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A Critical Evaluation of GAN-Based Data Extension Methods for Plant Disease Classification in Low-Resource Settings

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Accurate classification of plant diseases is crucial in agriculture, yet the development of accurate deep learning models often requires large and diverse datasets. Generative Adversarial Networks (GANs), introduced in 2014 and popularized for image synthesis in subsequent years, offer a promising approach for generating synthetic training samples beyond traditional augmentation methods such as rotation, resizing, cropping, flipping, brightness and contrast adjustments. Unlike basic augmentations, GANs are capable of creating more complex and realistic images, potentially improving model performance in data-scarce scenarios.

This study reviews recent advancements and applications of GANs in the context of plant disease detection, with a focus on their effectiveness as data extension tools. Several research works are analyzed, and various GAN architectures are evaluated—including DCGAN, WGAN, StyleGAN, and feature-transfer models like CycleGAN—on a dataset of 68 plant disease classes with sample sizes ranging from 15 to 200 images per class. The evaluation considers both the visual quality of the generated images and their impact on classification accuracy.

The findings highlight the strengths and limitations of each approach, providing practical insights into the applicability of GAN-based data extension methods for enhancing plant disease classification models trained on limited datasets.

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