Classification of Ocular Diseases using Convolutional Neural Networks (CNNs)

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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

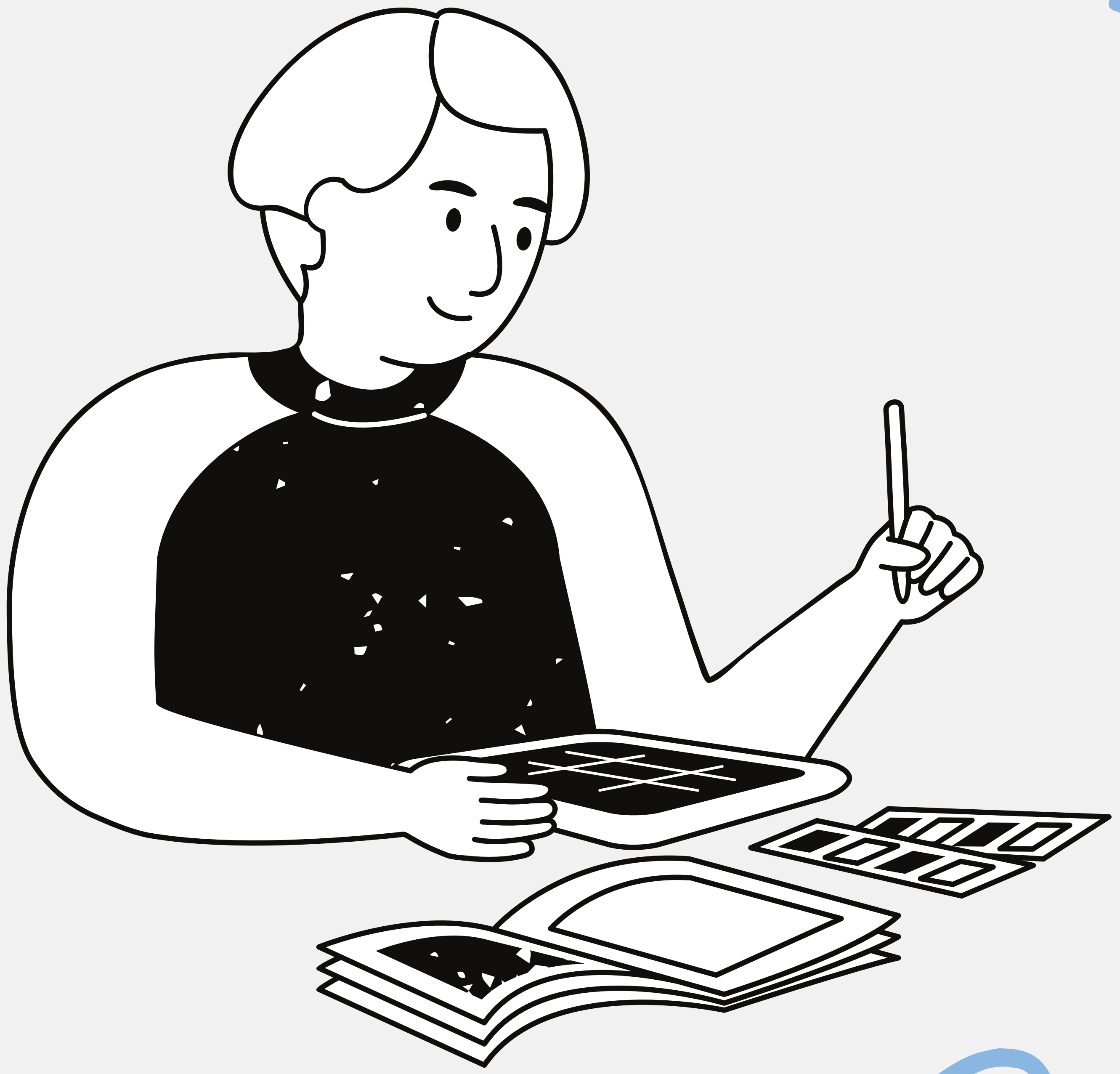
To compare the performance of different CNN architectures

