Land Region Monitoring for farming using Deep Learning

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EECE DEPARTMENT GITAM BENGALURU

INSTITUTION'S INNOVATION COUNCIL (Ministry of Education Initiative)

Department Research Day — Inspiring Minds, Advancing Frontiers

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Abstract

The decreasing agricultural land and growing population necessitate improved farming methods. Our project aims to create a free software tool to help farmers in India identify soil types and compositions, recommending suitable crops, fertilizers, and disease prevention strategies. Utilizing image processing techniques, the tool classifies various soil types such as sandy, saline, alkaline, and calcareous soils. The system operates in three stages: low-level processing enhances images and reduces noise for analysis, medium-level processing extracts key features using transformations and high-level processing employs Convolutional Neural Networks (CNN) for accurate classification. By analyzing soil images, the tool determines nutrient content and offers data-driven recommendations, improving yield and reducing costs. Designed for user-friendliness, it empowers farmers, even those with limited technical skills. This software can boost agricultural productivity and be adapted for diverse regions, fostering sustainable practices worldwide.

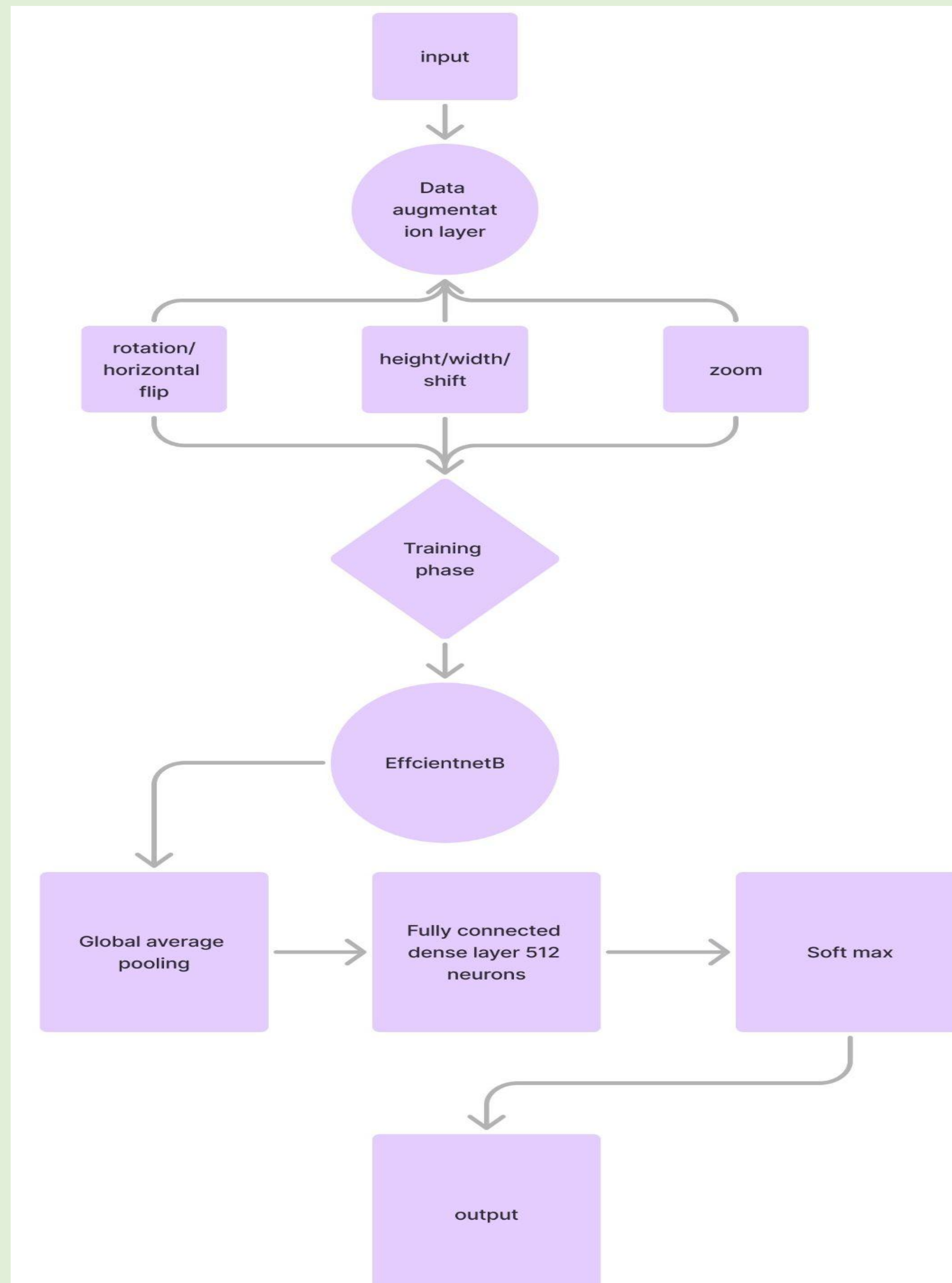
BackGround

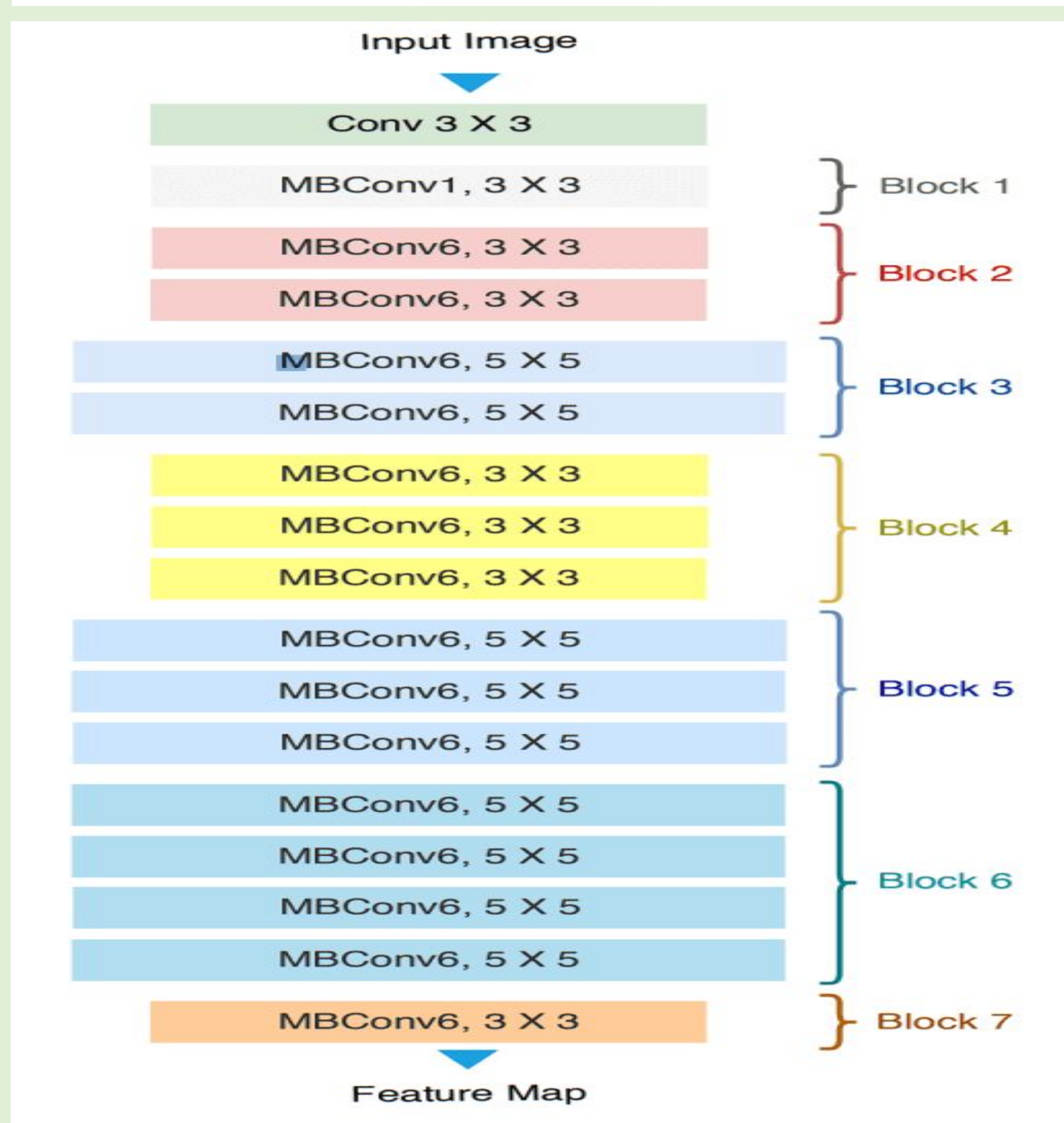
For generations, farmers have relied on their experience to understand the land and make decisions about which crops to grow. However, as agriculture becomes more complex—especially in a diverse country like India—this traditional approach is no longer enough. The wide variety of soil types, from sandy to alkaline and clay, makes it essential to have accurate tools for selecting the right crops.

