PARISODHANA 4.0

Team 64: Soil Quality and Management using DL and IoT for Precision Agriculture

Introduction

The project focuses on transforming traditional farming with an IoT and deep learning-based soil quality and management system. By deploying IoT sensors across fields, it collects real-time data on critical soil parameters like moisture, pH, and nutrients. Deep learning models analyze this data to predict soil health, detect issues, and offer crop and soil management recommendations. This intelligent, scalable, and affordable system aims to support precision agriculture, especially for small-scale farmers. It enhances productivity, reduces resource waste, and promotes sustainable farming. The report details the system's development, challenges, and future scope, highlighting its impact on modern agriculture.

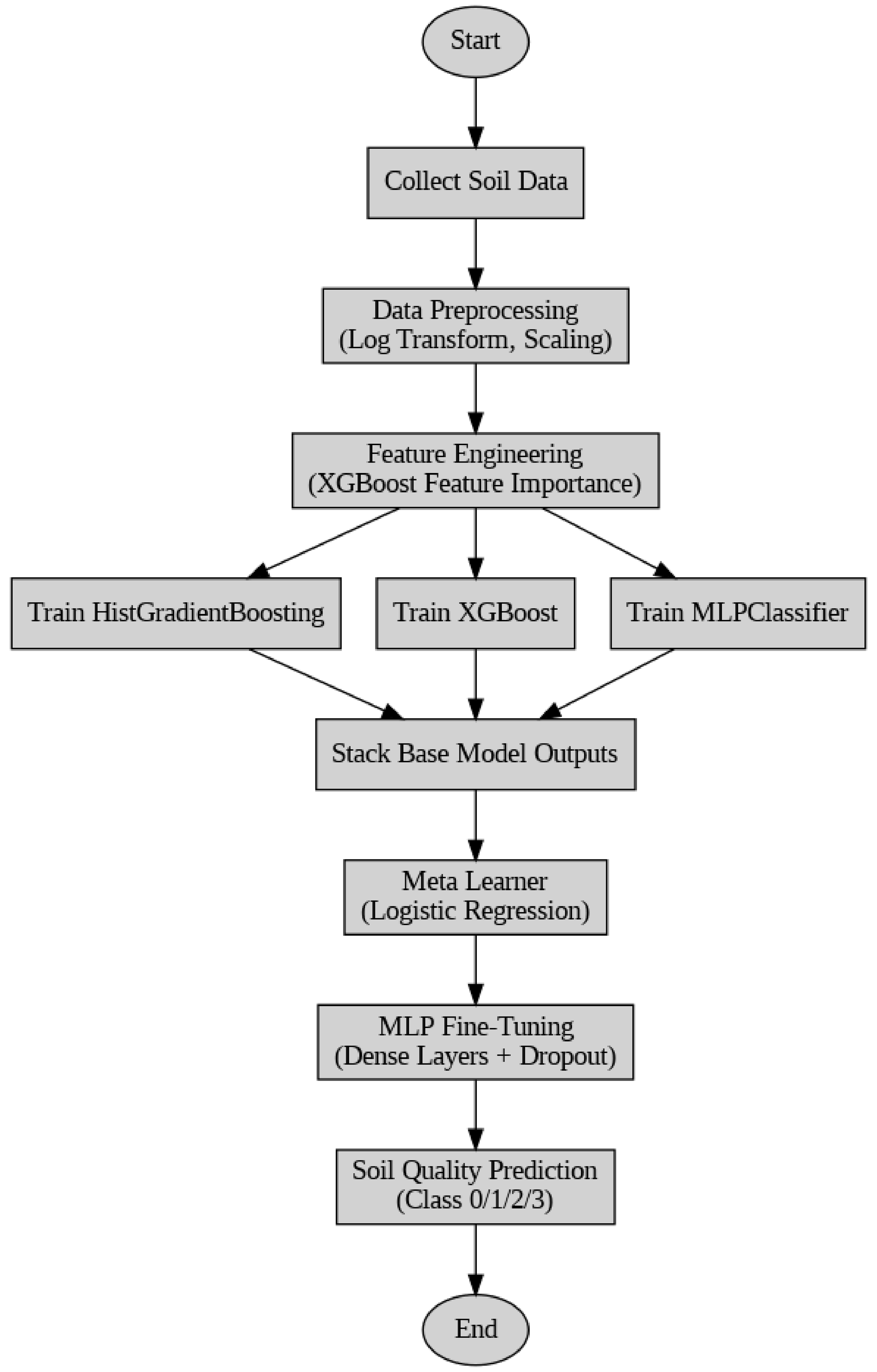
Objectives

- To design and implement an IoT-based soil monitoring system
- To collect and preprocess soil quality data for machine learning analysis
- To develop a deep learning model for soil quality classification
- To create a decision-support system for farmers
- To evaluate the system's performance in real-world farming scenarios
- To ensure scalability and accessibility for small-scale farmers

Key Technologies

- HistGradientBoost
- XGBoost
- Multi-Layer Perceptron
- Logistic Regression
- Flask
- Hyper Text Markup Language (HTML)
- Cascading Style Sheets (CSS)