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

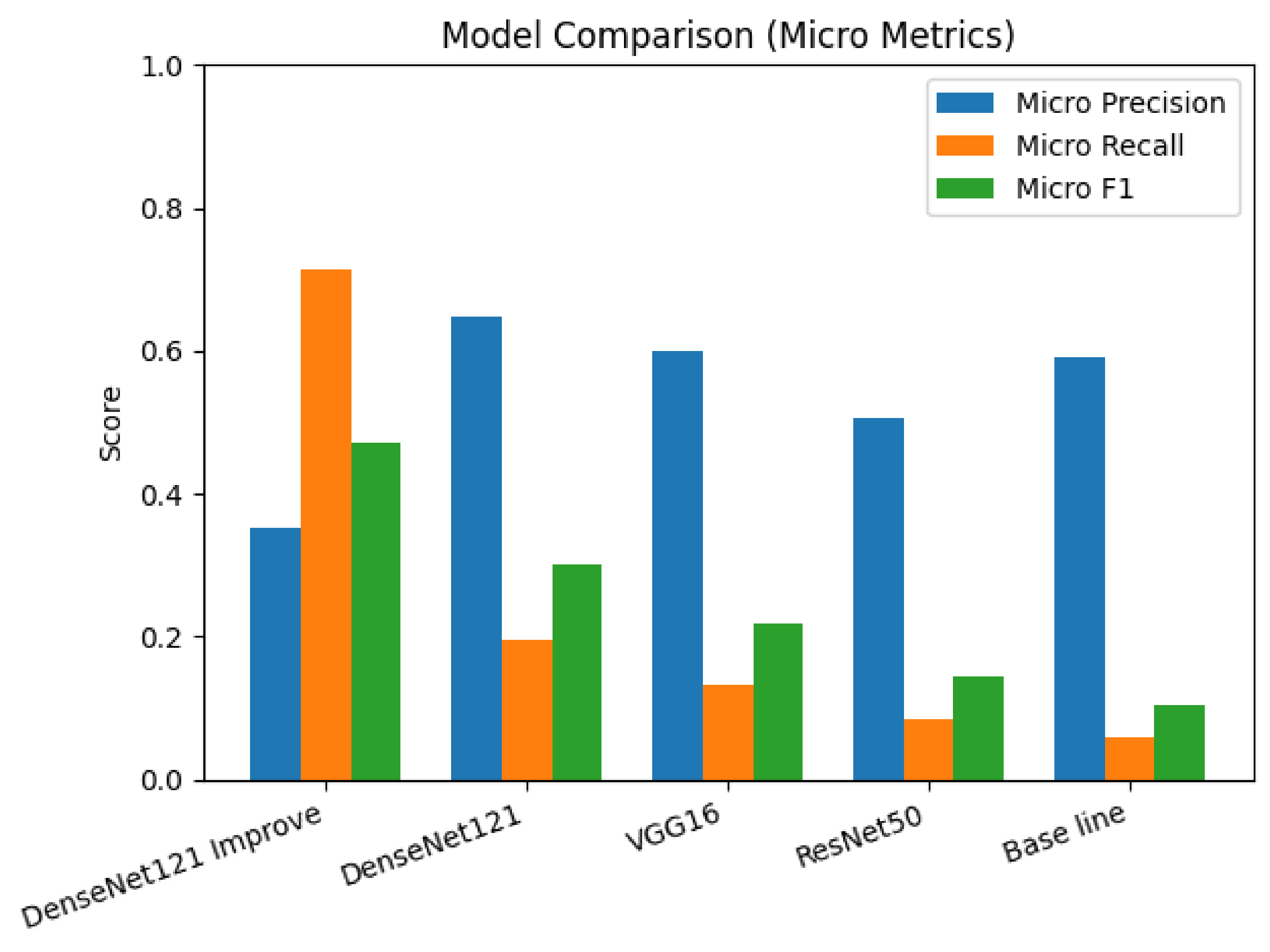
CNN Architecture Comparison

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



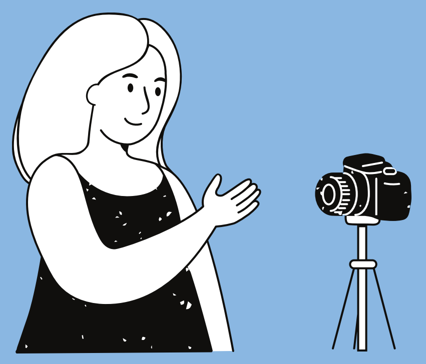
	Model	Micro Precision	Micro Recall	Micro F1
0	DenseNet121 Improve	0.353541	0.713939	0.472902
1	DenseNet121	0.646707	0.196364	0.301255
2	VGG16	0.600543	0.133939	0.219029
3	ResNet50	0.505455	0.084242	0.144416
4	Base line	0.592593	0.058182	0.105960

