# Group - 3

## Crawl and Conquer

# SmaranAI

## Team Members

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# SmaranAI - Alzheimer's Disease Prediction

## Introduction:

Alzheimer’s is driven by the accumulation of toxic proteins like amyloid-beta and tau, leading to brain atrophy, memory loss, and cognitive decline. We developed a deep learning model using Convolutional Neural Networks (CNNs) to classify stages of Alzheimer’s disease from over 85,000 brain MRI scans, categorized into Non-Demented, Very Mild, Mild, and Moderate Dementia.

We employed Convolutional Neural Networks (CNNs) for effective feature extraction and accurate classification. Our model demonstrates potential in aiding the differentiation of dementia stages, contributing to timely and informed medical intervention.

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# Problem Statement

## Why This Matters?

- Alzheimer's Disease is a **progressive brain disorder** that often goes undetected until it's too late. Traditional diagnosis methods are slow and limited, delaying treatment and impacting quality of life.
- This project focuses on building an intelligent model that leverages MRI imaging data to detect Alzheimer's early and accurately, identifying not just its presence—but also its stage.
- **Faster diagnosis. Smarter decisions. Better outcomes.**

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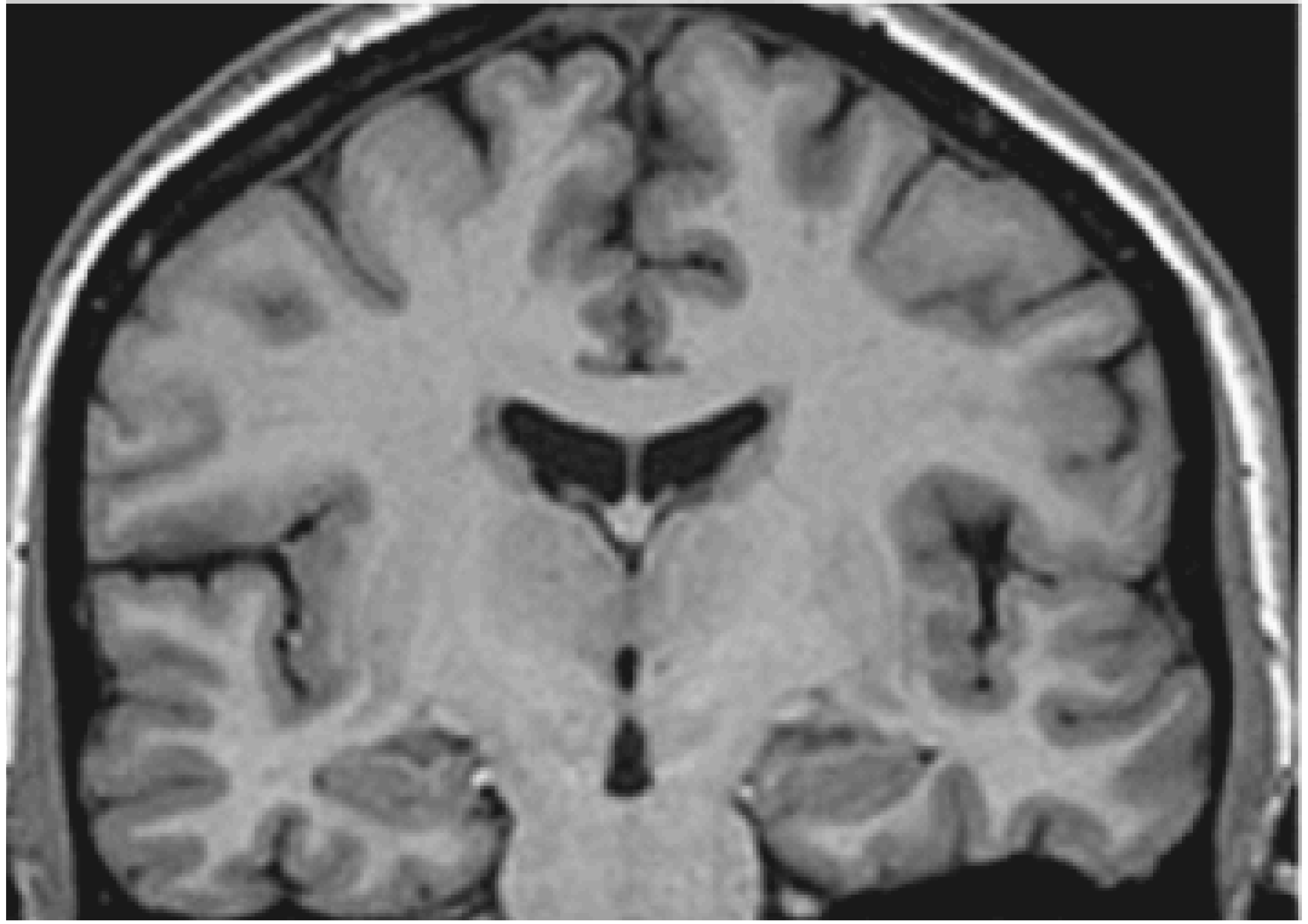
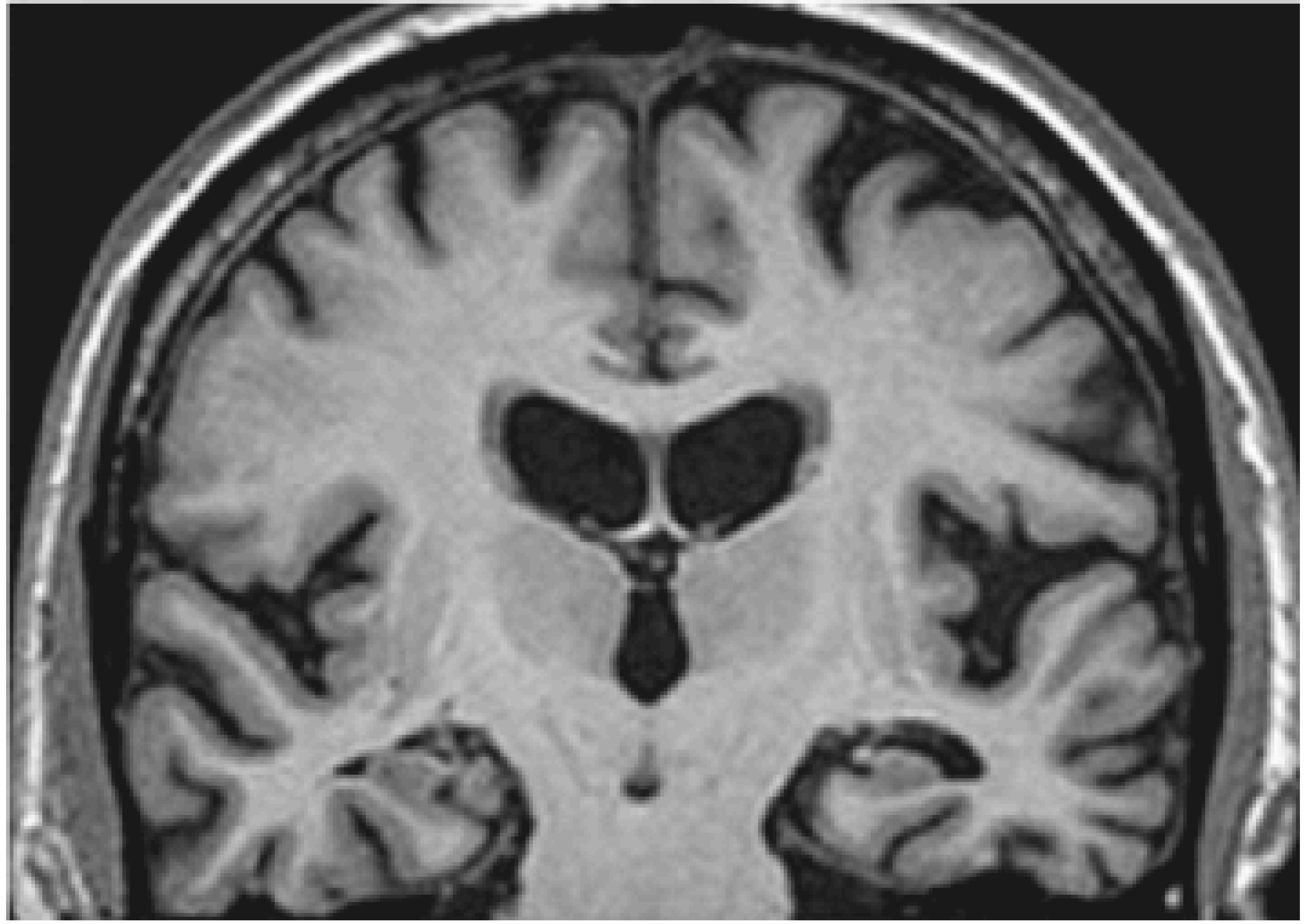
| Healthy Control | Alzheimer's Disease |
|---|---|
|  |  |

