu124 CUDA:0 (Tesla T4, 15095MiB)

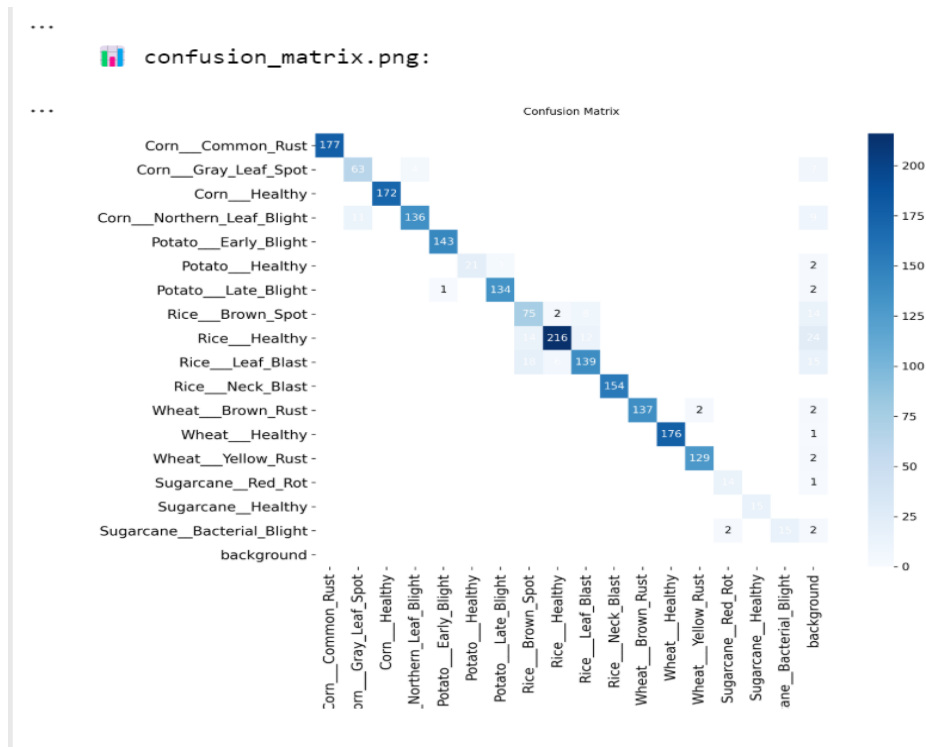
Model summary (fused): 92 layers, 25,849,603 parameters, 0 gradients, 78.7 GFLOPs

Class	Images	Instances	Box(P	R	mAP50	mAP50-95)
all	1999	1999	0.958	0.949	0.98	0.98
Corn__Common_Rust	177	177	0.998	1	0.995	0.995
Corn__Gray_Leaf_Spot	74	74	0.939	0.825	0.961	0.961
Corn__Healthy	172	172	0.998	1	0.995	0.995
Corn__Northern_Leaf_Blight	140	140	0.932	0.971	0.986	0.986
Potato__Early_Blight	144	144	1	0.996	0.995	0.995
Potato__Healthy	21	21	0.844	1	0.995	0.995
Potato__Late_Blight	137	137	0.993	0.994	0.995	0.995
Rice__Brown_Spot	107	107	0.925	0.72	0.899	0.899
Rice__Healthy	224	224	0.891	0.951	0.947	0.947
Rice__Leaf_Blast	159	159	0.899	0.84	0.936	0.936
Rice__Neck_Blast	154	154	0.998	1	0.995	0.995
Wheat__Brown_Rust	137	137	0.995	1	0.995	0.995
Wheat__Healthy	176	176	0.996	1	0.995	0.995
Wheat__Yellow_Rust	131	131	1	0.995	0.995	0.995
Sugarcane__Red_Rot	16	16	1	0.846	0.995	0.995
Sugarcane__Healthy	15	15	0.986	1	0.995	0.995
Sugarcane__Bacterial_Blight	15	15	0.889	1	0.991	0.991

Speed: 0.2ms preprocess, 8.7ms inference, 0.0ms loss, 1.8ms postprocess per image

Saving plant\_disease\_detection\_colab/yolov8m\_plant\_disease\_25epochs/predictions.json...

