Classification of Ocular Diseases using Convolutional Neural Networks (CNNs)

Nur Kholifah

Statistics, MSKÜ - 2025

Project Background

Why automation is needed?

01. Vision loss is a major global health problem

02. Early detection can prevent permanent blindness

03. Manual diagnosis is time-consuming and subjective

04. Need for automated and scalable solutions

Project Objectives

01

To develop a CNN-based model for ocular disease classification

02

To handle the problem as a multi-label classification task

03

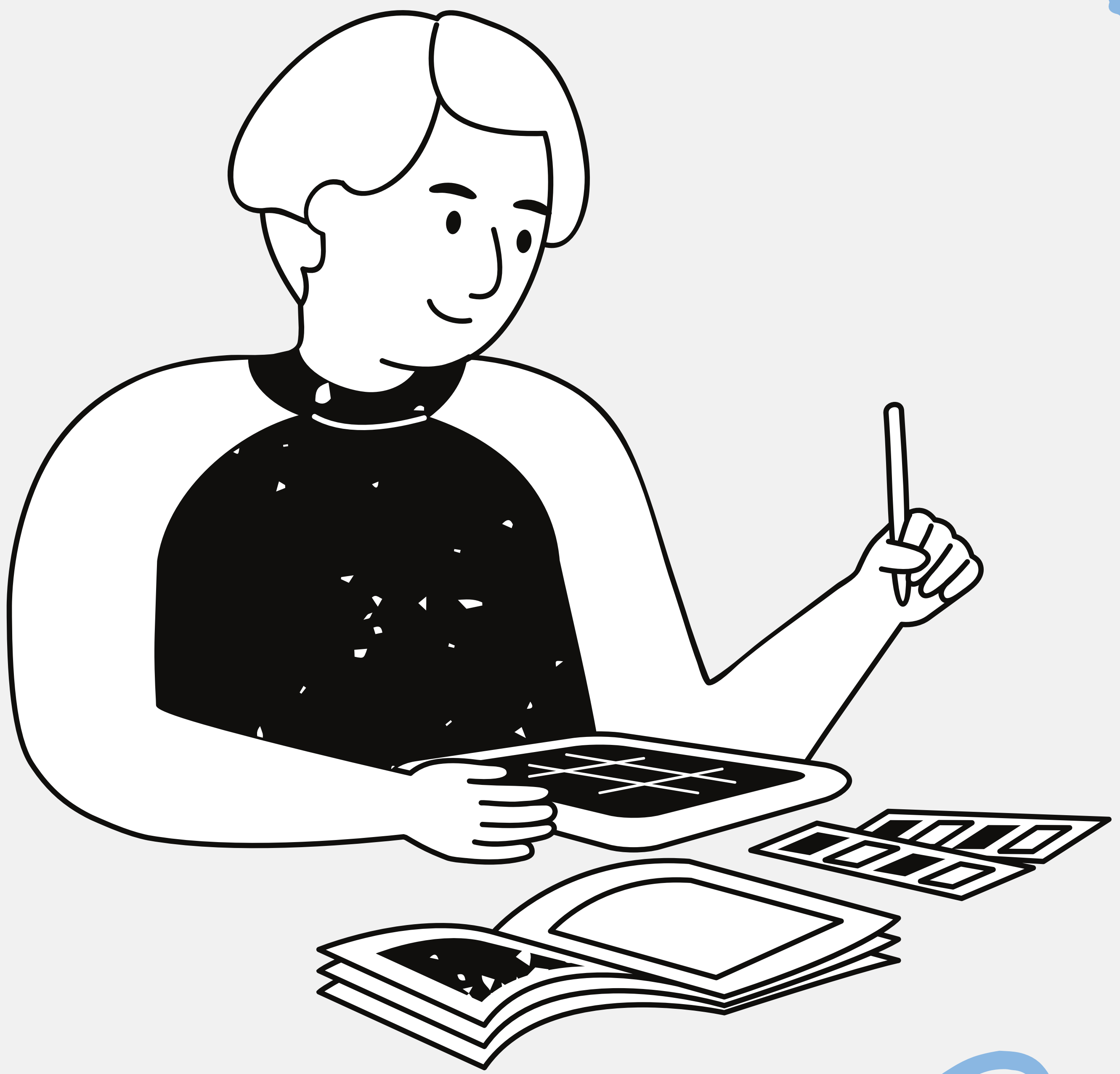
To compare the performance of different CNN architectures

04

To evaluate model performance using standard classification metrics

Dataset & Preprocessing

- Dataset source: **ODIR-5K dataset from Kaggle**
- Total images: **7,000 retinal fundus images**
- Multi-label annotations per image
- Disease classes: **Normal (N), Diabetes (D), Glaucoma (G), Cataract (C), Age-related Macular Degeneration (A), Hypertension (H), Pathological Myopia (M), Other abnormalities (O)**
- Image resized to **224 × 224 pixels**
- Preprocessing steps:
    - Image resizing
    - Normalization
    - Data augmentation (rotation, flipping)
- Train–validation split: **80% / 20%**