Decrease in the size of temporal and parietal lobes

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# Business Use Case

Early and accurate detection of Alzheimer’s is crucial for timely intervention and improved patient outcomes. Our machine learning model analyzes clinical and imaging data to classify disease stages, enabling more informed and proactive care.

## Use Case

- Enables early and more accurate diagnosis **before** severe symptoms develop.
- Reduces dependence on expensive and invasive procedures like **PET scans and lumbar punctures**.
- Can be **integrated into hospital systems** or used as a **clinical decision support tool**, enhancing care and lowering long-term healthcare costs.

# Data Overview & EDA

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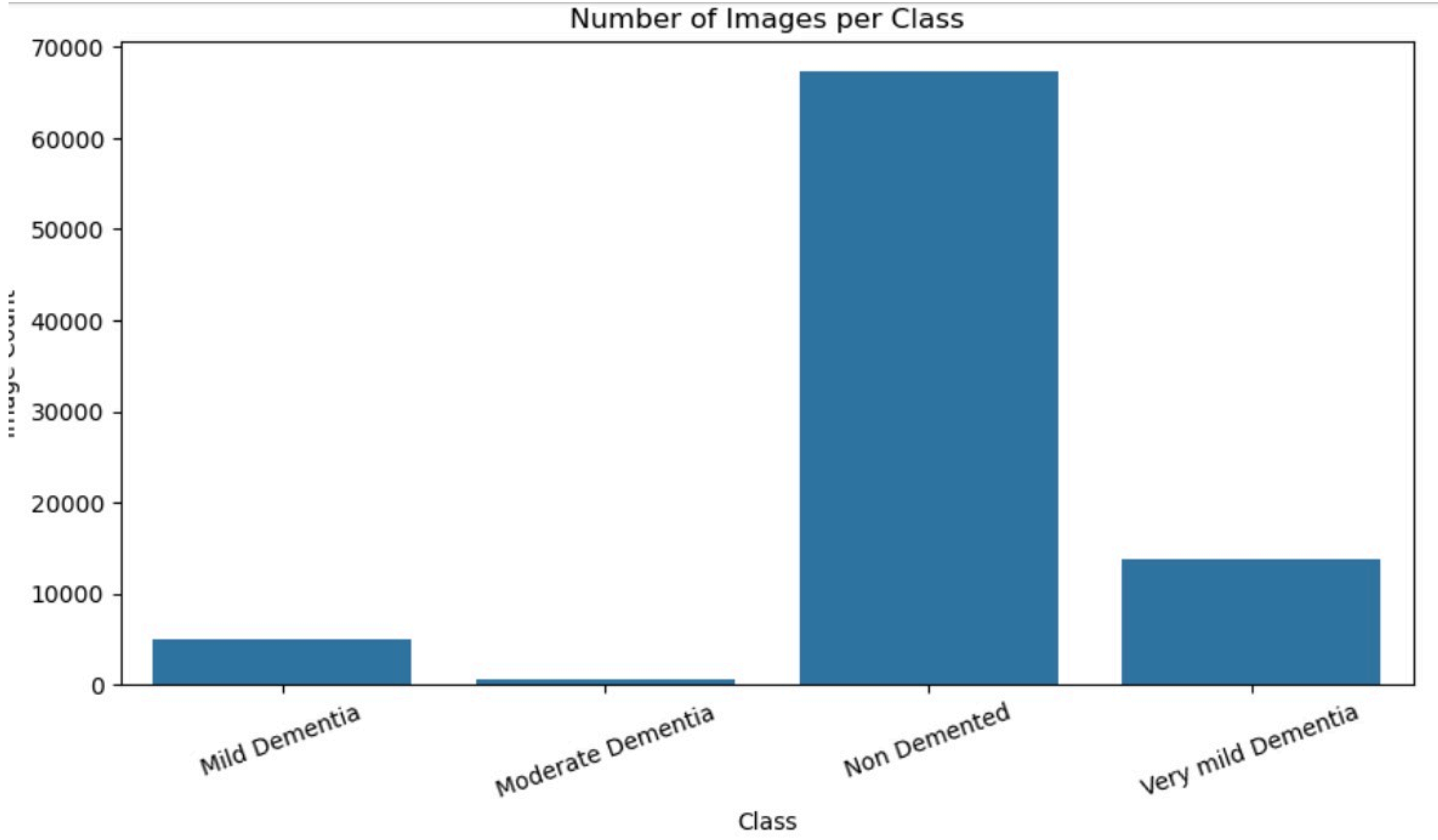
# Data Overview

**Dataset Name: OASIS (Open Access Series of Imaging Studies).**

- The OASIS dataset provides openly available MRI brain imaging data to support research in neuroscience, especially focused on cognitive aging and dementia.
- The dataset includes labeled ~85,000 images categorized by dementia severity.
- Each image belongs to one of the following dementia stages (i.e., the target variable): **Mild Dementia, Moderate Dementia, Very Mild Dementia, Non Demented.**




Sample Images per Class

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# EDA

**Highly imbalanced dataset**

- "Non Demented" dominates, accounting for ~77% of the total images.
- "Moderate Dementia" is severely underrepresented (~0.5%).

**Image Characteristics**

- All images are grayscale brain MRI scans.
- Unique image resolution: (248, 496)
- Number of corrupt/unreadable images: 0

**EDA Summary**

- Class imbalance is a significant challenge and will need to be addressed through data augmentation (especially for Moderate and Mild Dementia classes).
- Image quality and resolution are consistent, which is beneficial for model training.
- Sample visualizations show distinct anatomical features across classes, which may aid in classification.

