Potato Leaf Disease Detection using Dense Convolutional Neural Networks (D-CNNs)

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Problem Statement and Background

- **Problem Statement:** Potato leaf diseases like early and late blight impact productivity and food security. Current manual inspection methods are time-consuming, labor-intensive, and often inaccurate.
- **Background**:
  - Importance: Potato crops are economically valuable and crucial for food security.
  - Challenges: Disease detection is difficult due to subtle variations in symptoms.

Project Importance

- **Agricultural Productivity**: Early disease detection prevents crop losses.
- **Resource Optimization**: Automated methods reduce manual labor and pesticide use.
- **Food Security**: Accurate detection helps ensure stable food supplies.

Proposed Solution

- **Dense Convolutional Neural Network (D-CNN)**:
  - **Dense Blocks**: Connect all layers within a block to enhance feature propagation.
  - **Growth Rate**: Controls the amount of information added in each layer.
  - **Transition Layers**: Reduce dimensionality to prevent overly wide networks.
- This model aims to improve feature reuse, reduce vanishing gradient issues, and increase classification accuracy.

Model Architecture

Layers:

1. **Input Layer**: Receives resized images (224x224 pixels).
2. **Convolutional and Max Pooling Layers**: Initial feature extraction and dimension reduction.
3. **Dense Blocks and Transition Layers**: Enhance feature propagation and reduce dimensionality.
4. **Global Average Pooling and Dense Layers**: Aggregate features for classification.

Output Layer: Three-class softmax activation for final classification of healthy, early blight, and late blight leaves.

Implementation Details

Environment: Python, TensorFlow, Keras, and others.
Dataset Preparation:

- **Source**: PlantVillage dataset
- **Classes**: Healthy, Early Blight, Late Blight
- **Split**: Training (70%), Validation (20%), Test (10%)
- **Preprocessing**: Resized and scaled to 224x224 pixels, augmented with flips and rotations.

Training:

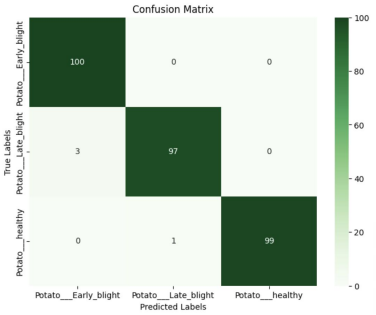
- Optimizer: Stochastic Gradient Descent (SGD) with a 0.001 learning rate
- Loss Function: Sparse categorical cross-entropy

Challenges and Solutions

- **Data Imbalance**: Addressed through data augmentation.
- **Overfitting**: Managed with dropout layers and early stopping.
- **Image Preprocessing**: Custom scaling and enhancement functions to improve model robustness.

Results

- **Training and Validation Performance**:
  - **Training Accuracy**: 98.47%
  - **Validation Accuracy**: 99.00%
  - **Test Accuracy**: 99.00%
- **Confusion Matrix**:



- **Performance Metrics**:

	precision	recall	f1-score	support
Potato___Early_blight	0.97	1.00	0.99	100
Potato___Late_blight	0.99	0.97	0.98	100
Potato___healthy	1.00	0.99	0.99	100
accuracy			0.99	300
macro avg	0.99	0.99	0.99	300
weighted avg	0.99	0.99	0.99	300

Comparison with Research Paper Models

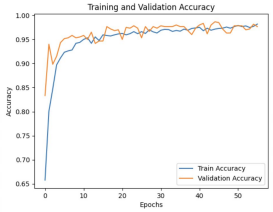
Pre-Trained Model	Training Acc (%)	Validation Acc (%)	Training Loss	Validation Loss	Testing Acc (%)
VGG16	95	94	0.0358	0.0430	94
VGG19	92	94	0.2935	0.0555	90
MobileNetV2	94	95	0.0771	0.0630	95
ResNet50	96	96	0.0174	0.0171	97
AlexNet	94	93	0.0602	0.0966	95

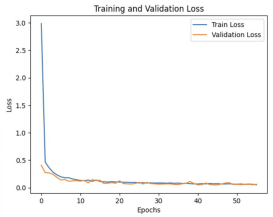
Main Paper Results:

- ResNet50: 97% test accuracy.
- VGG16 and VGG19 had lower performance, especially for healthy leaf detection.

D-CNN Performance:

- Outperformed ResNet50 with 98.67% test accuracy, demonstrating improved feature extraction and generalization.





My model	Training Accuracy (%)	Validation Accuracy (%)	Training Loss	Validation Loss	Testing Accuracy (%)
Dense CNN	97.81	97.67	0.0569	0.0604	98.67

References

- **Main Research Paper**: Erlin, Indra Fuadi, Ramalia Noratama Putri, Dewi Nasien, Gusrianty, and Dwi Oktarina. "Deep Learning Approaches for Potato Leaf Disease Detection: Evaluating the Efficacy of Convolutional Neural Network Architectures." Revue d'Intelligence Artificielle, Vol. 38, No. 2, April 2024, pp. 717-727. DOI: 10.18280/ria.380236.

- **Dataset**: Hughes, D.P., & Salathé, M. (2015). "An open access repository of images on plant health to enable the development of mobile disease diagnostics." arXiv preprint arXiv:1511.08060. Available at: https://data.mendeley.com/datasets/tywbtsjrjv/1.

Thank you!