CNN Model for Dementia Prediction

SOUMITA CHATTERJEE

MSA24006

Indian Institute of Information Technology,Lucknow.

Introduction

Dementia is an irreversible neurological disorder that greatly affects memory, cognitive function, and daily life. Early diagnosis is essential to management and intervention. Over the last few years, deep learning approaches, and notably Convolutional Neural Networks (CNNs), have proved incredibly promising for medical image analysis with their capability of automatically learning spatial hierarchies of features. This project introduces a CNN-based model for predicting dementia based on analyzing brain imaging data, including MRI scans, to reliably detect early stages of dementia. By utilizing the strong feature extraction ability of CNN, the model seeks to aid clinicians in providing timely and trustworthy diagnoses, improving patient outcomes in the process.

Data Preprocessing

1

Labeling Stages

The data collected via Kaggle was categorized into four stages: very mild, mild, moderate and nondemented

2

Data Cleaning

Outliers and missing values were handled to ensure dataset reliability.

3

Normalization

Image data underwent normalization to scale pixel values.

CNN Model Application

The CNN model was meticulously designed to enhance dementia prediction through efficient architecture selection, rigorous training, and robust evaluation strategies. This comprehensive approach ensures high accuracy and reliability in predictions.

1 ## Architecture Selection

A suitable CNN architecture was chosen to effectively capture features from the preprocessed data, particularly useful for image-based inputs in dementia prediction.

2 ## Training Process

The model was trained using the labeled dataset, leveraging powerful computing resources such as EarlyStopping ,handling class weights to enhance learning accuracy and convergence speed.

3 ## Evaluation Strategy

Employing a validation set to monitor the model's performance during

Convolutional Layers

Model: "sequential"

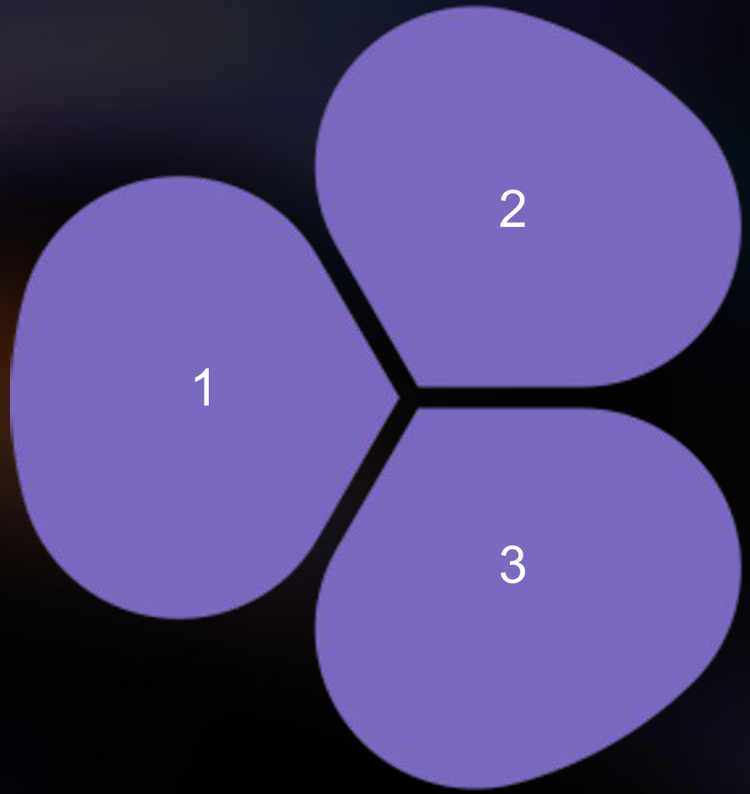
Layer (type)	Output Shape	Param #
conv2d (Conv2D)	(None, 222, 222, 32)	896
conv2d_1 (Conv2D)	(None, 220, 220, 32)	9,248
max_pooling2d (MaxPooling2D)	(None, 110, 110, 32)	0
conv2d_2 (Conv2D)	(None, 108, 108, 64)	18,496
conv2d_3 (Conv2D)	(None, 106, 106, 64)	36,928
max_pooling2d_1 (MaxPooling2D)	(None, 53, 53, 64)	0
conv2d_4 (Conv2D)	(None, 51, 51, 128)	73,856
conv2d_5 (Conv2D)	(None, 49, 49, 128)	147,584
max_pooling2d_2 (MaxPooling2D)	(None, 24, 24, 128)	0
flatten (Flatten)	(None, 73728)	0
dense (Dense)	(None, 256)	18,874,624
dropout (Dropout)	(None, 256)	0
dense_1 (Dense)	(None, 4)	1,028

Total params: 38,325,322 (146.20 MB)
Trainable params: 19,162,660 (73.10 MB)
Non-trainable params: 0 (0.00 B)

Understanding Grad-CAM

What is Grad-CAM?