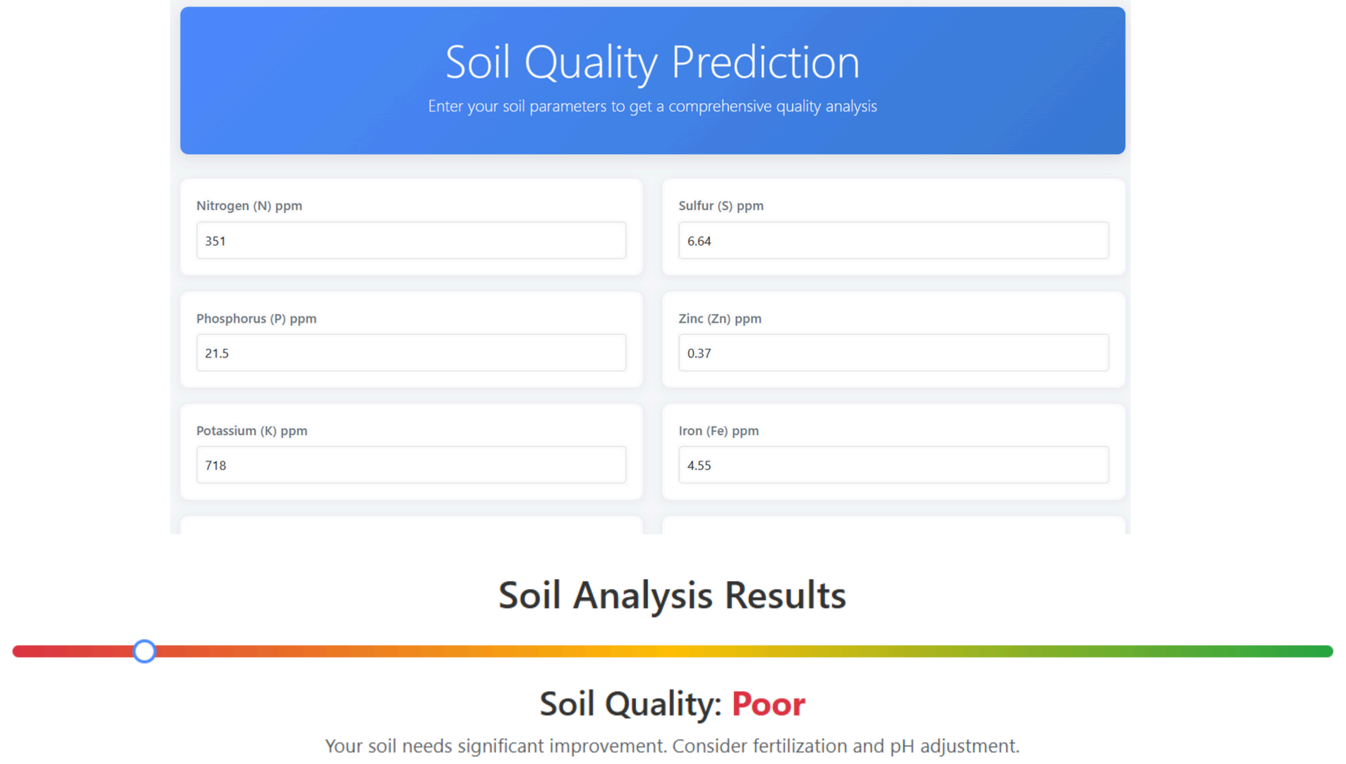
Architecture



Methodology

This project integrates IoT and deep learning for precision agriculture by predicting soil quality. IoT sensors collect real-time data on key soil parameters like pH, nutrients, and conductivity. The data is preprocessed and analyzed using a stacked ensemble model combining HistGradientBoosting, XGBoost, and MLPClassifier. A logistic regression meta-learner refines predictions, followed by fine-tuning with deep MLP layers. The system achieves high accuracy and provides explainable outputs via feature importance and confusion matrices. Deployed through a user-friendly interface, it offers real-time soil quality assessment and crop suggestions, enabling sustainable and data-driven soil management for farmers in rural settings.

Results



Guide:
Shaista Farhat
Assistant Professor - CSE(AI&ML)
Presented By:
A Ranjith Kumar - 21881A66D2
Abba Bharadwaj - 21881A66D3
S Dhanush Chowdary - 21881A66E5

Conclusion

This study demonstrates the effectiveness of a stacking ensemble model—combining HistGradientBoosting, XGBoost, and MLP classifiers—in predicting soil health categories with 87.5% accuracy. Key features like nitrogen and pH enabled strong classification for majority classes, while minority classes, particularly Class 2, faced recall issues due to class imbalance and overlapping features. The model shows promise for use in agricultural decision-support systems. Future enhancements will address imbalance using synthetic sampling and domain-specific feature engineering. Additionally, dynamic threshold learning could improve minority-class predictions. Overall, this scalable model offers context-aware insights for environmental and agricultural analytics.