Best Model Analysis DenseNet121

Achieves the highest Micro F1-score

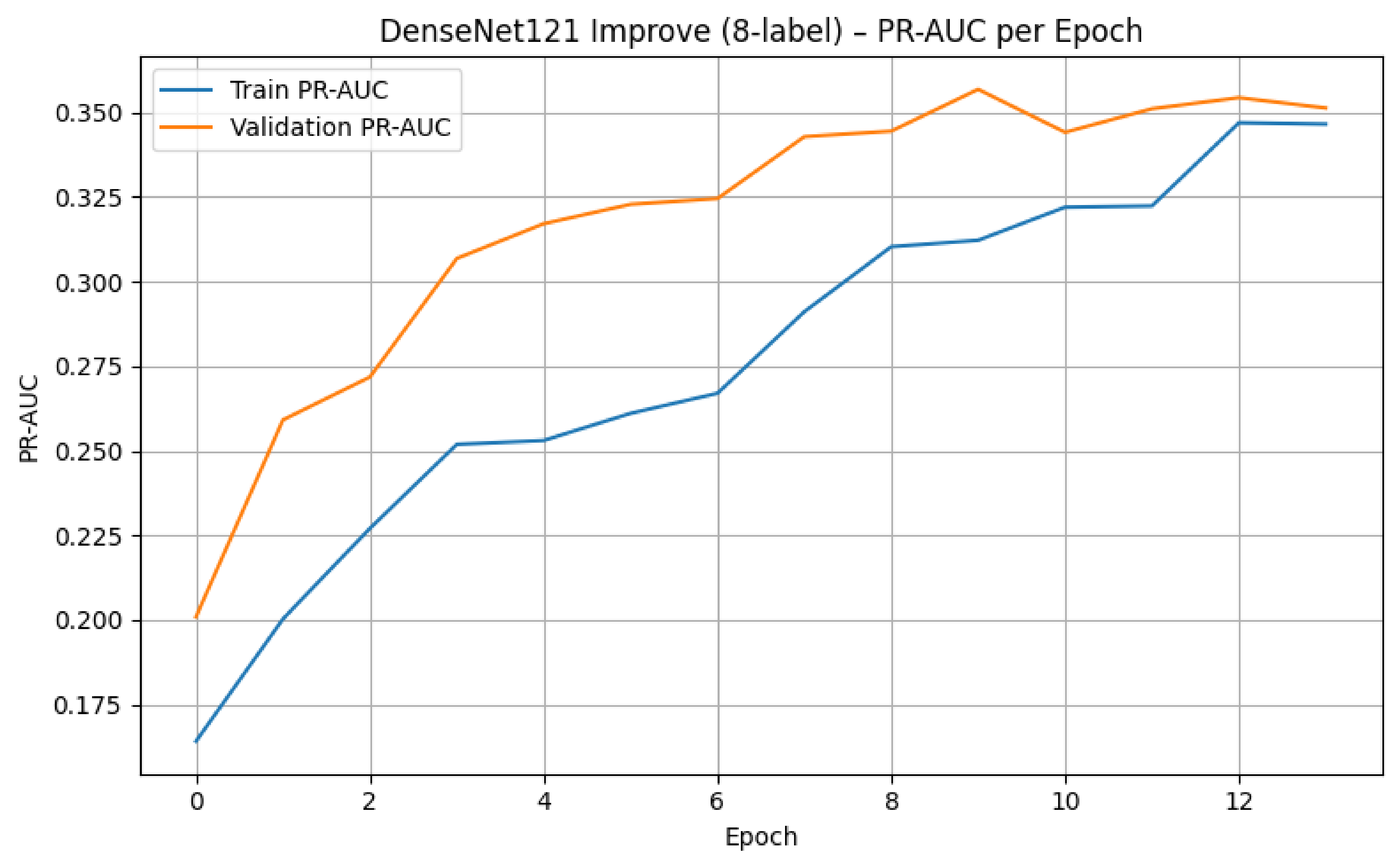
Better balance between precision and recall