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# Methodology

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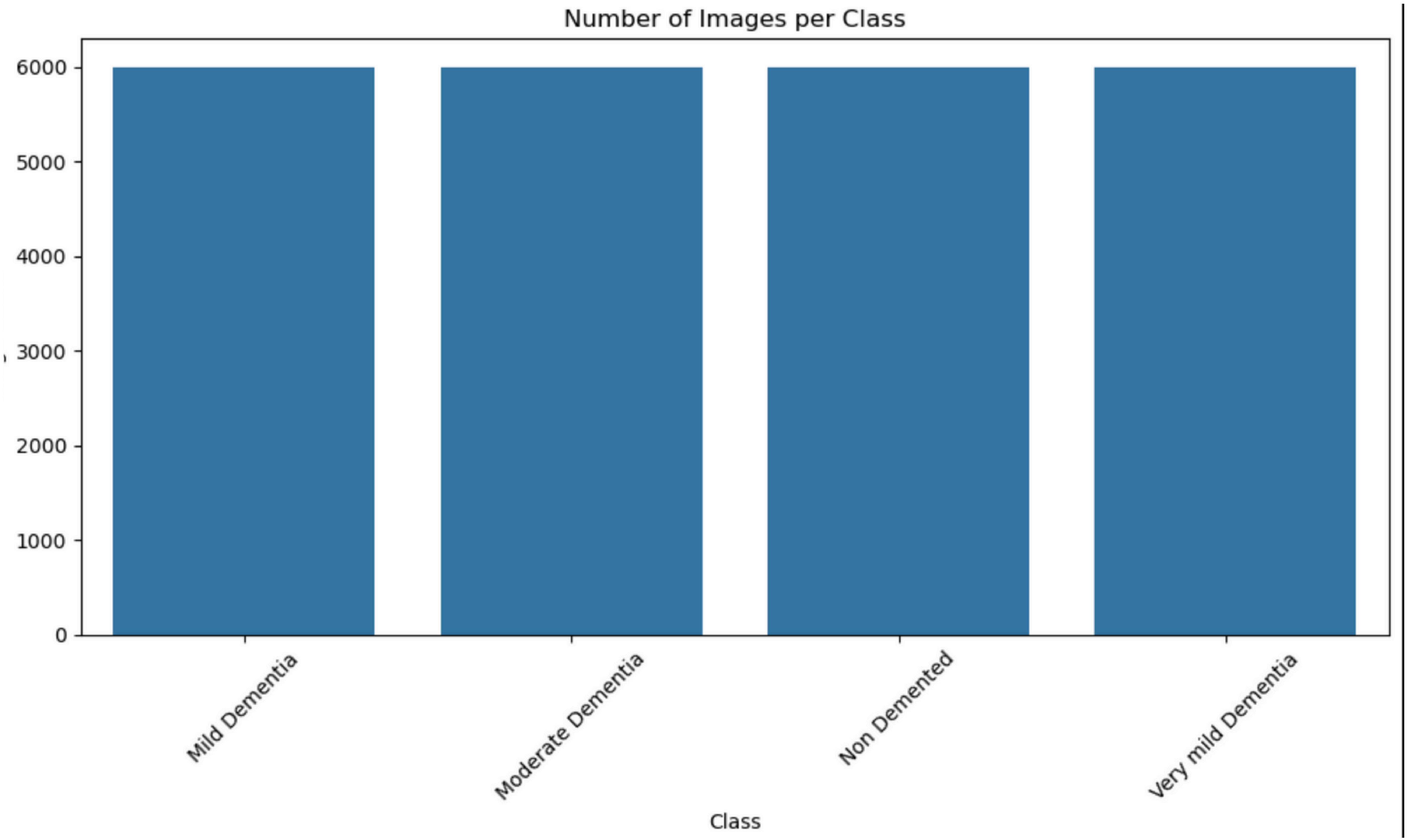


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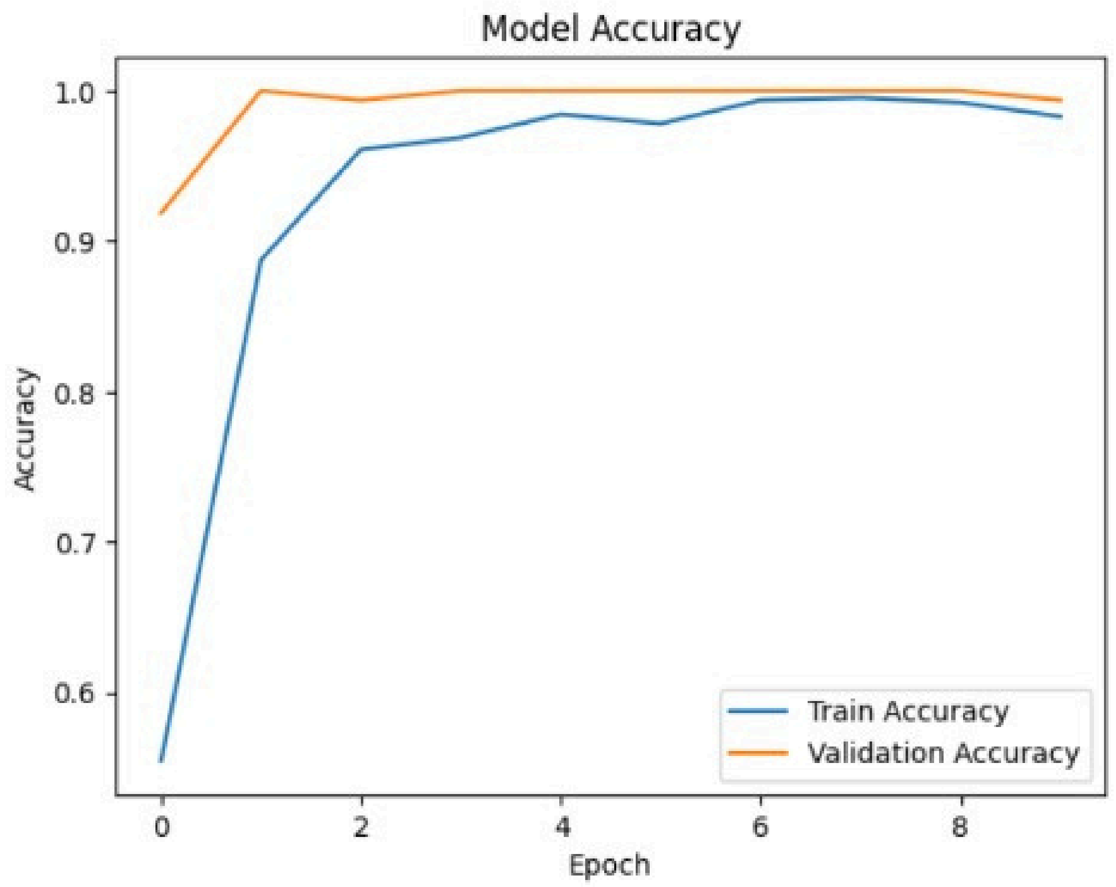
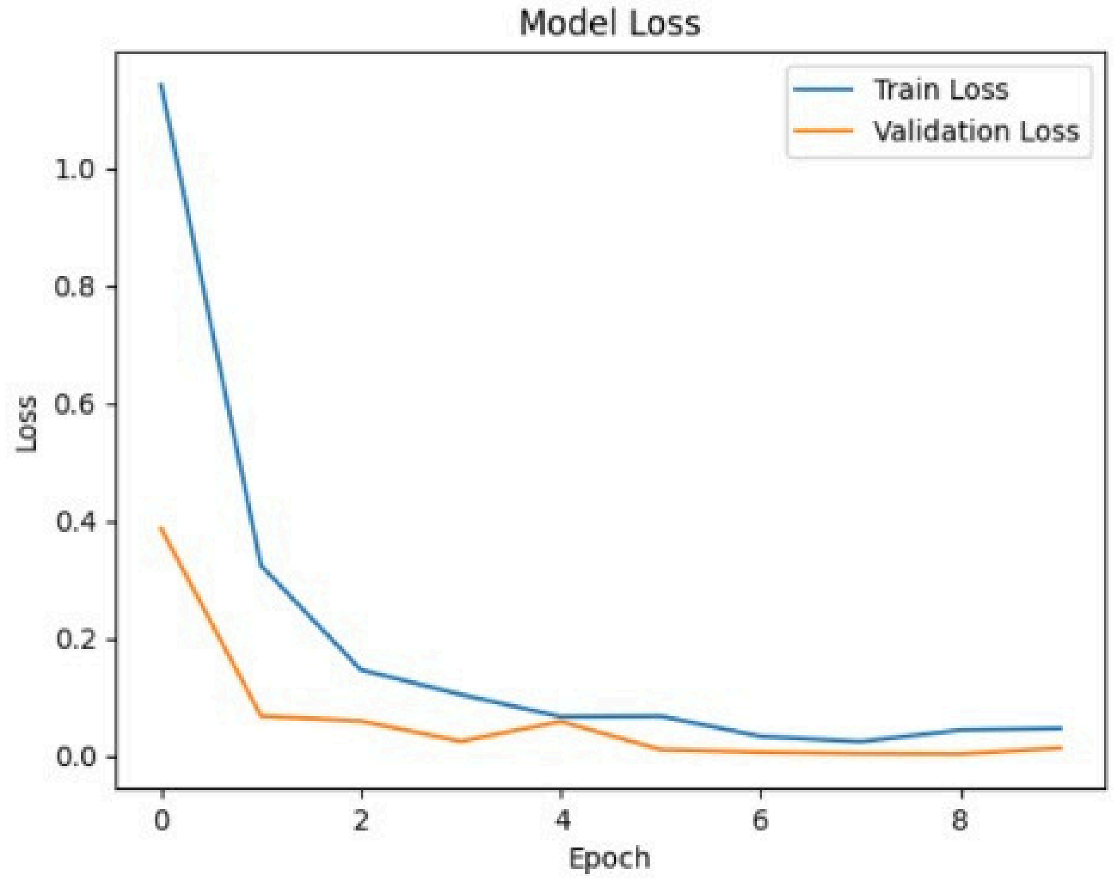
# Preprocessing

```
Image data shape: (800, 224, 224, 3)
Labels shape: (800,)
✅ Encoded labels shape: (800, 4)
✅ Class names: ['Mild' 'Moderate' 'Normal' 'VeryMild']
✅ X_train shape: (640, 224, 224, 3)
✅ y_train shape: (640, 4)
```