### Confusion Matrix:



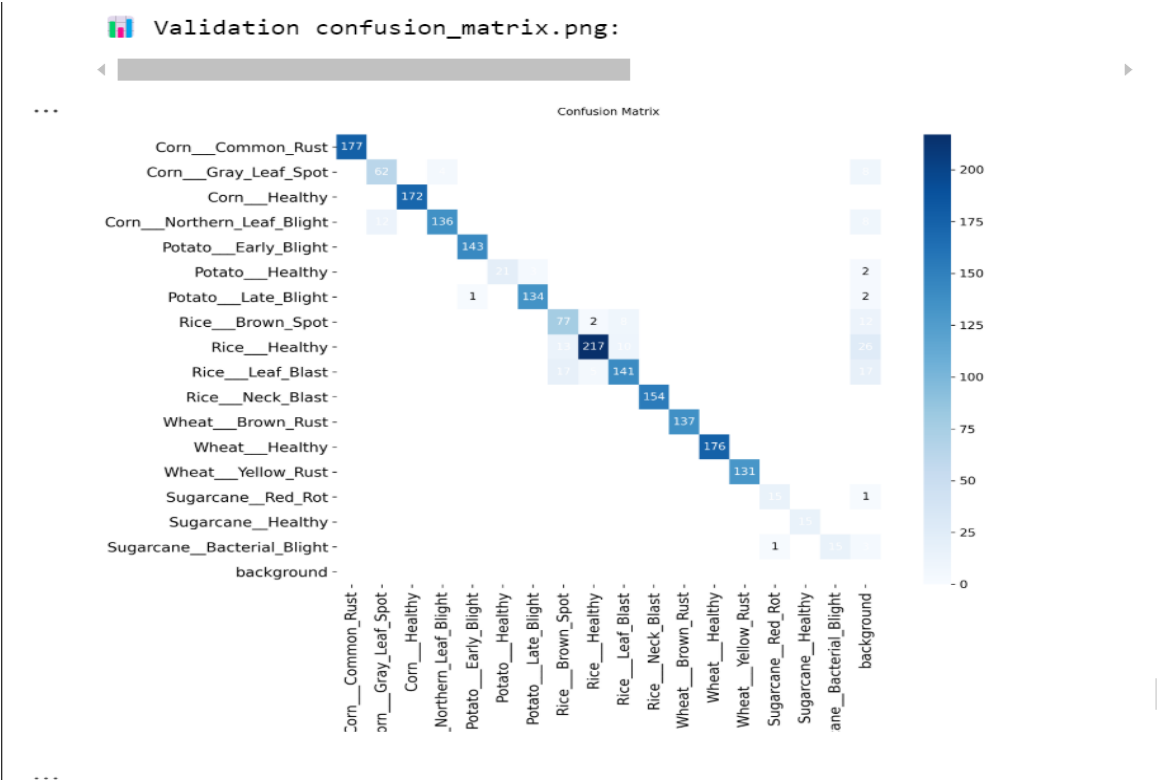
### Model Summary for Validation On Best Model:

```

Class          Images  Instances  Box(P          R          mAP50  mAP50-95): 100% ██████████ 125/125 [01:00<00:00, 2.08it/s]
      all        1999      1999      0.96      0.952      0.981      0.981
  Corn__Common_Rust  177      177      0.998      1      0.995      0.995
Corn__Gray_Leaf_Spot  74       74      0.939      0.83      0.961      0.961
  Corn__Healthy     172      172      0.998      1      0.995      0.995
Corn__Northern_Leaf_Blight 140      140      0.923      0.971      0.986      0.986
  Potato__Early_Blight 144      144      1      0.996      0.995      0.995
  Potato__Healthy     21       21      0.842      1      0.995      0.995
  Potato__Late_Blight 137      137      0.993      0.994      0.995      0.995
  Rice__Brown_Spot    107      107      0.928      0.727      0.9      0.9
  Rice__Healthy       224      224      0.885      0.955      0.947      0.947
  Rice__Leaf_Blast    159      159      0.898      0.843      0.936      0.936
  Rice__Neck_Blast    154      154      0.998      1      0.995      0.995
  Wheat__Brown_Rust   137      137      0.998      1      0.995      0.995
  Wheat__Healthy      176      176      0.998      1      0.995      0.995
  Wheat__Yellow_Rust  131      131      1      0.997      0.995      0.995
  Sugarcane__Red_Rot  16       16      1      0.874      0.995      0.995
  Sugarcane__Healthy  15       15      0.984      1      0.995      0.995
Sugarcane__Bacterial_Blight 15      15      0.941      1      0.995      0.995
Speed: 0.4ms preprocess, 19.2ms inference, 0.0ms loss, 1.1ms postprocess per image
Saving runs/detect/val/predictions.json...
Results saved to runs/detect/val
✔ Validation completed!