Recall improves significantly after optimization

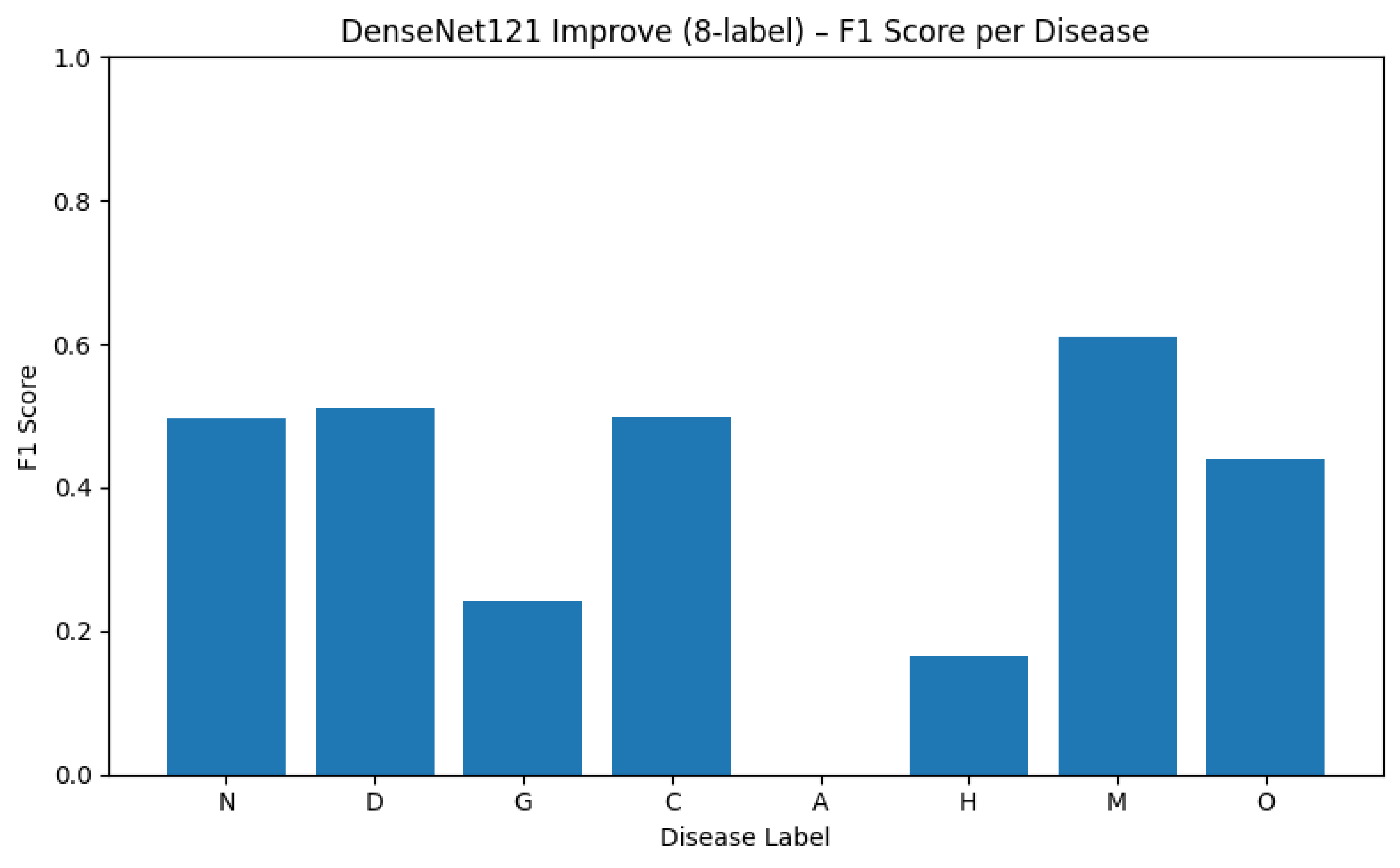


Dense connectivity helps capture subtle retinal features

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!

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