**Model: "functional"**

| Layer (type) | Output Shape | Param # | Connected to |
|---|---|---|---|
| input_layer (InputLayer) | (None, 224, 224, 3) | 0 | - |
| conv1_pad (ZeroPadding2D) | (None, 230, 230, 3) | 0 | input_layer[0][0] |
| conv1_conv (Conv2D) | (None, 112, 112, 64) | 9,472 | conv1_pad[0][0] |
| conv1_bn (BatchNormalizatio… | (None, 112, 112, 64) | 256 | conv1_conv[0][0] |
| conv1_relu (Activation) | (None, 112, 112, 64) | 0 | conv1_bn[0][0] |
| pool1_pad (ZeroPadding2D) | (None, 114, 114, 64) | 0 | conv1_relu[0][0] |
| pool1_pool (MaxPooling2D) | (None, 56, 56, 64) | 0 | pool1_pad[0][0] |
| conv2_block1_1_conv (Conv2D) | (None, 56, 56, 64) | 4,160 | pool1_pool[0][0] |
| conv2_block1_1_bn | (None, 56, 56, | 256 | conv2_block1_1_c |

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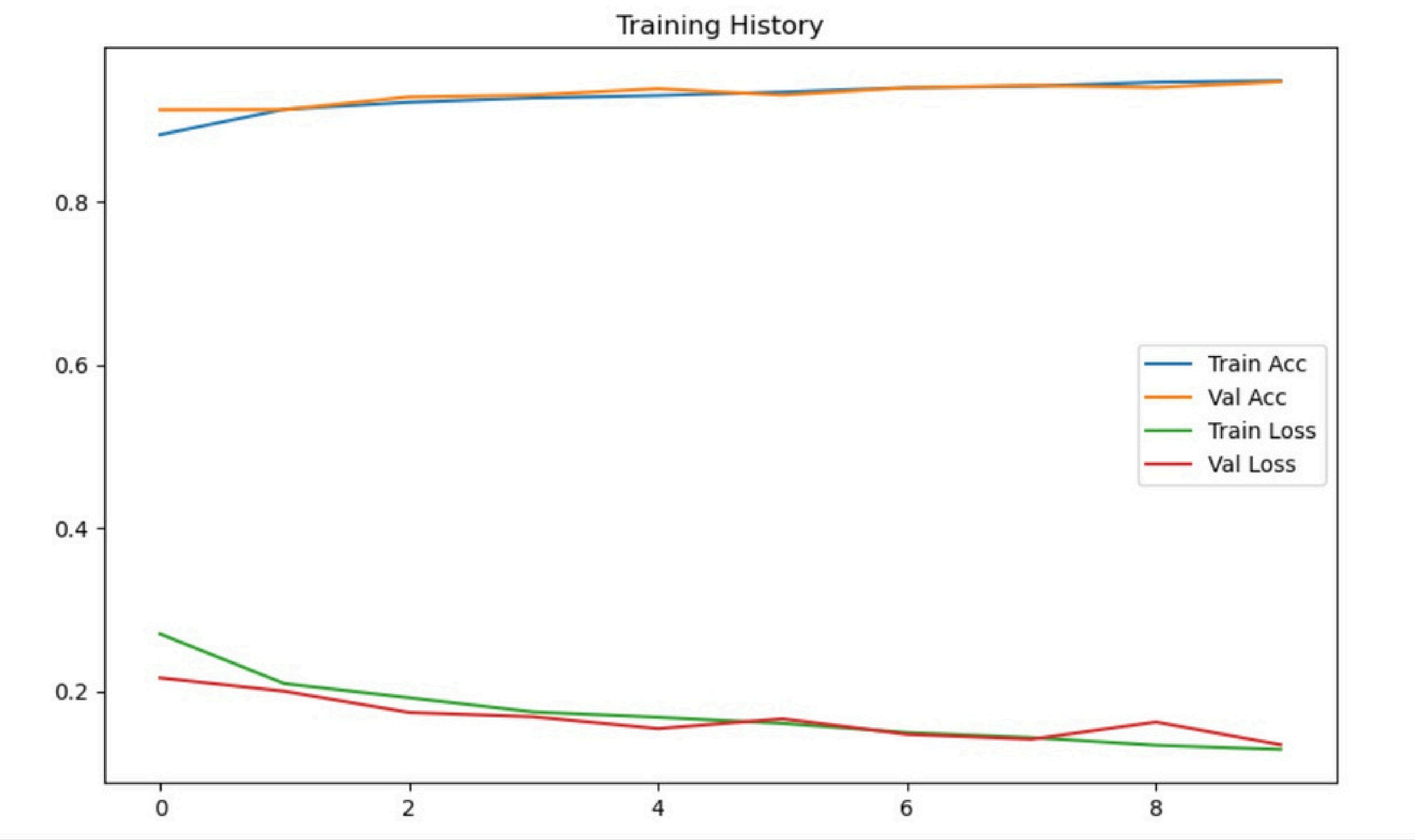
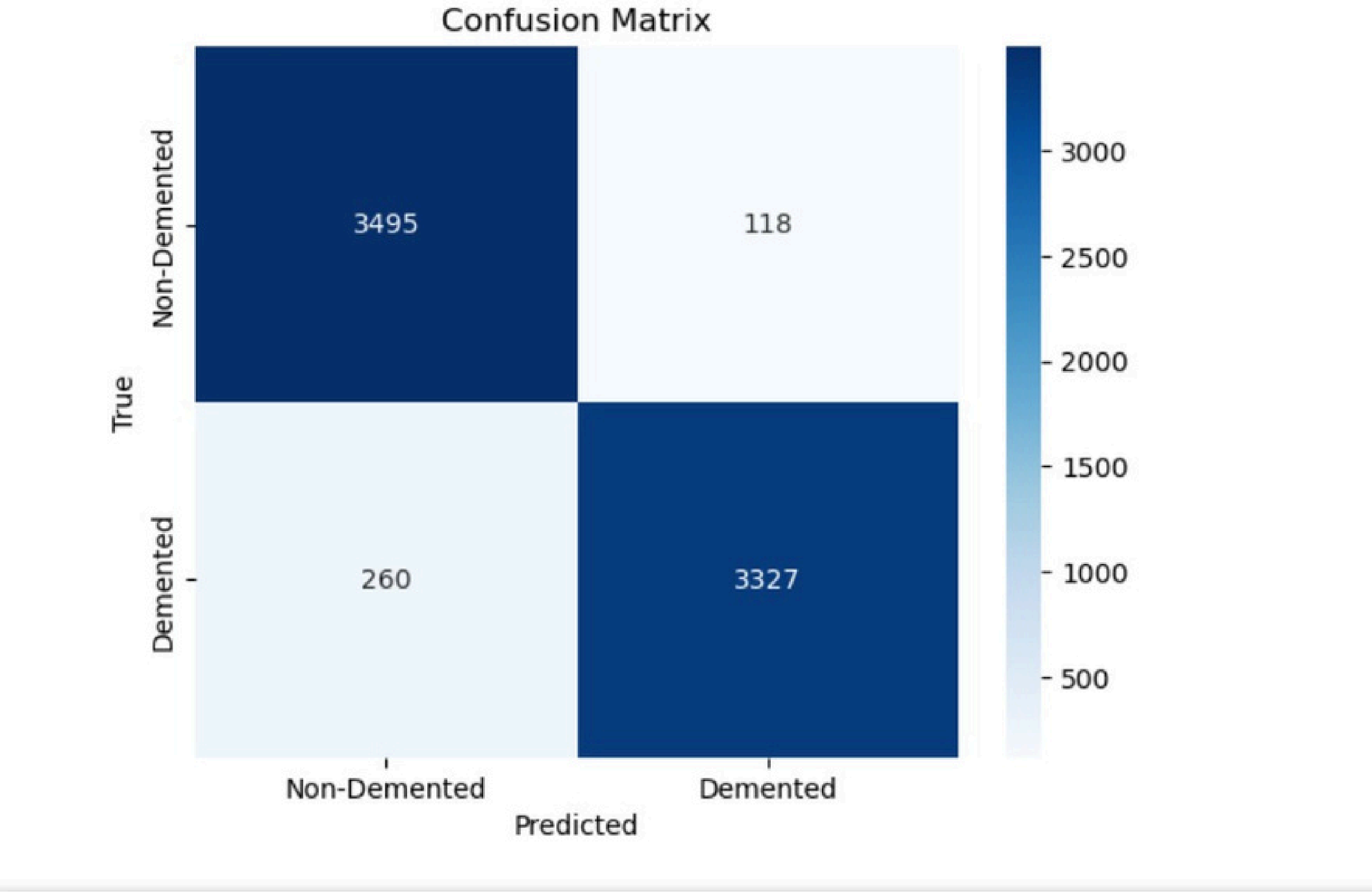
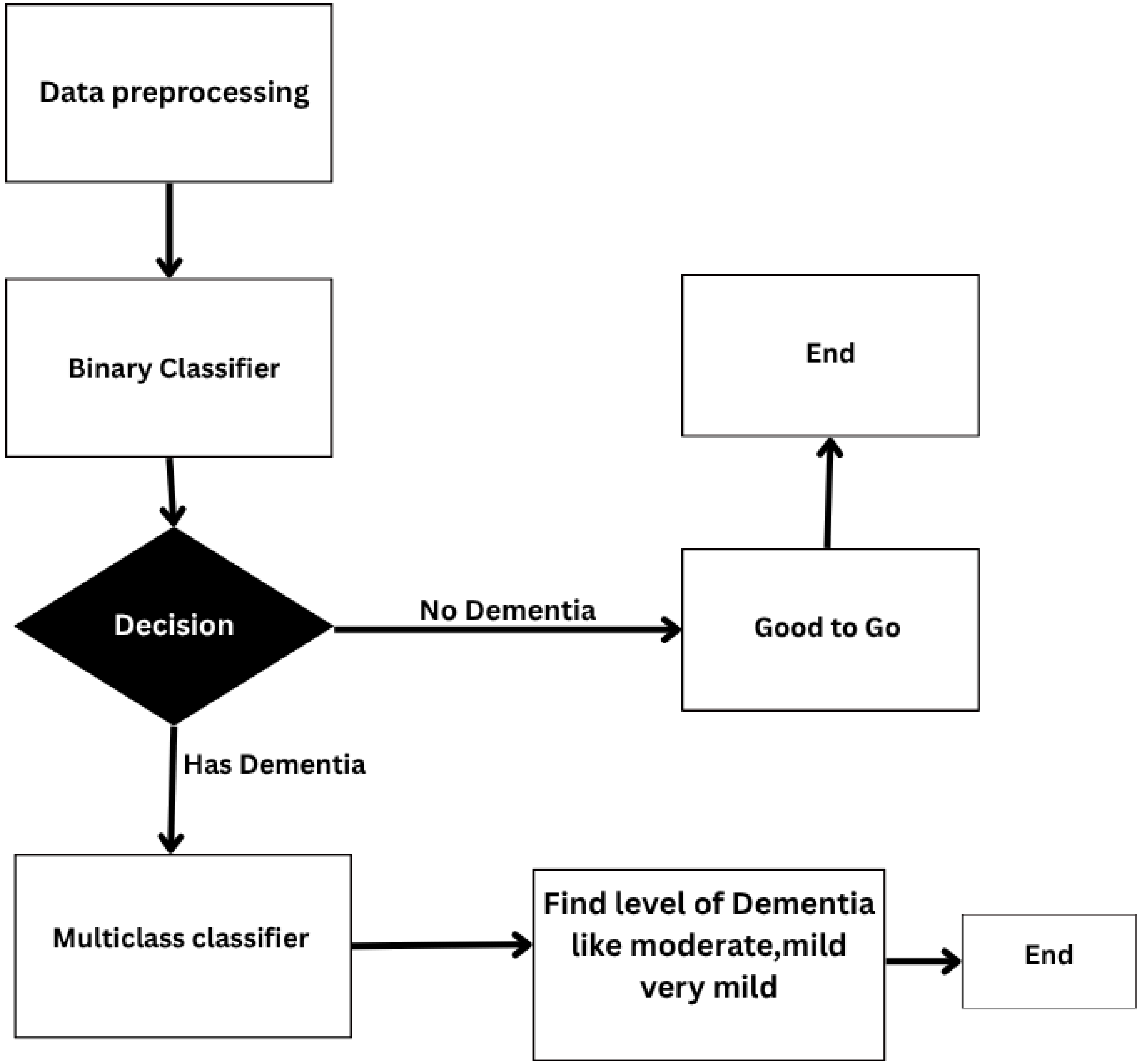
# Inception-ResNetV2




| | precision | recall | f1-score | support |
|---|---|---|---|---|
| Non-Demented | 0.93 | 0.97 | 0.95 | 3613 |
| Demented | 0.97 | 0.93 | 0.95 | 3587 |
| accuracy | | | 0.95 | 7200 |
| macro avg | 0.95 | 0.95 | 0.95 | 7200 |
| weighted avg | 0.95 | 0.95 | 0.95 | 7200 |