Grad-CAM provides visual explanations of model predictions by highlighting important regions in input images.



How It Works

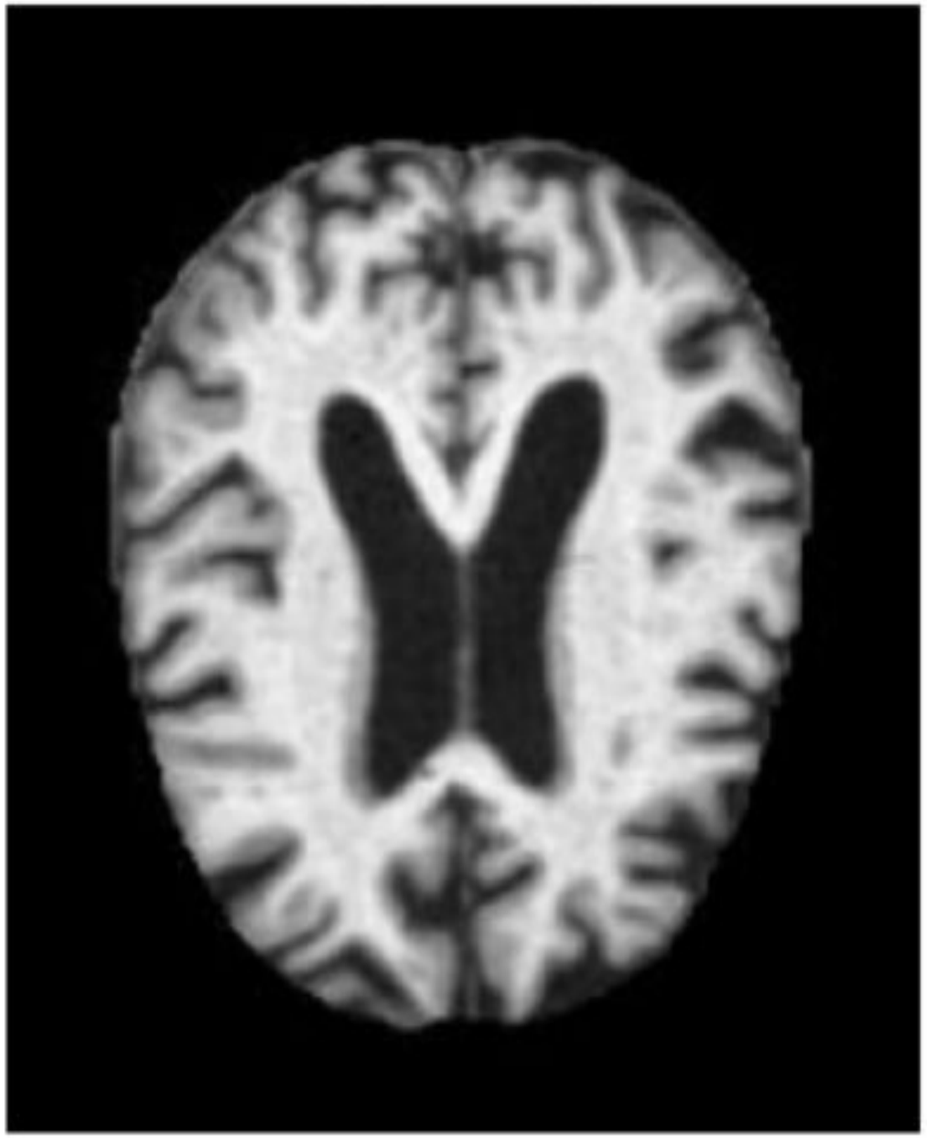
It utilizes gradient information from the last convolutional layer to produce heatmaps.

