ML-powered Crop & Fertilizer Recommendation System

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Introduction

- Precision farming is the next big revolution in agriculture. It aims to bring Artificial Intelligence to the farmers, allowing them to make precise decisions, resulting in higher harvest and less wastage of resources.
- In precision farming, a variety of IoT sensors can be used to gather various environmental parameters related to farms, including water requirements, climate, and soil nutrient level. The data collected can be utilized by an ML-powered crop and fertilizer recommendation system that can be used by farmers to determine what crop should be harvested and what fertilizer to be used to maximize yield.
- The crop and fertilizer recommendation system here considers several factors such as soil type, climate, rainfall, temperature, humidity, and pH levels to determine the most suitable crops and fertilizer to be used for a given region.

Datasets

Crops Recommendation dataset(from India): https://www.kaggle.com/datasets/atharvaingle/crop-recommendation-dataset/data

- Nitrogen (N): Ranges from 0 to 145 with a mean of around 50.55. Measured in kg/ha(Kilograms per hectare).
- Phosphorus (P): Ranges from 0 to 145 with a mean of approximately 53.36. Measured in kg/ha.
- Potassium (K): Has a wide range from 5 to 205, average near 48.15. Measured in kg/ha.
- Temperature: Varies from 8.83°C to 43.68°C, average around 25.62°C.
- Humidity: Ranges from 14.26% to nearly 100%, with an average of 71.48%.
- pH: Varies from 3.50 to 9.94, with a mean value close to 6.47.
- Rainfall: Ranges from 20.21 mm to 298.56 mm, with an average of 103.46 mm.
- Label: Includes crops like rice, chickpea, kidney beans, etc.

	N	P	K	temperature	humidity	ph	rainfall	label
0	90	42	43	20.879744	82.002744	6.502985	202.935536	rice
1	85	58	41	21.770462	80.319644	7.038096	226.655537	rice
2	60	55	44	23.004459	82.320763	7.840207	263.964248	rice
3	74	35	40	26.491096	80.158363	6.980401	242.864034	rice
4	78	42	42	20.130175	81.604873	7.628473	262.717340	rice

Datasets

Fertilizer Recommendation dataset(from India): https://www.kaggle.com/datasets/gdabhishek/fertilizer-prediction

To predict the fertilizer to be used, we use input parameters like Nitrogen(N), Phosphorous(P), potassium(K), temperature, humidity, and crop to be grown.

Temparature	Humidity	Crop Type	Nitrogen	Potassium	Phosphorous	Fertilizer Name
26	52	Maize	37	0	0	Urea
29	52	Sugarcane	12	0	36	DAP
34	65	Cotton	7	9	30	14-35-14
32	62	Tobacco	22	0	20	28-28
28	54	Paddy	35	0	0	Urea
26	52	Barley	12	10	13	17-17-17

Fertilizers used in dataset:

Urea: NPK of 46-0-0.
DAP (Diammonium phosphate): 18% Nitrogen and 46% Phosphorus
Fourteen-Thirty Five-Fourteen: Nitrogen at 14%, Phosphorus at 35% and Potassium at 14%
Twenty Eight-Twenty Eight: Nitrogen - 28% and Phosphorus -28%
Seventeen-Seventeen-Seventeen: 17% of nitrogen, 17% phosphorous, and 17% potassium.
Ten-Twenty Six-Twenty Six: Nitrogen at 10%, Phosphorus at 26% and Potassium at 26%

ML Model Selection – Crop recommendation

Naive Bayes (Classic ML algorithm):

- Gaussian Naive Bayes is effective when dealing with continuous data. This is relevant in agricultural datasets where many features such as temperature, rainfall, and pH levels are continuous and can be assumed to follow a Gaussian distribution.
- Even with a smaller amount of data, Naive Bayes can perform quite well, making it a good choice for problems where the amount of data may be limited.
- Accuracy obtained : 99.56%

Neural Networks:

- Strengths: Ability to learn non-linear relationships; suitable for large datasets with many features.
- Weaknesses: Require more data to train; more computationally intensive.
- Accuracy obtained : 96.81%

Why Naive Bayes Performs Better than Neural Networks in this case?