# Mobile Net

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# Model Parameters

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```
=== Dataset Configuration ===
```

| Parameter | Value |
|---|---|
| Base Directory | C:\Users\sandy\Downloads\binary_balanced_augmenteddd |
| Image Size | (224, 224) |
| Batch Size | 32 |
| Validation Split | 0.2 |
| Label Mode | binary |
| Seed | 42 |

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| Component | Role |
|---|---|
| **Data Augmentation** | Improves generalization, prevents overfitting |
| **Conv Blocks** | Extract visual features at multiple scales |
| **BatchNorm** | Normalizes outputs to stabilize training |
| **Dropout** | Reduces overfitting by regularizing large dense layers |
| **Learning Rate Scheduler** | Gradually refines weights for better convergence |
| **Softmax Output** | Converts logits to class probabilities |

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# Result & Analysis

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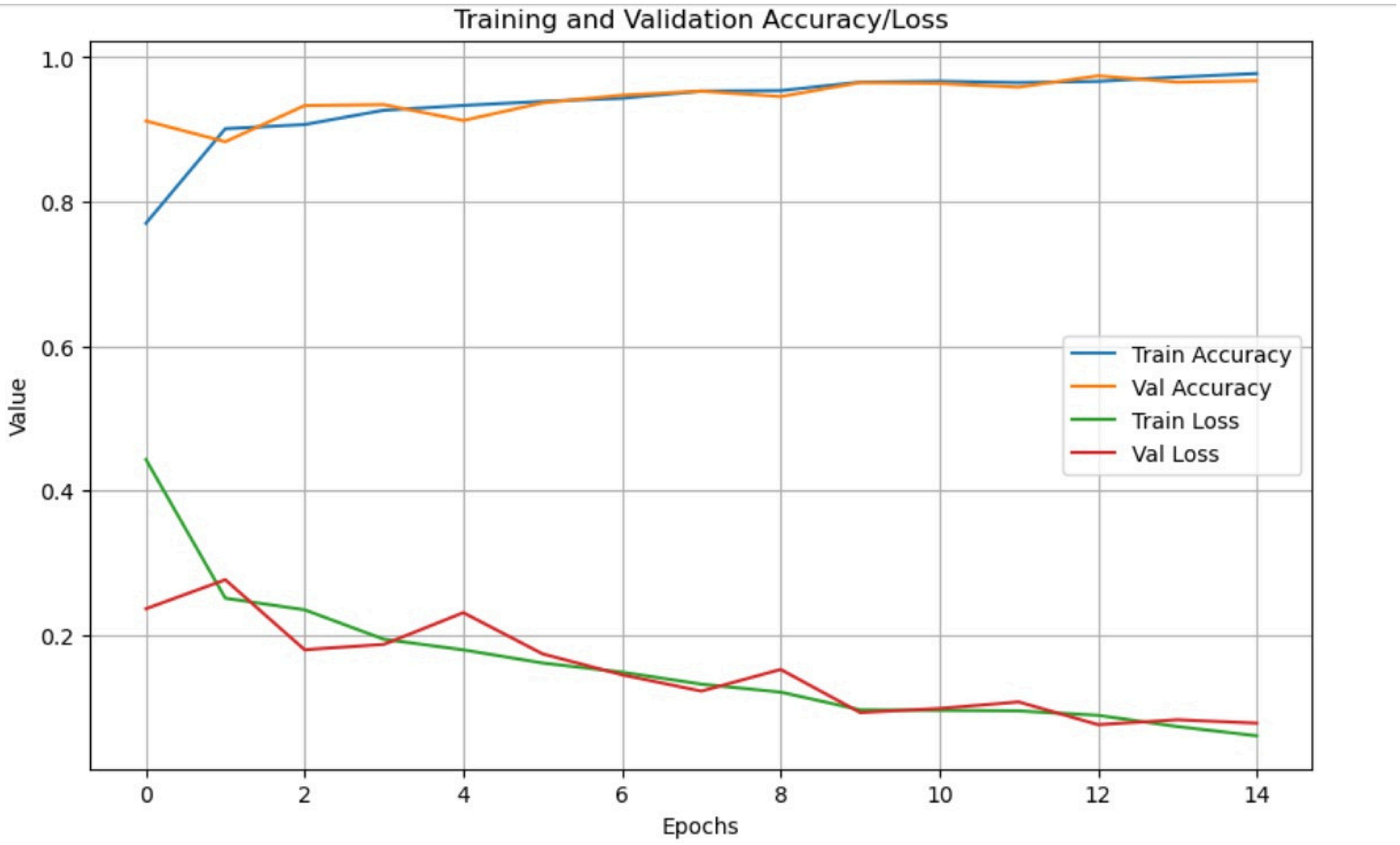


# Classification

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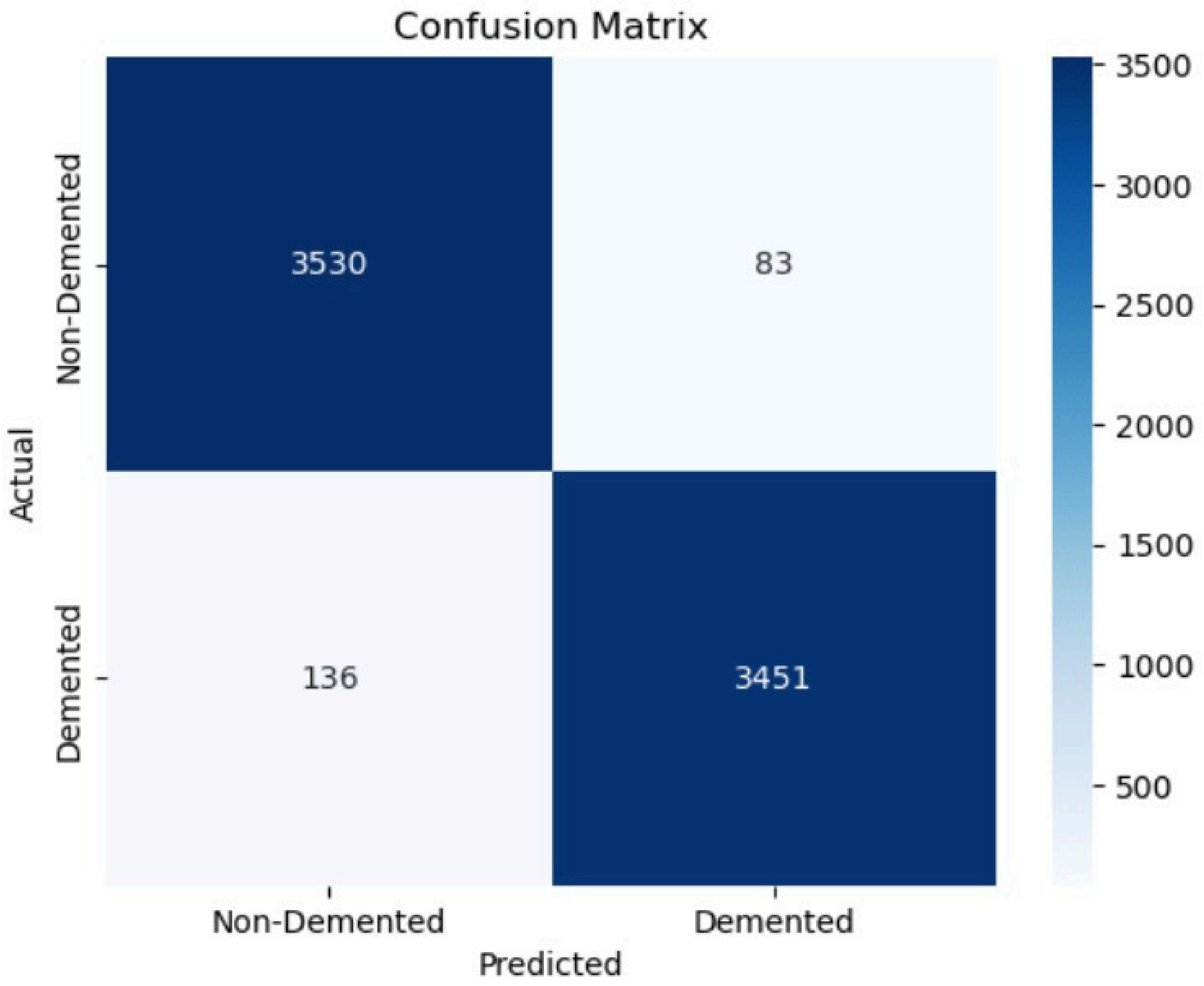


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# Stage 1 binary classification