Benefits

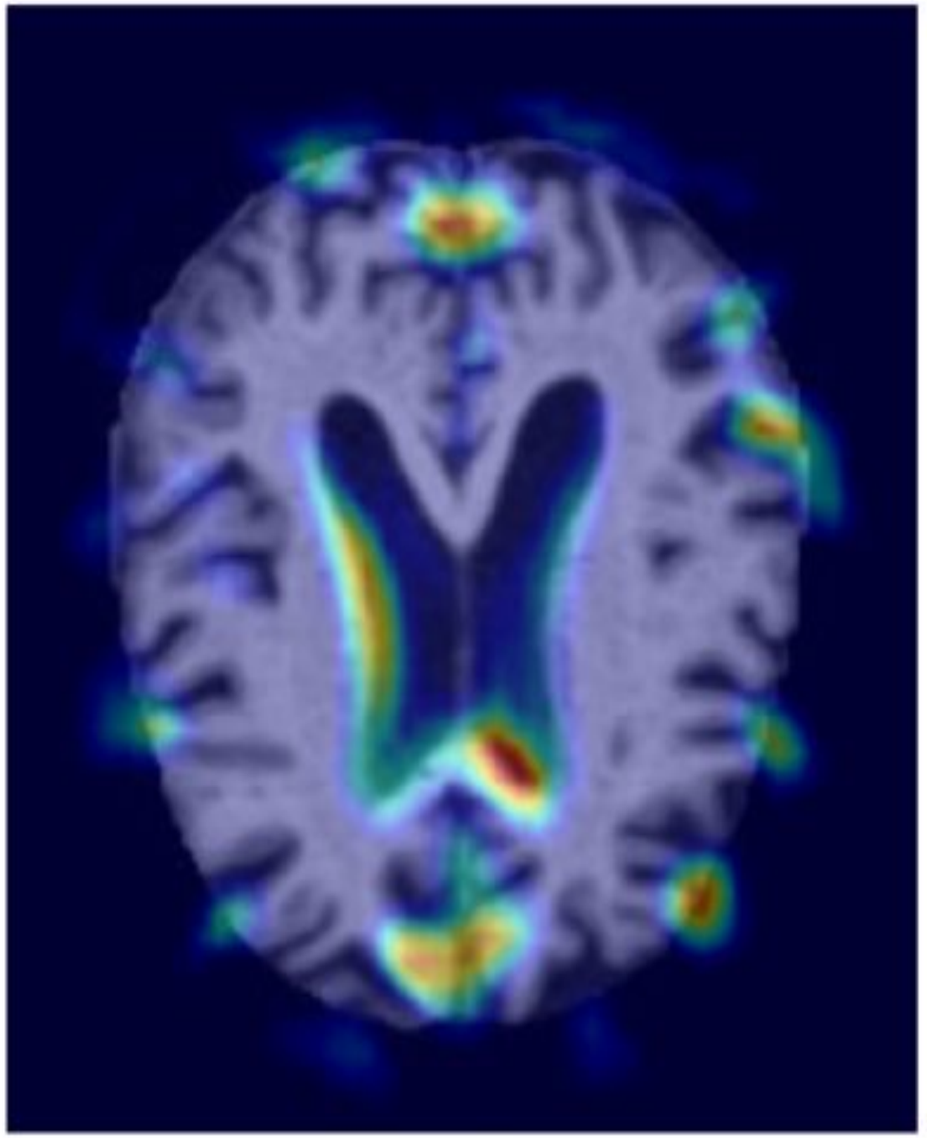
This technique enhances interpretability, crucial for medical applications.

```
1/1 ━━━━━━━━━━━━━━━━━━━━ 1s 1s/step
```

Original Image



Grad-CAM



Model Deployment with Streamlit

User Interface

The model was deployed using Streamlit to create an interactive web application, making it user-friendly for clinicians to input new data and receive predictions.

Live Demo

Streamlit enables real-time predictions, allowing healthcare professionals to visualize results instantly and monitor model performance.

Integration

This deployment is integrated with CI/CD pipelines for continuous updates, ensuring the model stays current with new data and methodologies.