```

Confusion Matrix:



Prediction:

Predicting: Corn\_\_Healthy\_02369.jpg

image 1/1 /content/dataset/test/images/Corn\_\_Healthy\_02369.jpg: 640x640 1 Corn\_\_Healthy, 36.4ms  
Speed: 3.7ms preprocess, 36.4ms inference, 2.0ms postprocess per image at shape (1, 3, 640, 640)  
Results saved to runs/detect/predict

Corn\_\_Healthy 0.99



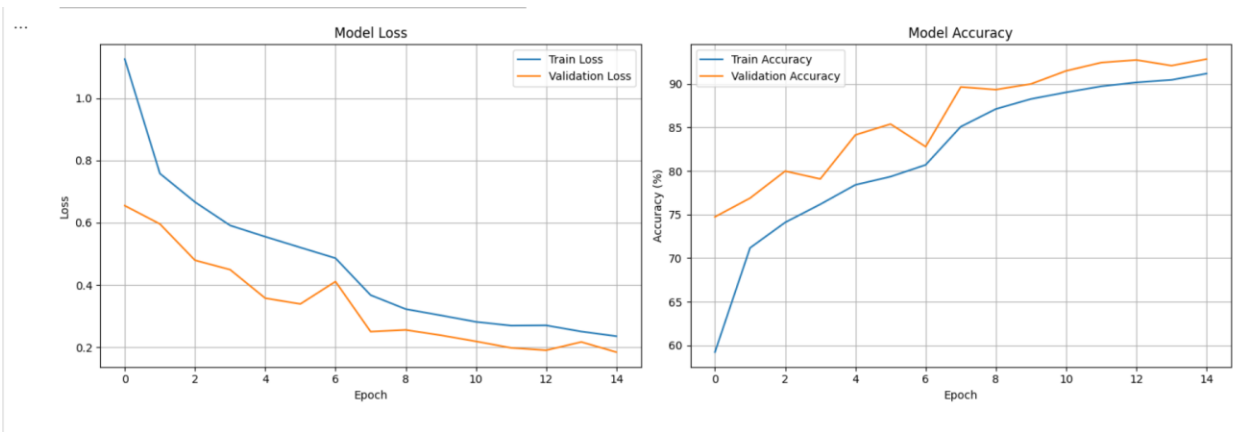
## For Disease Classification Using ResNet:

### ➤ Training For Epochs (15):

```
Starting training...
Epoch 1/15 [Train]: 100%|██████████| 625/625 [04:35<00:00, 2.27it/s, Loss=0.3717, Acc=59.21%]
Epoch 1/15 [Val]: 100%|██████████| 125/125 [00:39<00:00, 3.17it/s, Loss=0.8596, Acc=74.74%]
Epoch [1/15]
Train Loss: 1.1256, Train Acc: 59.21%
Val Loss: 0.6548, Val Acc: 74.74%
Best Val Acc: 74.74%
-----
Epoch 2/15 [Train]: 100%|██████████| 625/625 [04:17<00:00, 2.42it/s, Loss=1.6602, Acc=71.18%]
Epoch 2/15 [Val]: 100%|██████████| 125/125 [00:37<00:00, 3.37it/s, Loss=0.7406, Acc=76.89%]
Epoch [2/15]
Train Loss: 0.7581, Train Acc: 71.18%
Val Loss: 0.5960, Val Acc: 76.89%
Best Val Acc: 76.89%
-----
Epoch 3/15 [Train]: 100%|██████████| 625/625 [04:16<00:00, 2.44it/s, Loss=0.6063, Acc=74.10%]
Epoch 3/15 [Val]: 100%|██████████| 125/125 [00:37<00:00, 3.38it/s, Loss=0.5918, Acc=79.99%]
Epoch [3/15]
Train Loss: 0.6664, Train Acc: 74.10%
Val Loss: 0.4794, Val Acc: 79.99%
Best Val Acc: 79.99%
-----
Epoch 4/15 [Train]: 100%|██████████| 625/625 [04:10<00:00, 2.49it/s, Loss=0.4057, Acc=76.18%]
Epoch 4/15 [Val]: 100%|██████████| 125/125 [00:37<00:00, 3.30it/s, Loss=0.4708, Acc=79.09%]
Epoch [4/15]
Train Loss: 0.5913, Train Acc: 76.18%
Val Loss: 0.4493, Val Acc: 79.09%
Best Val Acc: 79.99%
```

```
Epoch 12/15 [Train]: 100%|██████████| 625/625 [04:12<00:00, 2.47it/s, Loss=0.3178, Acc=89.72%]
Epoch 12/15 [Val]: 100%|██████████| 125/125 [00:37<00:00, 3.36it/s, Loss=0.1612, Acc=92.45%]
Epoch [12/15]
Train Loss: 0.2695, Train Acc: 89.72%
Val Loss: 0.1980, Val Acc: 92.45%
Best Val Acc: 92.45%
-----
Epoch 13/15 [Train]: 100%|██████████| 625/625 [04:14<00:00, 2.46it/s, Loss=0.2503, Acc=90.17%]
Epoch 13/15 [Val]: 100%|██████████| 125/125 [00:37<00:00, 3.37it/s, Loss=0.1320, Acc=92.75%]
Epoch [13/15]
Train Loss: 0.2703, Train Acc: 90.17%
Val Loss: 0.1904, Val Acc: 92.75%
Best Val Acc: 92.75%
-----
Epoch 14/15 [Train]: 100%|██████████| 625/625 [04:10<00:00, 2.49it/s, Loss=0.0415, Acc=90.46%]
Epoch 14/15 [Val]: 100%|██████████| 125/125 [00:36<00:00, 3.39it/s, Loss=0.0946, Acc=92.10%]
Epoch [14/15]
Train Loss: 0.2505, Train Acc: 90.46%
Val Loss: 0.2170, Val Acc: 92.10%
Best Val Acc: 92.75%
-----
Epoch 15/15 [Train]: 100%|██████████| 625/625 [04:15<00:00, 2.45it/s, Loss=0.1371, Acc=91.18%]
Epoch 15/15 [Val]: 100%|██████████| 125/125 [00:36<00:00, 3.41it/s, Loss=0.1063, Acc=92.85%]
Epoch [15/15]
Train Loss: 0.2355, Train Acc: 91.18%
Val Loss: 0.1842, Val Acc: 92.85%
Best Val Acc: 92.85%
```