Unfortunately, current soil testing methods can be expensive and time-consuming, leaving small-scale farmers at a disadvantage. To address this challenge, we are developing an **automated soil classification tool** that harnesses the power of **image processing** and **Convolutional Neural Networks (CNNs)**. This innovative system will analyze soil images to accurately identify soil types and provide tailored crop recommendations.

Our goal is to help farmers increase their yields, reduce costs, and embrace sustainable farming practices through data-driven decisions. Designed to be user-friendly and free, this tool aims to offer real-time analysis and scalable solutions that benefit not just Indian agriculture but farming communities worldwide.

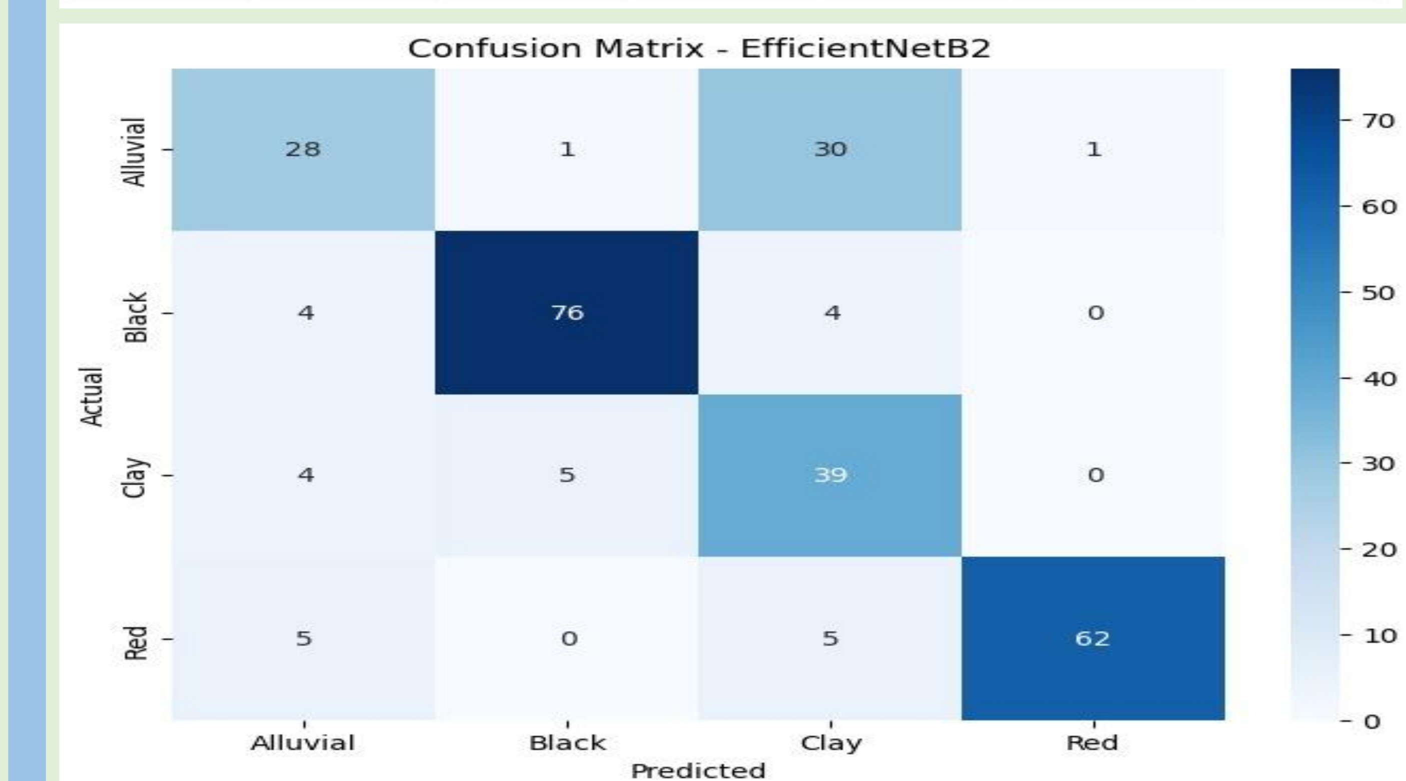
Methods

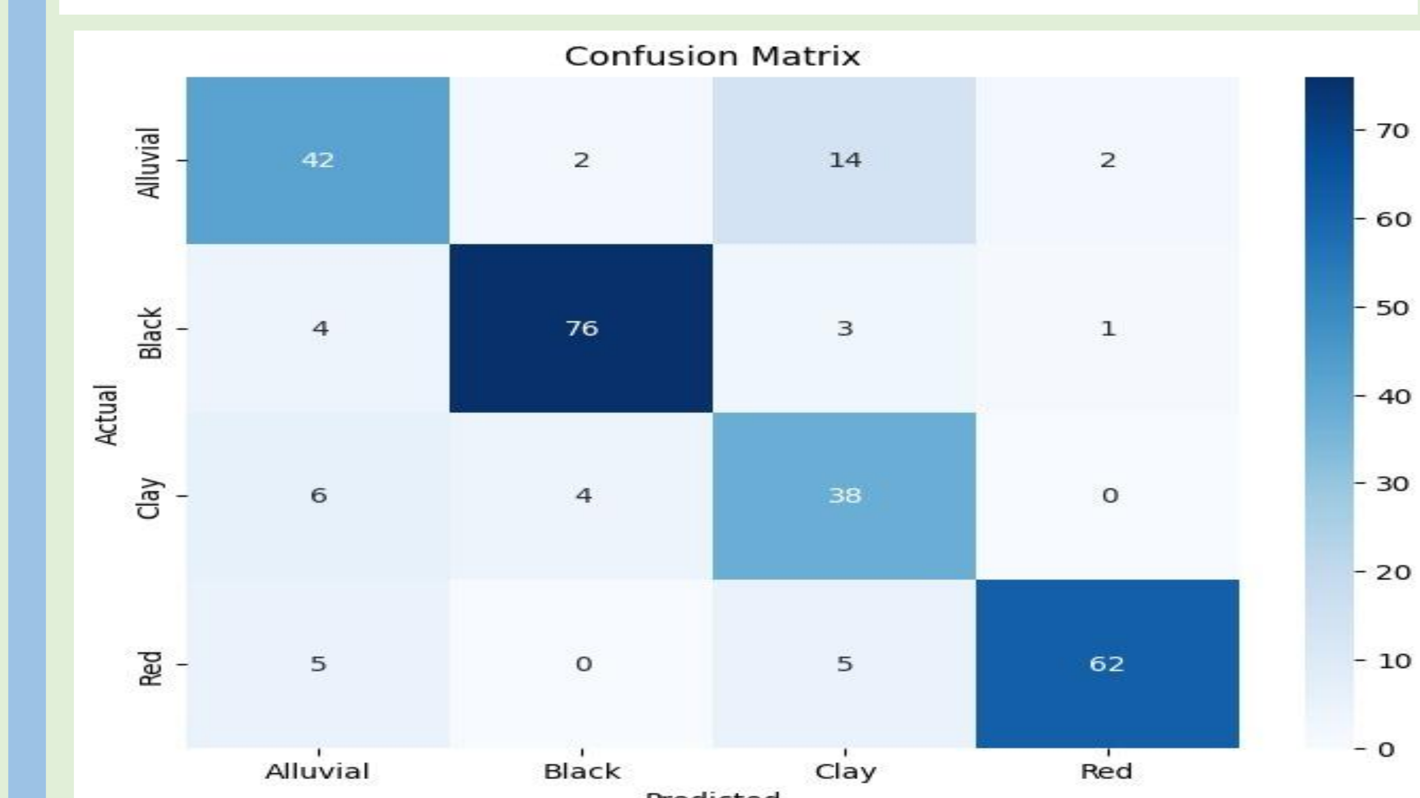


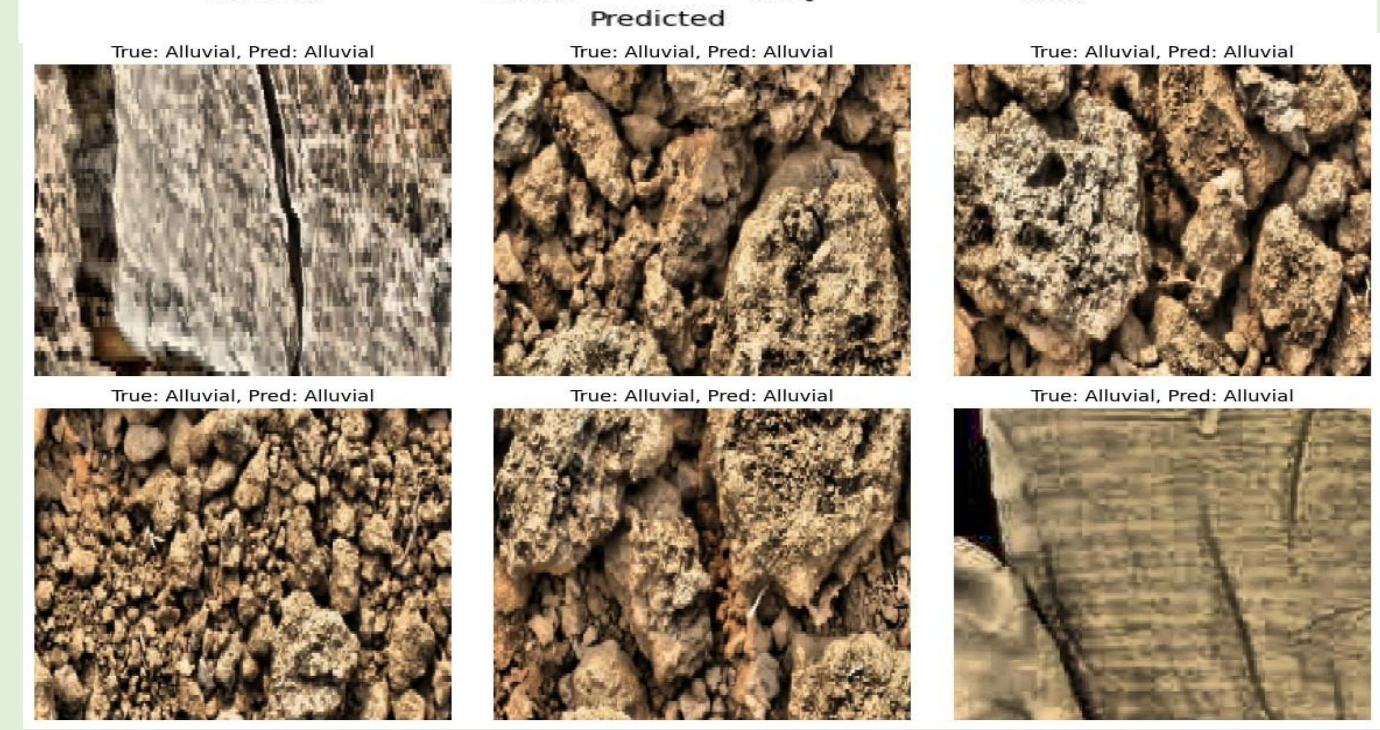


Results

Model	Accuracy	ROC AUC Score	Soil Type	Precision	Recall	F1-Score
EfficientNet B0	89%	0.9496	Alluvial Soil	0.68	0.57	0.62
			Black Soil	0.90	0.92	0.91
			Clay Soil	0.60	0.85	0.71
			Red Soil	0.98	0.82	0.89
