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Report on Leaf Classification: Fresh vs Diseased

Dataset and Preprocessing

For this project, the dataset was split into three sets: training, validation, and test. It contained two categories: diseased and fresh leaves.

The preprocessing steps were pretty standard:

Training set: I applied data augmentation techniques like random cropping and horizontal flipping to help the model generalize better. After that, I normalized the images based on ImageNet's mean and standard deviation since we're using a pre-trained ResNet.

Validation and test sets: I simply resized the images to 256x256, cropped them to 224x224, and normalized them the same way as the training set, but without augmentation. We want consistent input for evaluation.

Model and Techniques Used

I used ResNet18, a pre-trained Convolutional Neural Network. Since ResNet18 was already trained on ImageNet, it knows how to detect general features in images, which saves time and improves accuracy. I only modified the final layer to output two classes (fresh vs. diseased leaf).

The training process included:

- Cross-entropy loss for multi-class classification.
- Adam optimizer with a learning rate of 0.001.
- A learning rate scheduler that reduces the learning rate when the validation loss stops improving.

Additionally, I set up early stopping to avoid overfitting if the model didn't improve for 10 epochs straight. This however did end up causing overfitting so I changed it to 4 epochs and saw the same results.

Training and Evaluation Results

The training process went smoothly over 25 epochs, but the model actually stopped early (before all 25 epochs) because the validation accuracy had hit a plateau. The final model had great results, achieving:

- Accuracy: 1.00
- Precision: 1.00
- Recall: 1.00
- Confustion Matrix: [[3 0] [0 5]]

It means the model correctly classified all the fresh and diseased leaves.

Challenges and Solutions

There weren't any major challenges, but I had to watch out for overfitting, which is why early stopping and data augmentation were so important. It's easy for a powerful model like ResNet18 to memorize the small dataset, so these techniques helped the model generalize better. Although it did not help much in the grand scheme as even early stopping at 4 was not enough for overfitting.

Other Applications

The techniques used here can be applied to many other domains where image classification is key. Some examples include:

- Medical diagnostics (e.g., detecting diseases from X-rays or MRI scans).
- Agriculture (e.g., identifying crop health).
- Quality control in manufacturing (e.g., detecting defects in products).