Experimental Setup

- Task formulation: **Multi-label image classification**
- Deep learning framework: CNN
- Transfer learning approach
- Pre-trained models used:
  - •VGG16
  - •ResNet50
  - •DenseNet121
- Same dataset and evaluation protocol used for all models

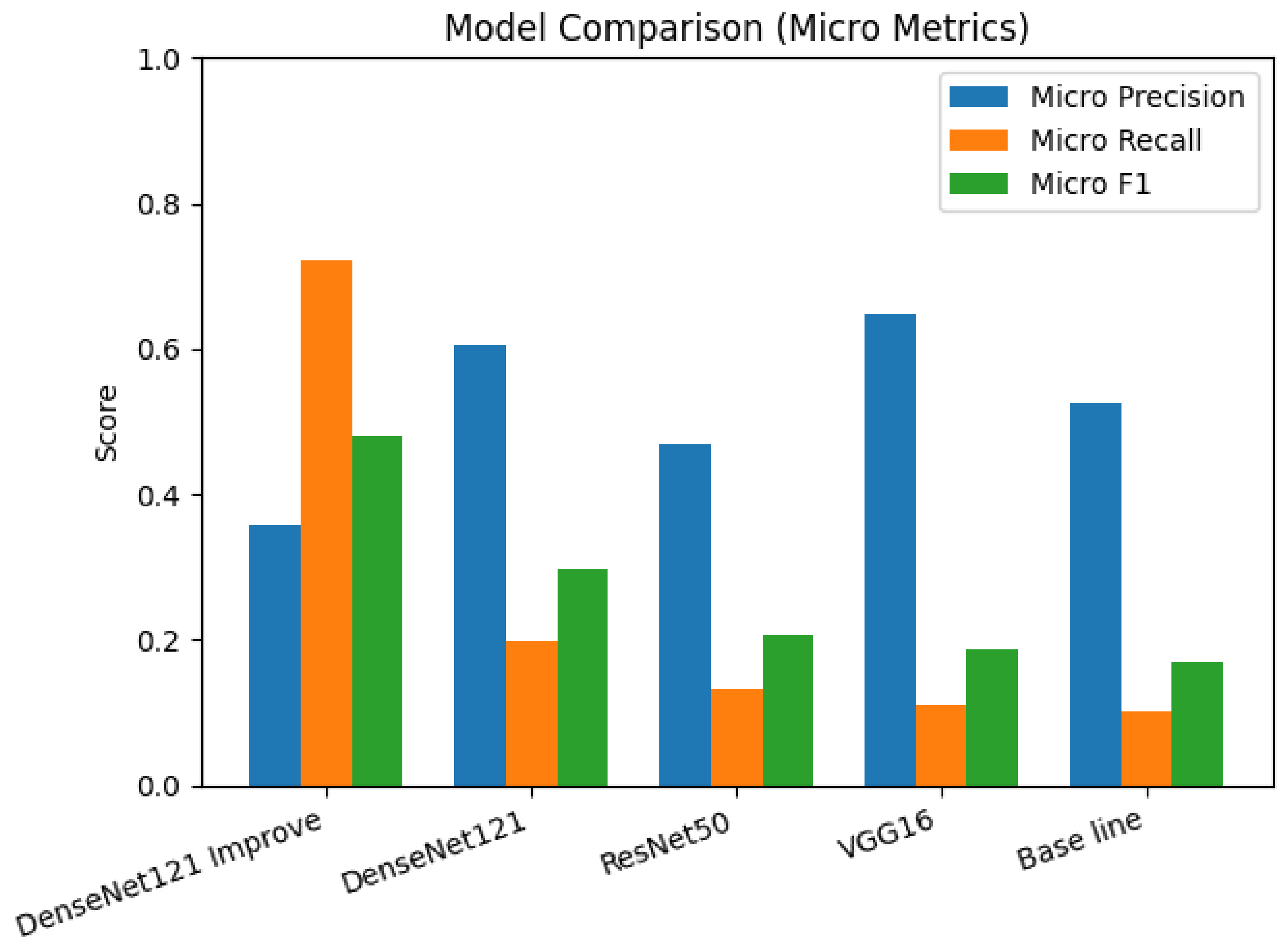
CNN Architecture Comparison

VGG16
- Deep stacked convolutional layers
- Simple and uniform architecture
- Used as baseline model

ResNet50
- Residual (skip) connections
- Helps mitigate vanishing gradient problem
- Enables deeper network training