# Model Loss & Accuracy:

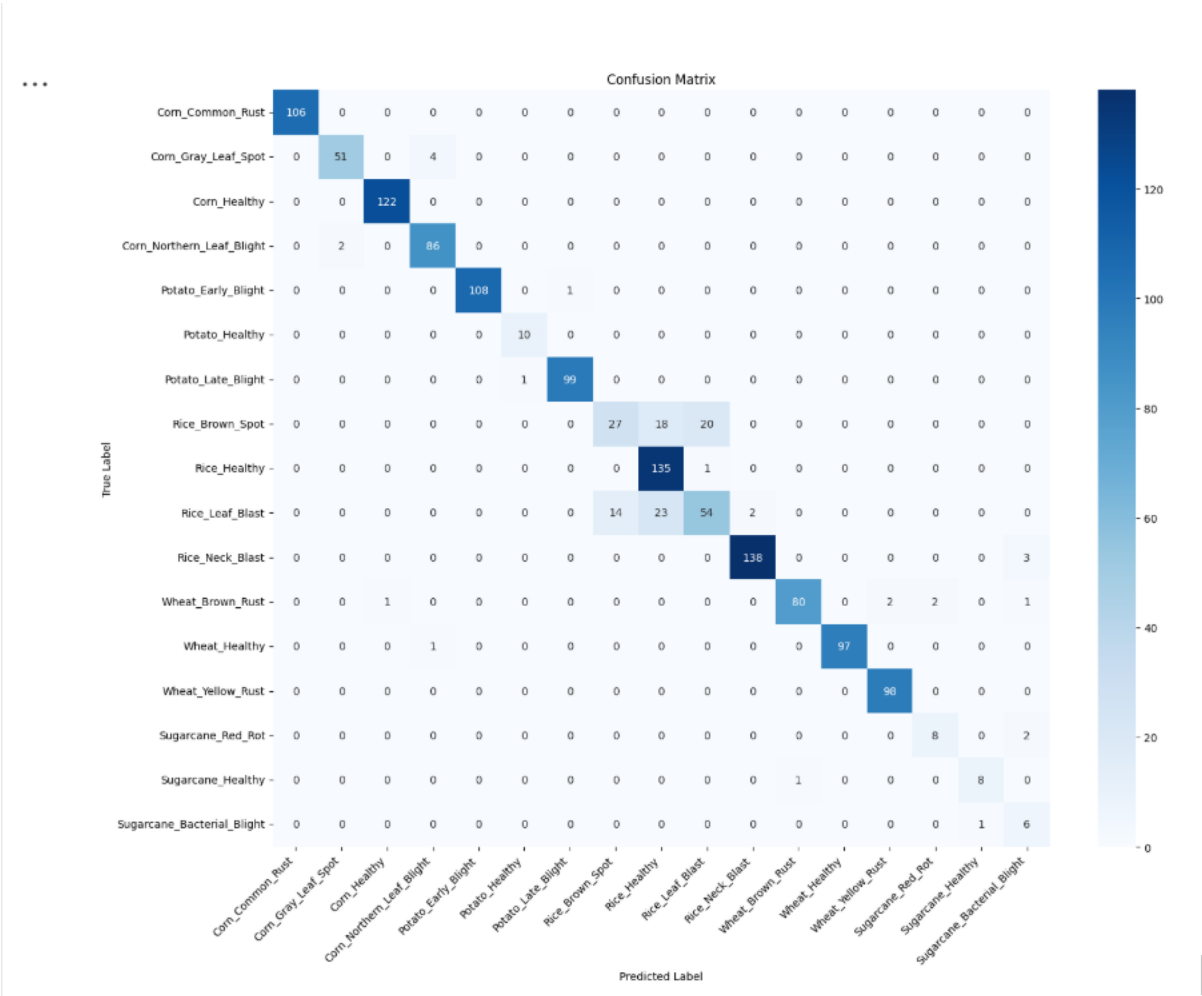


# Classification Report:

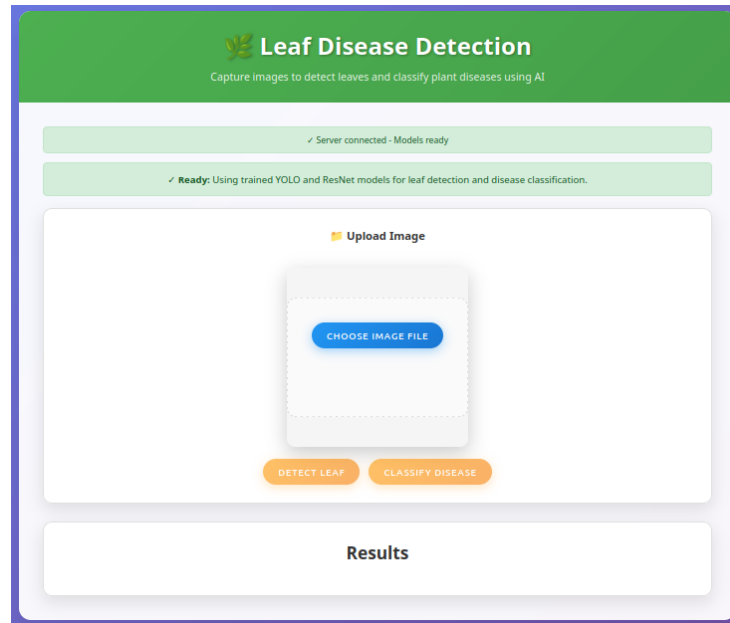
Evaluating on test set...  
Testing: 100%[██████████] 84/84 [00:31<00:00, 2.64it/s]  
Test Accuracy: 0.9250

Classification Report:	precision	recall	f1-score	support
Corn_Common_Rust	1.00	1.00	1.00	106
Corn_Gray_Leaf_Spot	0.96	0.93	0.94	55
Corn_Healthy	0.99	1.00	1.00	122
Corn_Northern_Leaf_Blight	0.95	0.98	0.96	88
Potato_Early_Blight	1.00	0.99	1.00	109
Potato_Healthy	0.91	1.00	0.95	10