```
1279/1279 ━━━━━━━━━━━━━━━━━━━━ 25s 19ms/step
                      precision    recall  f1-score   support

     Mild Impairment       0.91      0.94      0.93       179
 Moderate Impairment       1.00      1.00      1.00        12
       No Impairment       0.94      0.89      0.92       640
Very Mild Impairment       0.85      0.90      0.87       448

            accuracy                           0.90      1279
           macro avg       0.92      0.93      0.93      1279
        weighted avg       0.90      0.90      0.90      1279
```

**Stage 2 classification**

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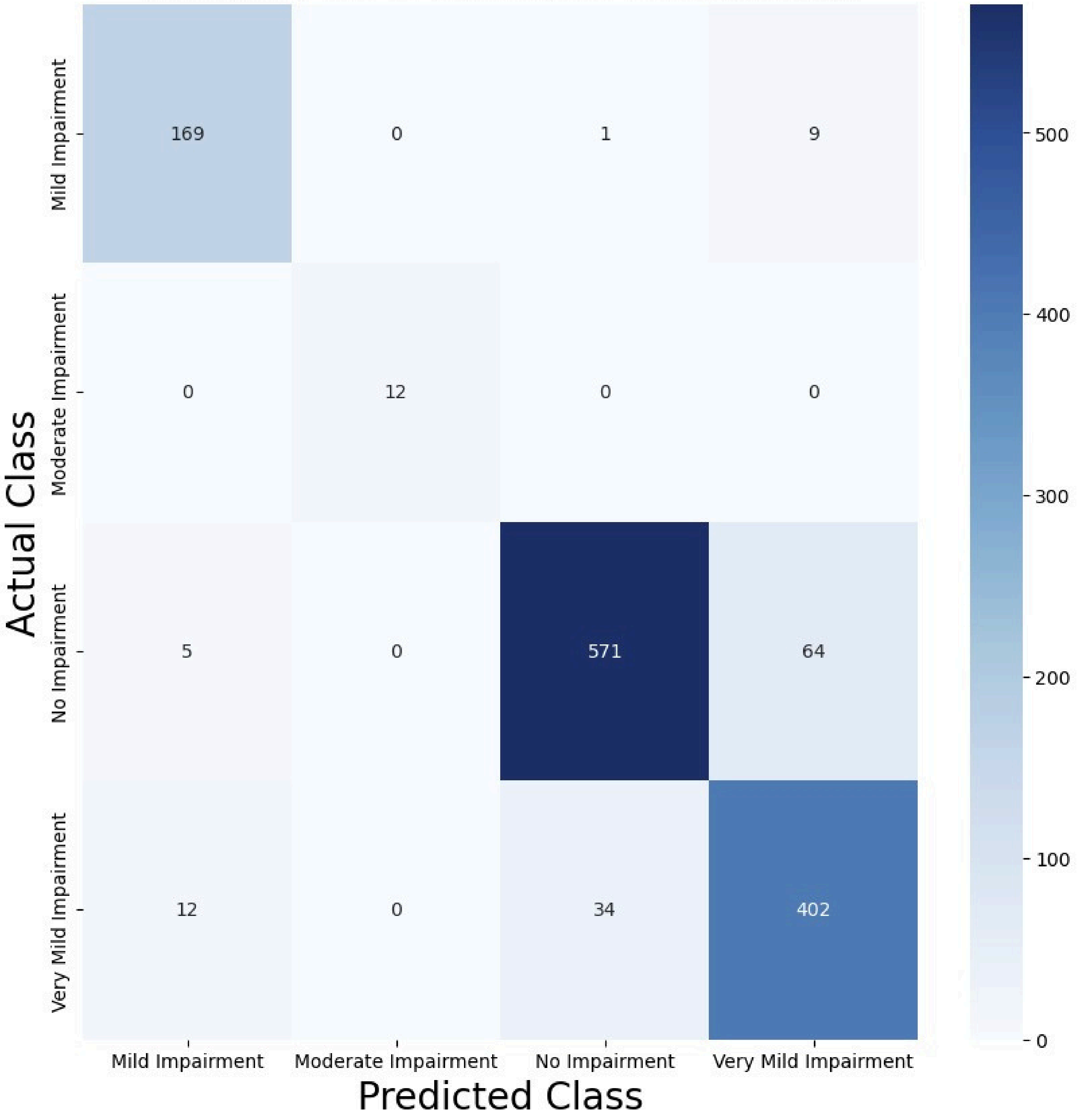
# Alzheimer's Disease Detection

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# Demo
# &
# Challenges

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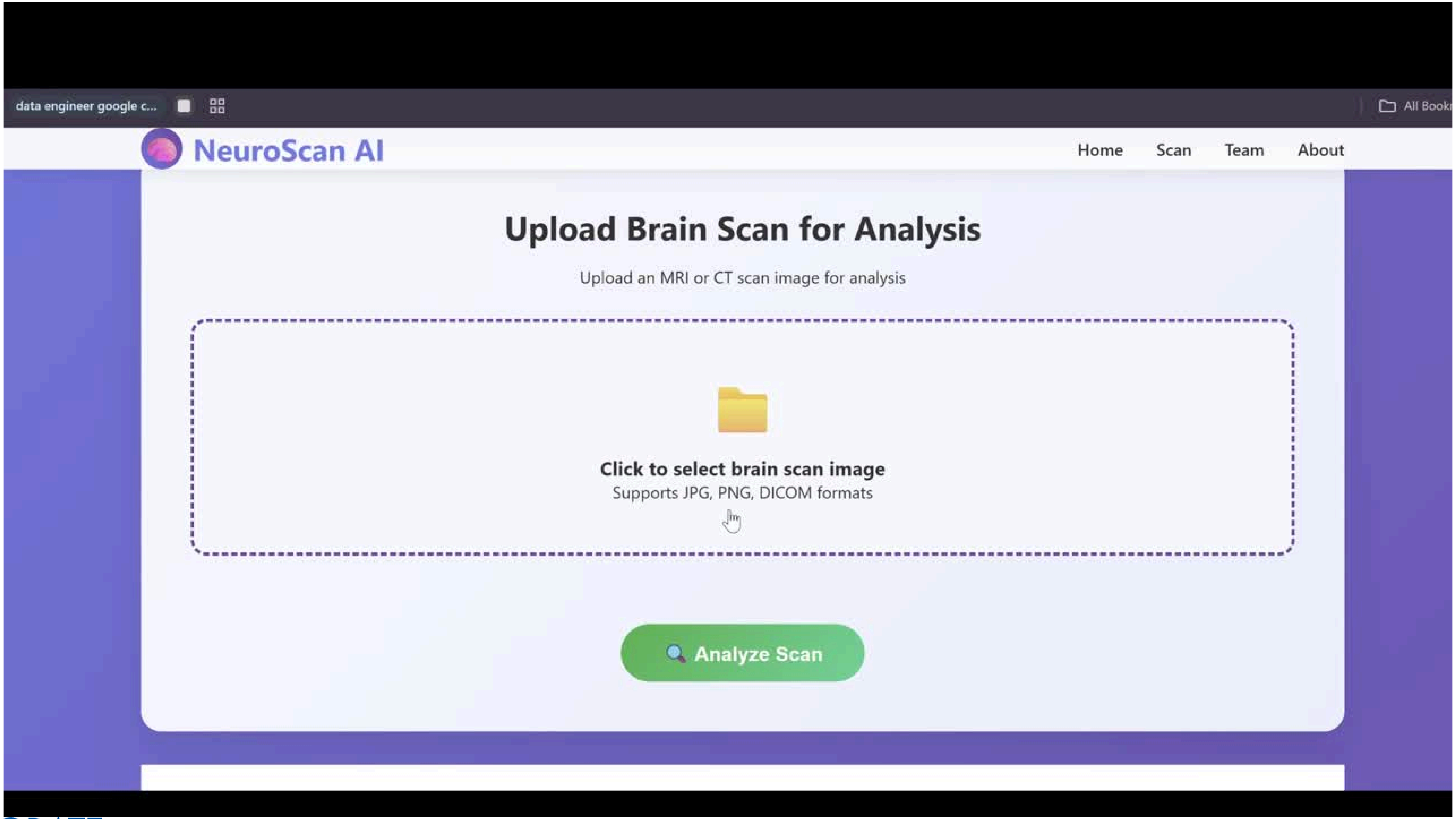


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# Challenges

**Data Requirements:** CNNs need large labeled datasets for effective training.

**Overfitting**: CNNs can easily overfit on small datasets without proper regularization or augmentation.

**High Memory Usage:** Residual networks can consume more GPU memory due to their depth.

Limited laptop GPU memory and processing power often slow down deep CNN and ResNet training, causing longer runtimes and occasional thermal throttling.

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# References