RESULTS

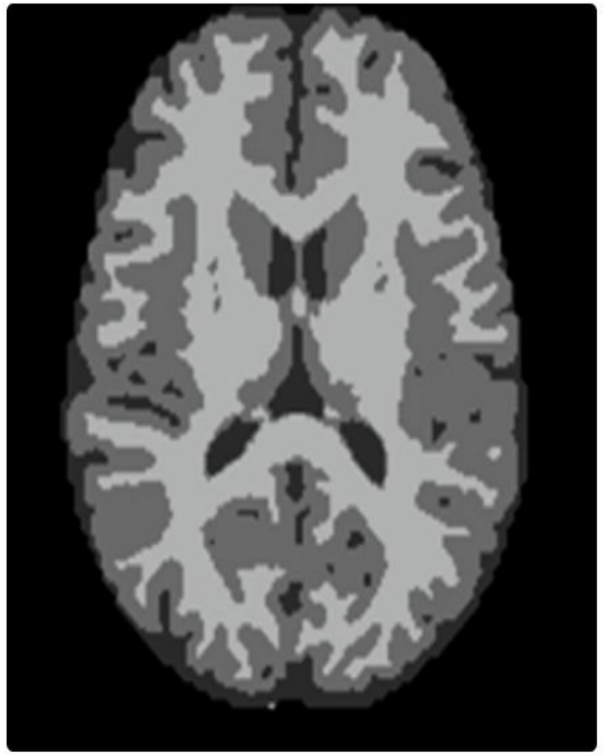
Alzheimer's Detection from MRI

Upload an MRI image to predict dementia stage.

Choose an MRI image...

Drag and drop file here
Limit 200MB per file • JPG, JPEG, PNG
Browse files

normal_2.png 87.6KB



Uploaded MRI

Processing...

Predicted: **NonDemented** with **65.58%** confidence

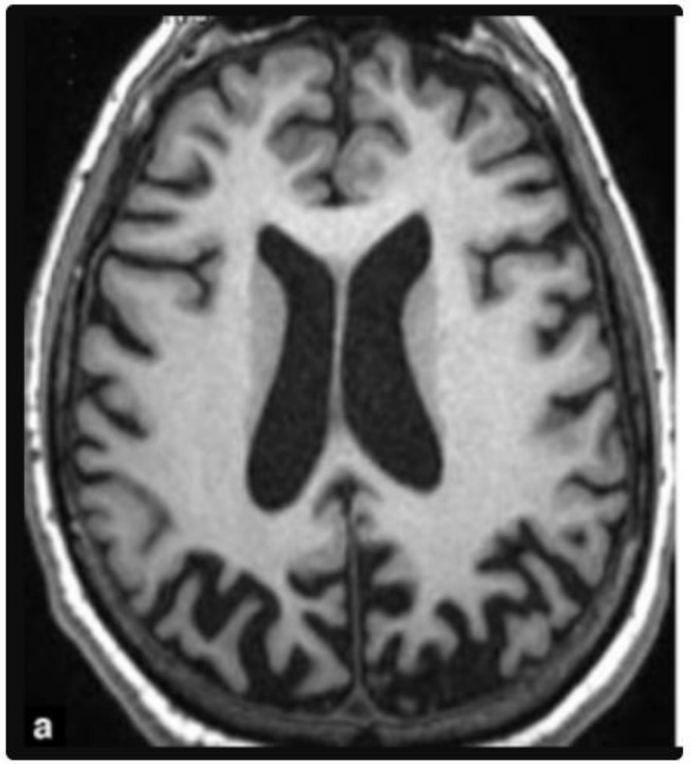
Alzheimer's Detection from MRI

Upload an MRI image to predict dementia stage.

Choose an MRI image...

Drag and drop file here
Limit 200MB per file • JPG, JPEG, PNG
Browse files

40yearold_mild1.png 119.0KB



Uploaded MRI

Processing...

Predicted: **MildDemented** with **99.14%** confidence

Current Model Performance Metrics

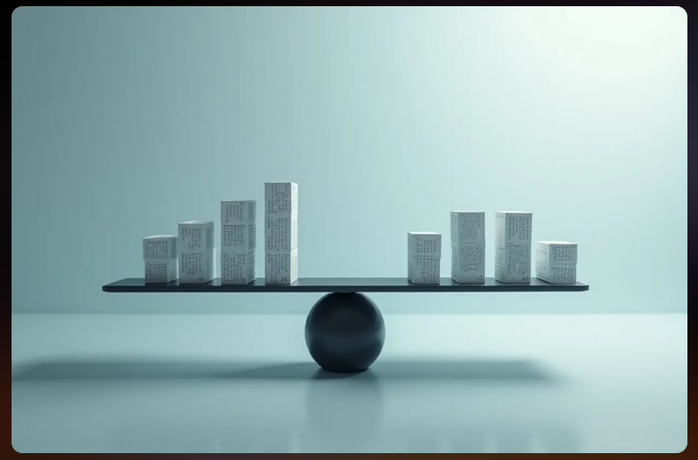
```
104/104 ━━━━━━━━━━━━━━━━━━━━ 15s 134ms/step
Classification Report:

                    precision    recall  f1-score   support

     MildDemented       0.62      0.82      0.71       691
ModerateDemented        1.00      0.97      0.98       524
      NonDemented       0.68      0.72      0.70      1152
VeryMildDemented        0.60      0.43      0.50       960

         accuracy                           0.69      3327
        macro avg       0.72      0.73      0.72      3327
     weighted avg       0.69      0.69      0.69      3327
```