Potato_Late_Blight	0.99	0.99	0.99	100
Rice_Brown_Spot	0.66	0.42	0.51	65
Rice_Healthy	0.77	0.99	0.87	136
Rice_Leaf_Blast	0.72	0.58	0.64	93
Rice_Neck_Blast	0.99	0.98	0.98	141
Wheat_Brown_Rust	0.99	0.93	0.96	86
Wheat_Healthy	1.00	0.99	0.99	98
Wheat_Yellow_Rust	0.98	1.00	0.99	98
Sugarcane_Red_Rot	0.80	0.80	0.80	10
Sugarcane_Healthy	0.89	0.89	0.89	9
Sugarcane_Bacterial_Blight	0.50	0.86	0.63	7
accuracy			0.92	1333
macro avg	0.89	0.90	0.89	1333
weighted avg	0.92	0.92	0.92	1333

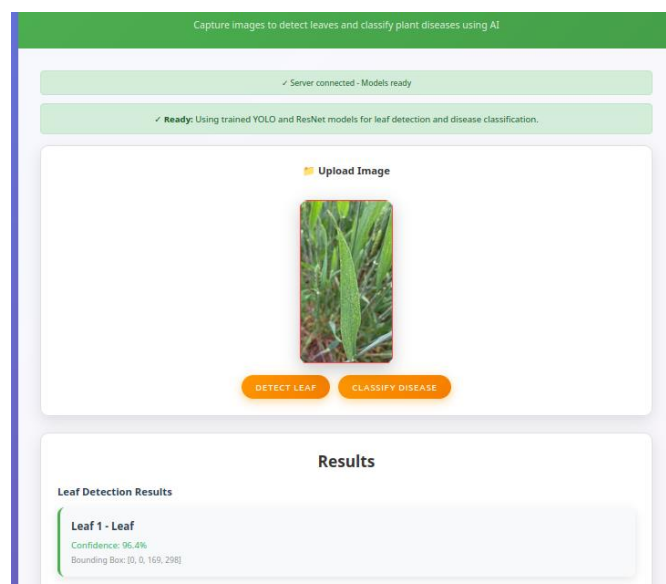
Confusion Matrix:

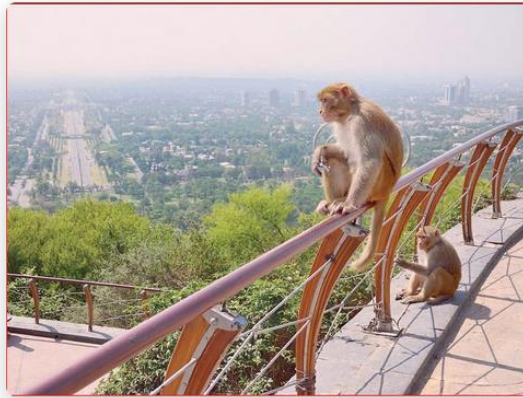


## 6. Output:



## Leaf Detection:





DETECT LEAF

CLASSIFY DISEASE

## Results

### Leaf Detection Results

Confidence: - Not confident in our prediction

## Disease Classification:

Capture images to detect leaves and classify plant diseases using AI

✓ Server connected - Models ready

✓ Ready: Using trained YOLO and ResNet models for leaf detection and disease classification.

📷 Upload Image



DETECT LEAF

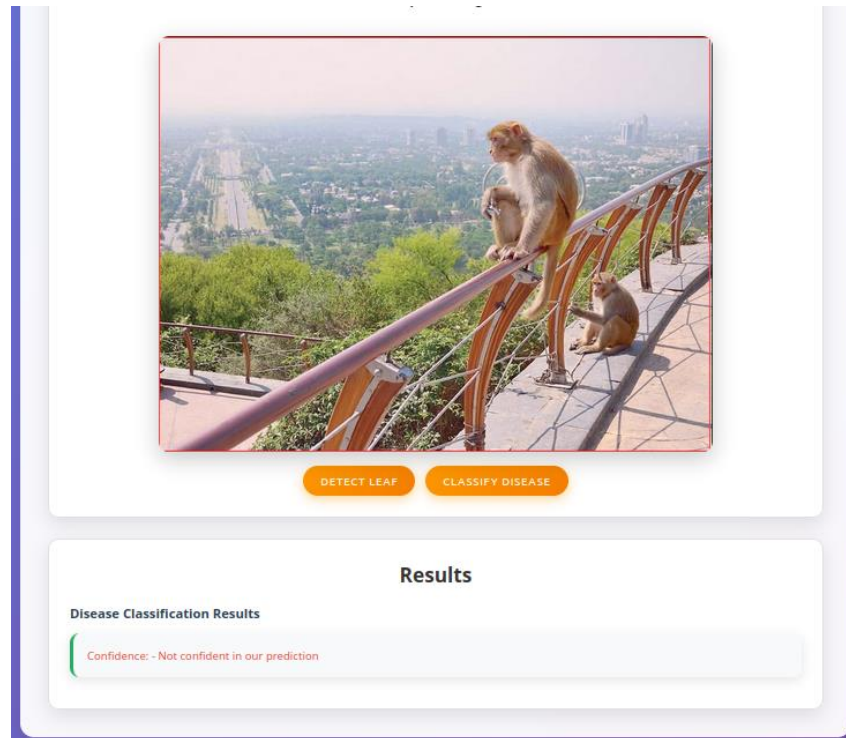
CLASSIFY DISEASE

## Results

### Disease Classification Results

1. Wheat Brown Rust

Confidence: 72.0%



## 7. Conclusion

This project successfully demonstrates the integration of computer vision techniques in the agricultural domain. By combining object detection and image classification with an interactive frontend, it delivers an end-to-end plant disease diagnosis tool. The **YOLOv8** and **ResNet** models provide accurate results, while the **web interface** ensures accessibility and ease of use. Future work can focus on expanding the dataset, improving mobile compatibility, and adding multilingual support for regional users.