**Alzheimer's Disease Detection Using Deep Learning on Neuroimaging: A Systematic Review**

Alzheimer's disease (AD) is a pressing global issue, demanding effective diagnostic approaches. This systematic review surveys the recent literature (2018 onwards) to illuminate the current landscape of AD...

MDPI / Feb 21, 2024

**Diagnosis of Alzheimer's Disease via Multi-modality 3D...**

Alzheimer's Disease (AD) is one of the most concerned neurodegenerative diseases. In the last decade, studies on AD diagnosis attached great significance to artificial intelligence (AI)-based...

arXiv.org


**Convolutional neural networks for Alzheimer's disease detection on MRI images**

Purpose: Detection of Alzheimer's disease (AD) on magnetic resonance imaging (MRI) using convolutional neural networks (CNNs), which is useful for detecting AD in its preliminary states. Approach: Our study...

PubMed Central (PMC)


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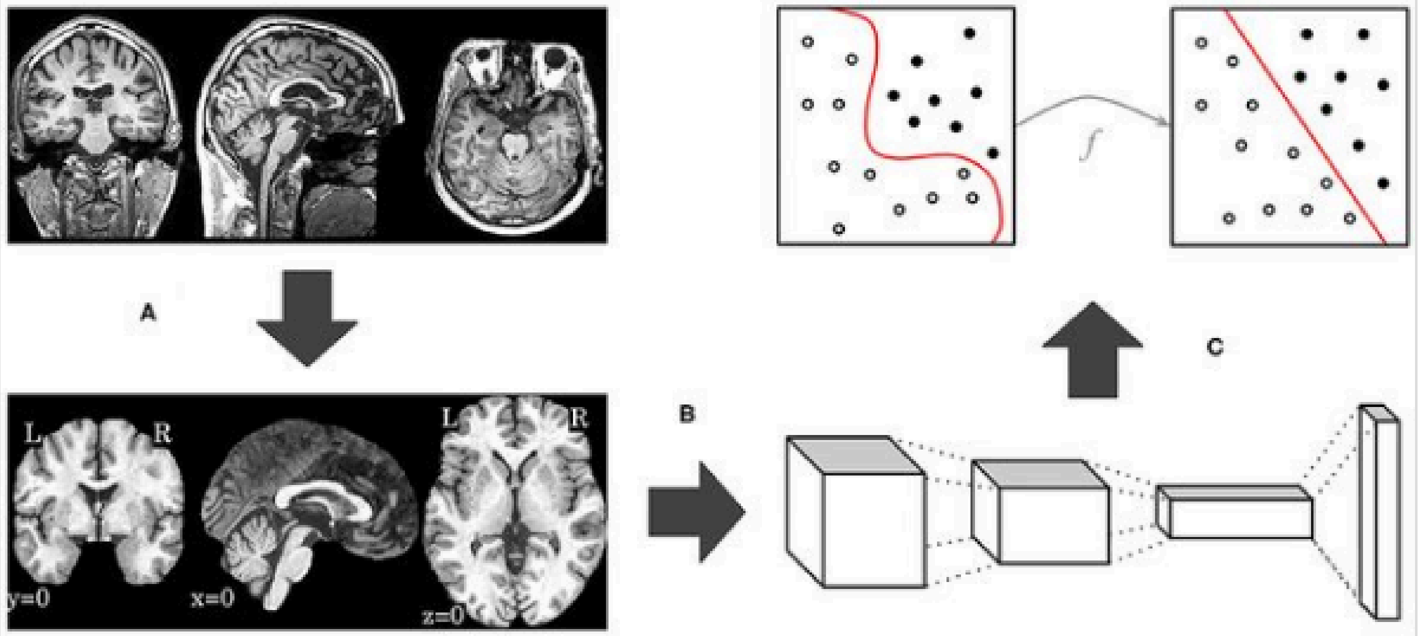
# References




**Alzheimer's Disease Detection Through Whole-Brain 3D-CNN MRI**

The projected burden of dementia by Alzheimer's disease (AD) represents a looming healthcarecrisis as the population of most countries grows older. Although ...

Frontiers

https://www.sciencedirect.com/science/article/pii/S2352914824001072

https://www.nature.com/articles/s41598-024-53733-6

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