Policy Brief

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Agricultural soil characterization and crop recommendation using deep learning algorithms: Model Selection and AI Application Development

Context to the study

- Agriculture serves as the lifeblood of numerous nations, with soil playing a pivotal role as its fundamental component.
- The global population is rapidly increasing, resulting in a corresponding surge in food demand.
- Part of the solution is to know the type of soil and identify the most suitable crops and fertilizers to unpack the potential of the soil to increase productivity.

Summary of findings

- The findings highlight that ResNet50 and DenseNet201 were better than other models for all performance metrics.
- A user-friendly application was built enabling soil identification and providing recommendations.
- The AI application is built on ResNet50 model architecture because it was found more performant.
- The developed application is meant to empower farmers to optimize their practices in the face of land degradation and climate change challenges.

Introduction

in West Africa the success of farming is heavily reliant on the characteristics of the soil, as it determines the appropriate crop selection, fertilizer usage, and farming techniques. Therefore, soil analysis becomes crucial in making informed decisions about farming practices (Jones, 1993).

Particularly, Sub-Saharan Africa (SSA) has faced several challenges throughout the years, including a rapidly expanding population, significant urbanization, climate change, and persistent food insecurity (Sakho-Jimbira & Hathie, 2020).

In order to address this knowledge-gap, this study aims to:

- To build different machine learning models for soil types classification in Maradi;
- To identify out of the studied models the best in classifying soil types in Maradi;
- To build an AI-based application for soil type classification in Maradi;
- To integrate local language in the system.

Summary of Research

Agriculture is vital, and soil is a fundamental component with unique characteristics for different crops. This thesis research aimed to develop a deep learning-based system for soil type classification. It explores the performances of eight CNNs architectures namely, DenseNet201, MobileNetV3Large, VGG16, VGG19, InceptionV3, ResNet50, Xception, and a novel architecture referred to as simple_architecture, for classifying agricultural soil types found in Maradi, Niger. The research methodology encompasses data collection, cleaning, preprocessing, model building, hyperparameter optimization, model compilation, and the development of an AI-based application. The findings highlight that ResNet50 and DenseNet201 were better than other models for all performance metrics. Thus, the developed application is meant to empower farmers to optimize their practices in the face of land degradation and climate change challenges.

Research Findings

This study enbled to find that:

ResNet50 and Densenet201 achieved the highest validation accuracies of 98.9% and 98.4% respectively, indicating superior performance compared to the other models. On the other hand, Inception_v3 had the lowest validation accuracy which is 75.1% even though all the models have demonstrated good learning performances.

MobileNetV3Large and the novel architecture outperformed other models in terms of precision even though slightly higher that of ResNet50 and VGG19. But Resnet50 is still having the highest test and validation accuracies. On the other hand, it shows that Inception_V3 scored the lowest precision, recall, and f1-score. It can also be observed that all the models have the validation and test accuracies without significant different nearly the same in termers of values.

The previous figure shows how the results of the classification are displayed.

Policy Recommendations

Building such an application is potentially very important to help farmers adapt to climate change but this potential should be unlocked to make application effectively important.

1) Dataset expansion

The dataset used in this research can be expanded to include a wider range of soil types and regions. This would allow for more robust model training and evaluation, ensuring the applicability of the soil identification application across diverse agricultural contexts.

2) Farmers training on the application

Farmers of the area covered by the research should be trained on the right way to use the application efficiently.

3) Evaluating the economic and environmental impacts of adopting the application

The AI-based soil identification application can provide valuable insights into its effectiveness and potential benefits. Assessing factors such as cost savings, yield improvement, and environmental sustainability will further support the case for the widespread adoption of such technology in the agricultural sector.

References

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