Plant Disease Detection System for Sustainable Agriculture

Week 1 Report – Problem Statement and Project Pipeline by Arindam Santra

# Problem Statement

Agriculture is the backbone of the economy in many countries, particularly in developing regions, where a significant portion of the population depends on farming for livelihood. One of the major challenges in agriculture is the early and accurate detection of plant diseases. If not addressed promptly, these diseases can significantly affect crop yield, leading to economic loss and food insecurity.  
  
Traditional methods of plant disease detection involve manual observation by experts, which is time-consuming, prone to human error, and not scalable. The lack of affordable and scalable diagnostic solutions leaves many farmers without the necessary tools to identify and treat plant diseases in a timely manner.

# Aim of the Project

This project aims to develop an automated Plant Disease Detection System using deep learning techniques to help farmers identify diseases from leaf images of crops. The system will serve as a sustainable agricultural support tool that enables:  
- Timely detection of plant diseases.  
- Reduction in the dependency on human expertise.  
- Support for better crop health and yield.  
- A contribution to smart and sustainable farming practices.

# Project Pipeline

## Step 1: Data Collection and Loading

- A dataset (~2 GB ZIP file) is provided.  
- The dataset consists of two folders: train and valid.  
 - The train folder includes multiple categories (e.g., Grape Black Rot, Grape Healthy, Peach Leaf Curl, Peach Healthy, etc.).  
 - Each category folder contains multiple images of leaves.  
 - The valid folder is used as test data during evaluation.

## Step 2: Upload Dataset to Google Colab

- Mount Google Drive in Colab.  
- Upload the ZIP dataset file.  
- Use Python code to unzip the dataset within the Colab environment.

## Step 3: Image Processing and Augmentation

- Resize and normalize all images.  
- Apply image augmentation techniques such as:  
 - Rotation  
 - Zoom  
 - Flip (horizontal/vertical)  
 - Brightness adjustment  
This helps improve model generalization and performance.

## Step 4: CNN Model Development

- Build a Convolutional Neural Network (CNN) using frameworks like TensorFlow/Keras.  
- The model will learn to classify images into their respective disease categories.  
- Key layers include:  
 - Convolutional layers  
 - Pooling layers  
 - Dropout  
 - Dense (fully connected) layers  
- Compile using suitable loss and optimizer functions.

## Step 5: Model Testing and Evaluation

- Evaluate the trained model using the valid dataset.  
- Use metrics such as:  
 - Accuracy  
 - Precision  
 - Recall  
 - Confusion Matrix  
- Analyze model performance and adjust as needed for improvements.

# Conclusion

The development of a deep learning-based plant disease detection system will support farmers in detecting crop diseases early, increasing productivity, and promoting sustainable agricultural practices. This Week 1 document outlines the problem context and project pipeline, serving as a foundational step toward building a smart agriculture solution.