DenseNet121
- Dense connections between layers
- Feature reuse across the network
- Improved gradient flow and efficiency

Model Performance Comparison



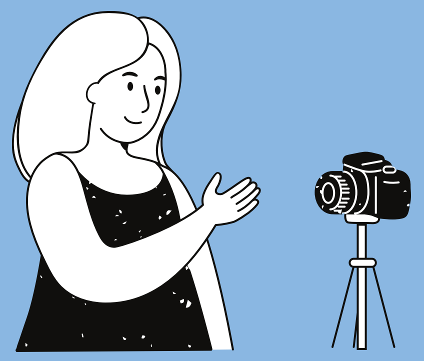
	Model	Micro Precision	Micro Recall	Micro F1
0	DenseNet121 Improve	0.354603	0.707273	0.472374
1	DenseNet121	0.637708	0.209091	0.314925
2	VGG16	0.701493	0.113939	0.196038
3	ResNet50	0.533981	0.100000	0.168453
4	Base line	0.526119	0.085455	0.147028

Achieves the highest Micro F1-score

Better balance between precision and recall

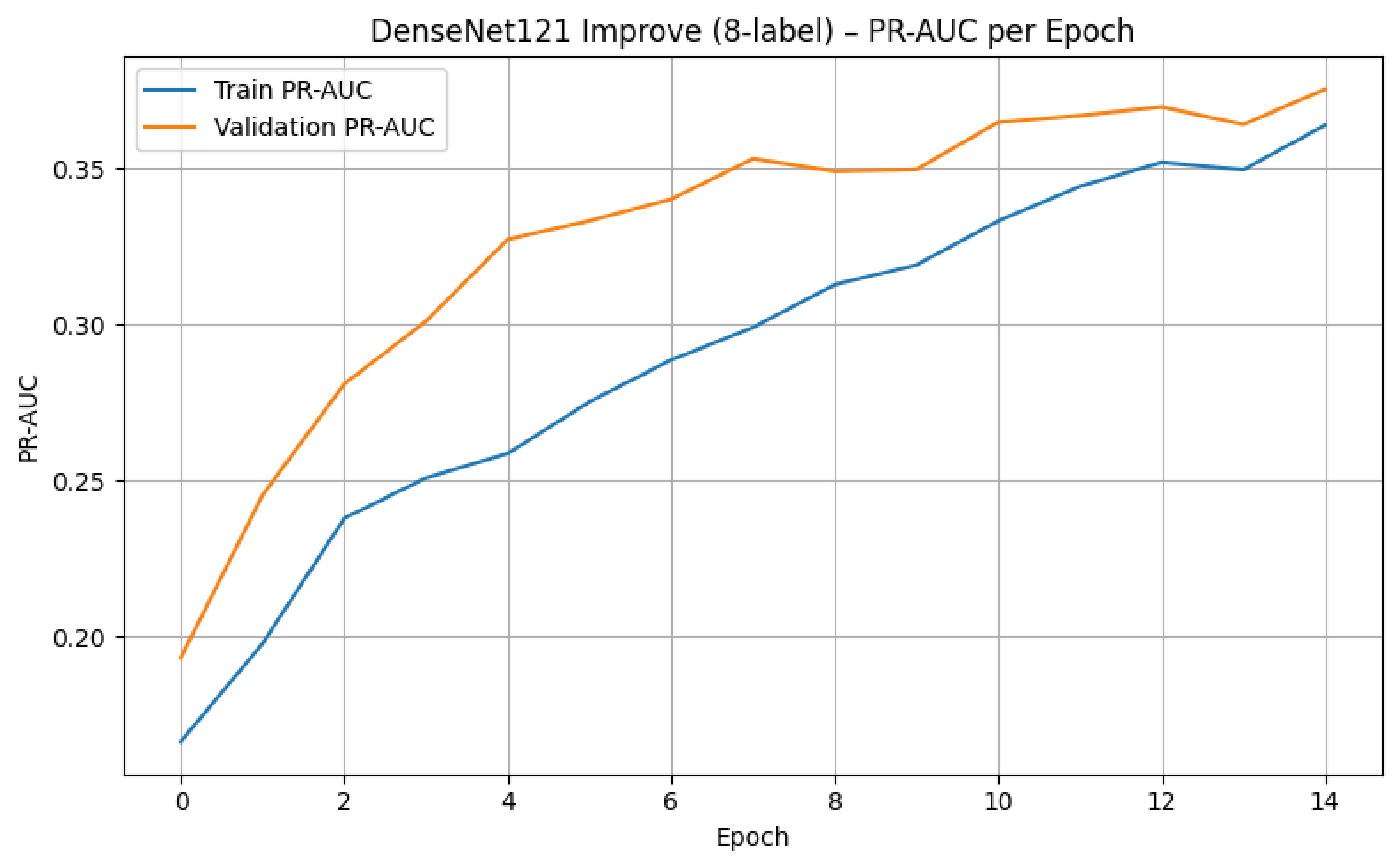
Best Model Analysis DenseNet121

Recall improves significantly after optimization

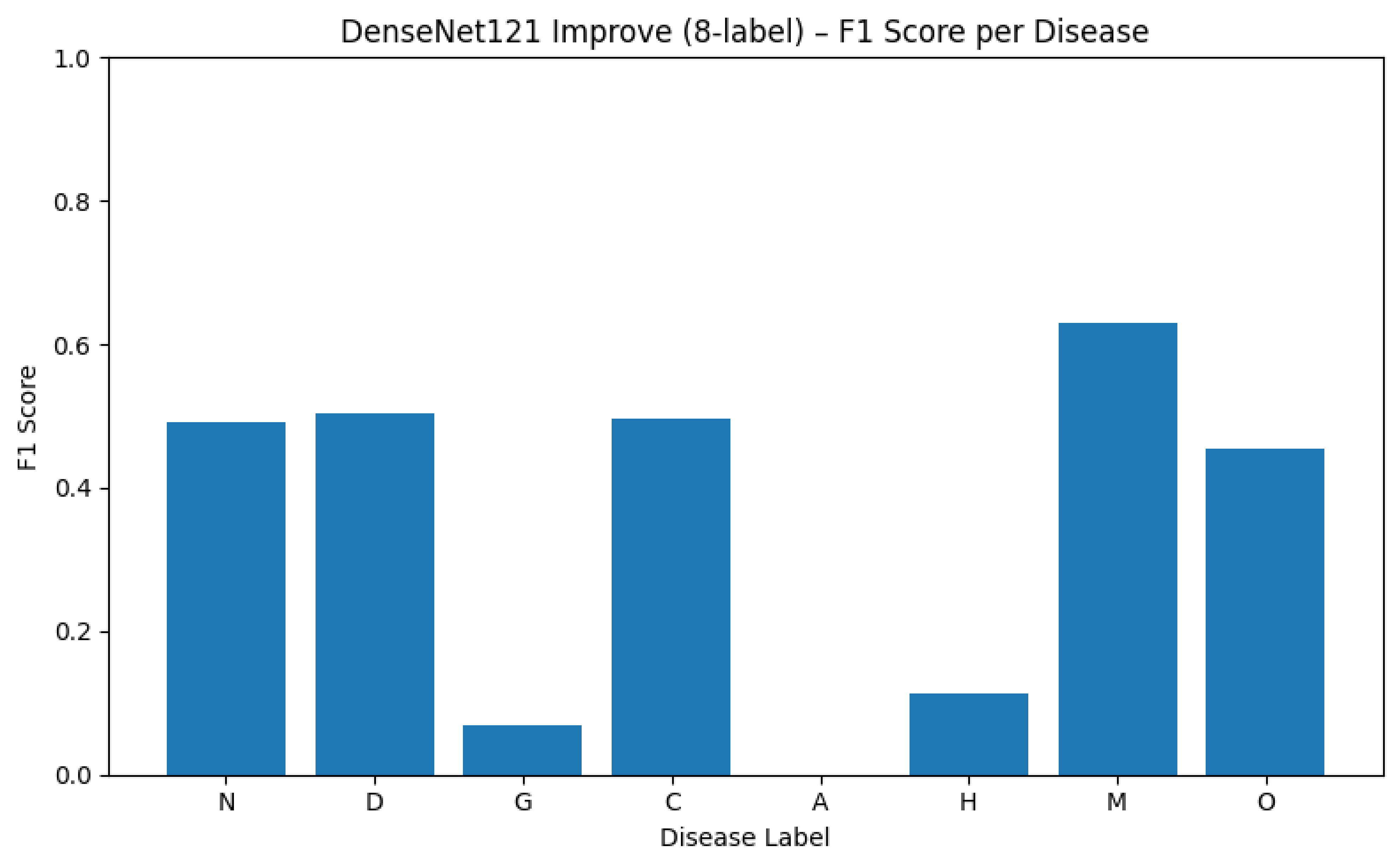


Dense connectivity helps capture subtle retinal features

Training Progress (PR-AUC per Epoch)



Per-Disease Performance Analysis



Conclusion

01

Convolutional neural networks can be used to support ocular disease classification from retinal images, addressing the need for automated diagnostic assistance.

02

The multi-label formulation allows the model to handle cases where multiple ocular diseases appear in a single image.

03

Among the evaluated architectures, DenseNet121 shows the best overall performance by achieving a better balance between precision and recall.

04

These results indicate that CNN-based approaches have the potential to help reduce reliance on manual diagnosis, while still requiring expert supervision.

Thank you very much!

Nur Kholifah