Overcoming Challenges



Data Balancing

Strategies were employed to balance the dataset, which included techniques like oversampling of minority classes, ensuring equitable data distribution.

Increasing Accuracy

More training epochs were utilized in the model's training, allowing fine-tuning of weights and improved predictions.

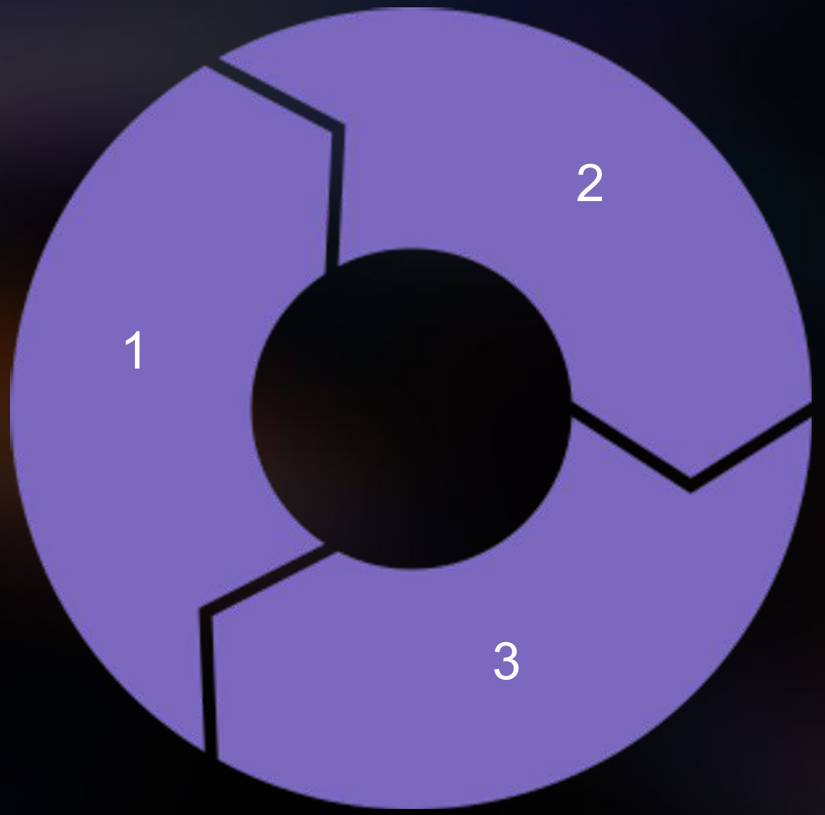
Deeper Layers and Augmentation

Implementing deeper convolution layers and data augmentation techniques enhanced the model's robustness.

Future Directions

Improved Accuracy

Further research will focus on optimizing the model through advanced techniques such as hyperparameter tuning and transfer learning to achieve even higher accuracy.



Medical Insights

The ultimate goal is to provide deeper medical insights into dementia progression, potentially aiding in early diagnosis and treatment strategies.

Collaboration Opportunities

Future collaborations with healthcare professionals could lead to additional datasets and real-world applications, enhancing the model's impact in clinical settings.

Conclusion on CNN Model for Dementia Prediction

In conclusion, the CNN model demonstrates significant potential in predicting dementia stages with sound preprocessing techniques, effective deployment, and visual interpretability through Grad-CAM, emphasizing its readiness for practical use in medical fields.

Significant Potential

The CNN model showcases great promise in predicting dementia stages.

Effective Deployment

Utilizing sound preprocessing techniques for optimal results.

Visual Interpretability

Grad-CAM enhances the understanding of model predictions visually.


THANK YOU!