- Naive Bayes helps to avoid overfitting, a problem that more complex models face. Neural Networks suffer from overfitting, since there is need for more data.

ML Model Selection – Crop recommendation

- **Training Time Comparison**

Observations: Naive Bayes requires significantly less training time compared to Neural Networks, making it efficient for scenarios with limited computational resources.

- **Memory Usage Evaluation**

Observations: Neural Networks consume more memory due to their complex architecture, while Naive Bayes, with its simpler structure, has a lower memory footprint, suitable for deployment with restricted memory.

- **Model Complexity and Size**

Observations: Naive Bayes, being fundamentally simpler, has fewer parameters and thus lower complexity.

ML MODEL SELECTED:

Considering all the above factors, **Naive Bayes** ML Algorithm is used for Crop Recommendation System.

Why is fertilizer recommendation needed?

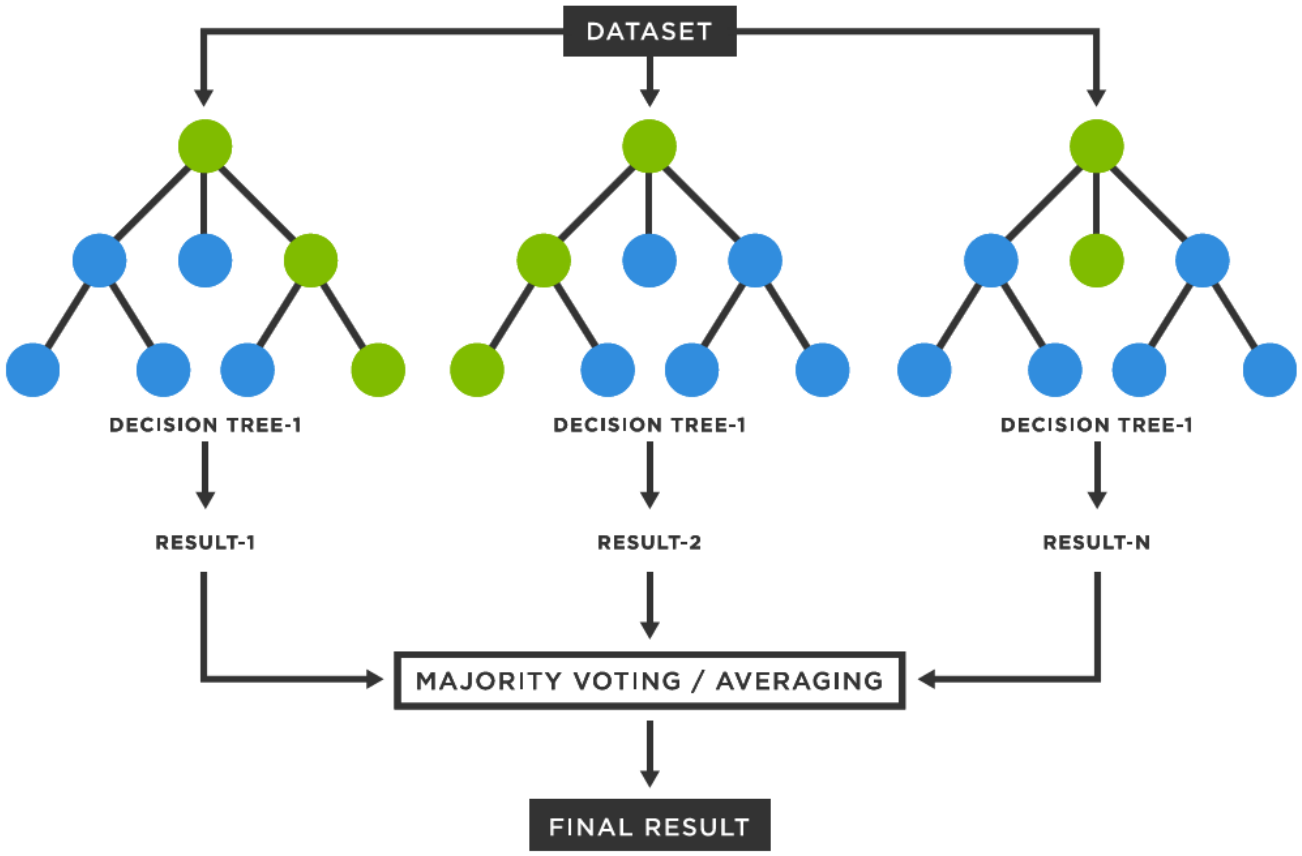
Even when a suitable crop is recommended for a particular soil type, fertilizer recommendations are still needed because:

1. **Nutrient Depletion in soil due to continuous farming**: Over time, repeated planting of crops in the same soil depletes essential nutrients.
2. **Boosting Crop Yield**
3. **Compensating for Weather (Rainfall and Leaching)**: In regions with heavy rainfall, essential nutrients can be washed away from the soil (leaching). Fertilizers help to replenish these lost nutrients.

ML Model Selection – Fertilizer recommendation

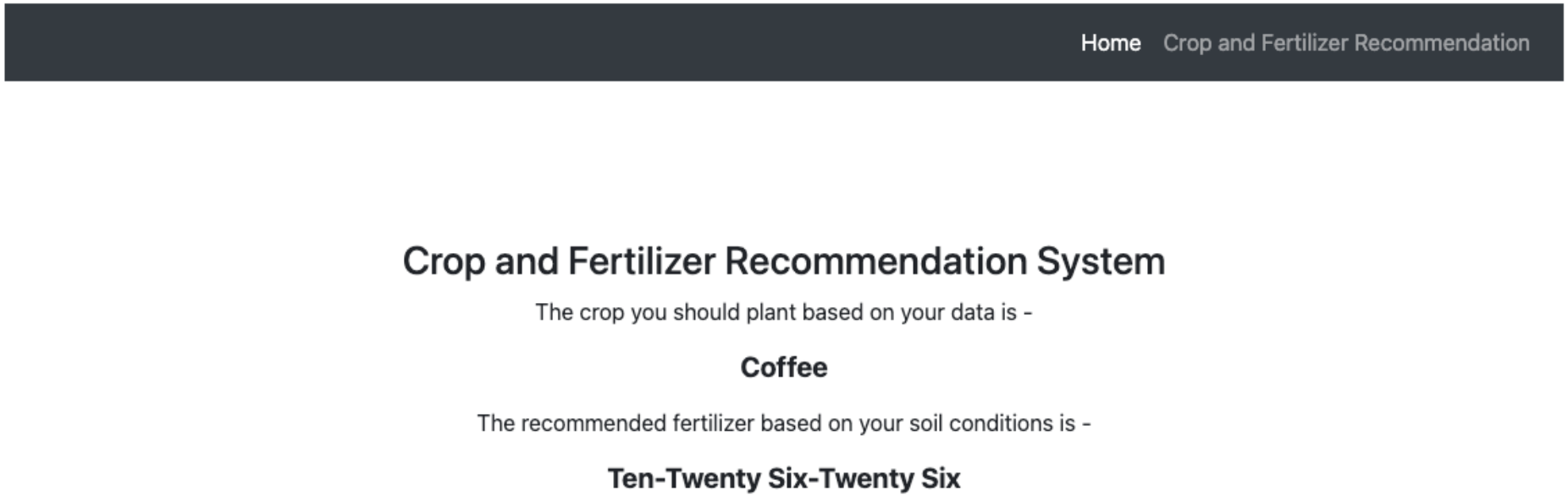
Random Forest:

- Based on the concept of ensemble learning, this technique enhances the performance of the model using an ensemble of classifiers(Decision Trees)
- Accuracy obtained : 98.22%



Web Application Using Flask in Python 3

Flask is a lightweight Python web framework that provides tools to create web applications in Python.



THANK YOU!!