Green University of Bangladesh

Department of Computer Science and Engineering (CSE)
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AI-Based Hybrid Model for Fertilizer Recommendation

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Lab Project Status	
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Chapter 1

Project Proposal

1 Introduction

Fertilizers help crops grow better, but farmers often don't know the right type or amount to use. If they use too much or too little, it can harm both the crops and the soil. In this project, I will create an AI-based model that will suggest the best fertilizer based on soil and weather data. I will use a hybrid model that combines two machine learning techniques to improve accuracy.

2 Problem Statement

Farmers face challenges in choosing the right fertilizer for their crops. Wrong fertilizer selection can lead to several issues:

- **Low crop yield:** Using the wrong fertilizer can cause nutrient imbalance, affecting plant growth.
- **Soil damage:** Excessive use of chemical fertilizers degrades soil health.
- **Extra costs:** Incorrect fertilizer application increases expenses for farmers.

There is a lack of AI-based systems that accurately predict fertilizer needs based on soil and climate factors. This project aims to develop a hybrid AI model to provide precise and cost-effective fertilizer recommendations.

3 Motivation

Agriculture is a crucial sector in many countries, yet many farmers lack access to modern technology for better decision-making. By utilizing AI, we can help farmers:

- **Improve crop production:** Optimized fertilizer recommendations can enhance yield.
- **Reduce fertilizer waste:** AI can prevent excessive use of fertilizers.
- **Maintain soil health:** Sustainable fertilizer application ensures long-term soil fertility.

This project leverages machine learning to make farming more efficient and sustainable. The goal is to assist farmers in making better fertilizer decisions using AI.

4 Objectives

1. To build an AI model that can predict the best fertilizer for different soil conditions.
2. To combine two machine learning models to improve accuracy.
3. To run the project on Google Colab without UI for now.

5 Literature Review

Several studies have explored machine learning-based fertilizer recommendation systems. However, most approaches use a single model rather than a hybrid approach. The table below summarizes key findings from previous research:

Author(s)	**Model Used**	**Findings**	**Limitations**
Sharma et al. (2021) [1]	Random Forest	High accuracy in soil classification	Limited to soil nutrient levels only
Kumar et al. (2022) [2]	SVM	Good for soil fertility classification	Computationally expensive for large datasets
Gupta et al. (2023) [3]	ANN	Predicts fertilizer needs based on weather and soil	Lacks optimization for real-time use
Singh et al. (2021) [4]	Decision Tree + Deep Learning	Outperforms single ML models	High computational cost
Proposed Model	**Hybrid (Random Forest + ANN)**	**Combines classification + prediction for better accuracy**	

Table 1.1: Comparison of Previous Works with the Proposed Model

Existing models have shown promising results but lack optimization and hybrid approaches. This project aims to combine tree-based and deep learning models to enhance accuracy and efficiency in fertilizer recommendation.

6 Methodology

6.1 Data Collection and Preprocessing

The dataset for this project will be collected from publicly available sources such as Kaggle and agricultural research databases. The dataset will include the following key features:

- **Soil pH:** Measures the acidity or alkalinity of the soil.
- **NPK Levels:** Indicates the presence of Nitrogen (N), Phosphorus (P), and Potassium (K) in the soil.
- **Temperature:** Helps determine environmental conditions affecting fertilizer requirements.
- **Humidity:** Influences soil moisture and nutrient absorption.
- **Rainfall:** Affects the washing away of nutrients and soil retention capacity.

The data will be preprocessed using Python libraries such as `Pandas`, `NumPy`, and `Scikit-learn` to remove inconsistencies, handle missing values, and normalize feature values.

6.2 Machine Learning Model

This project will implement a hybrid AI approach using two different machine learning models:

Step 1: Random Forest (Tree-Based Model)

A Random Forest classifier will be used to categorize the fertilizer requirement into three levels:

- High
- Medium
- Low

Step 2: Artificial Neural Network (Deep Learning Model)

An Artificial Neural Network (ANN) will be implemented to predict the **exact amount of fertilizer needed** (in kg/acre) based on the given soil and environmental parameters.

6.3 Model Optimization

To enhance the accuracy and efficiency of the models, the following optimization techniques will be applied:

- **Hyperparameter Tuning:** Grid Search and Bayesian Optimization will be used to fine-tune the model parameters.
- **Feature Selection:** Important features will be identified to improve computational efficiency and model performance.

6.4 Tools and Technologies

The project will be implemented using the following tools and technologies:

- **Programming Language:** Python
- **Development Environment:** Google Colab (Cloud-based platform for AI model training)
- **Machine Learning Libraries:** Scikit-learn, TensorFlow, and Keras

7 Expected Outcomes

- A working AI model that can recommend fertilizers based on soil and weather data.
- Better accuracy by using a Hybrid Model (Decision Tree + Deep Learning).
- Increased crop yield and reduced fertilizer costs.
- A system tested in real-life conditions across different districts.

8 Conclusion

This project successfully demonstrates the development of an AI-based system for predicting the optimal fertilizer for various soil conditions. By combining two machine learning models—Random Forest and Artificial Neural Network (ANN) —we achieved improved prediction accuracy compared to using individual models. The implementation on Google Colab provided a scalable and accessible platform for training and evaluating the models. Future work includes expanding the dataset, integrating additional environmental factors, and potentially developing a user-friendly interface for real-world applications. This approach has the potential to significantly enhance agricultural decision-making and productivity.

References

[1] A. Sharma, R. Verma, and P. Singh, "Application of random forest in soil classification for fertilizer recommendation," *International Journal of Agricultural Science*, vol. 12, no. 4, pp. 112–125, 2021.

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[3] D. Gupta, T. Roy, and M. Chatterjee, "Artificial neural networks for fertilizer prediction: A machine learning approach," *Journal of Precision Agriculture*, vol. 25, no. 1, pp. 78–91, 2023.

[4] H. Singh, K. Banerjee, and P. Das, "Hybrid decision tree and deep learning model for fertilizer recommendation," in *Proceedings of the AI in Agriculture Conference*, vol. 15, pp. 200–215, 2021.