EfficientNet B1	78%	0.9423	Alluvial Soil	0.68	0.47	0.55
			Black Soil	0.93	0.90	0.92
			Clay Soil	0.50	0.81	0.62
			Red Soil	0.98	0.86	0.92
EfficientNet B2	83%	0.9497	Alluvial Soil	0.74	0.70	0.72
			Black Soil	0.93	0.90	0.92
			Clay Soil	0.63	0.79	0.70
			Red Soil	0.95	0.86	0.91







Future Perspectives

Expanding Datasets

- One of the critical next steps is expanding the dataset to include more diverse and representative soil samples. The current dataset has limitations, which may impact the model's generalizability. Collecting more extensive soil images across various regions, seasons, and conditions will improve the model's ability to handle diverse scenarios and enhance its robustness.

Improving Accuracy and Precision

- Future efforts will focus on boosting model accuracy and precision. This can be achieved through fine-tuning hyperparameters and experimenting with alternative architectures. Additionally, employing more sophisticated data augmentation techniques will ensure better generalization and improved prediction performance.

Integration with IoT for Real-Time Data

- A major future goal is to integrate the system with IoT devices to enable real-time data collection and analysis. This could empower farmers to receive instant soil and crop recommendations, significantly enhancing decision-making on the field. Real-time IoT integration will open up new possibilities for autonomous monitoring and intelligent farming systems.

Conclusion

In this project, we built an image classification model using EfficientNet, enhanced with data augmentation and fine-tuned for high performance. Along the way, we tackled common challenges like overfitting and class imbalance, ensuring the model stayed reliable across a variety of datasets. The results—high accuracy, precision, and recall—show that the model is ready for real-world applications.

This journey highlighted the value of combining smart architectures with thoughtful optimization. While there's still room to explore, especially in making the model suitable for real-time use, the strong foundation we've built here demonstrates its potential to solve practical, meaningful problems.