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"Improved Classification of Alzheimer's Disease with Convolutional Networks

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ABSTARCT

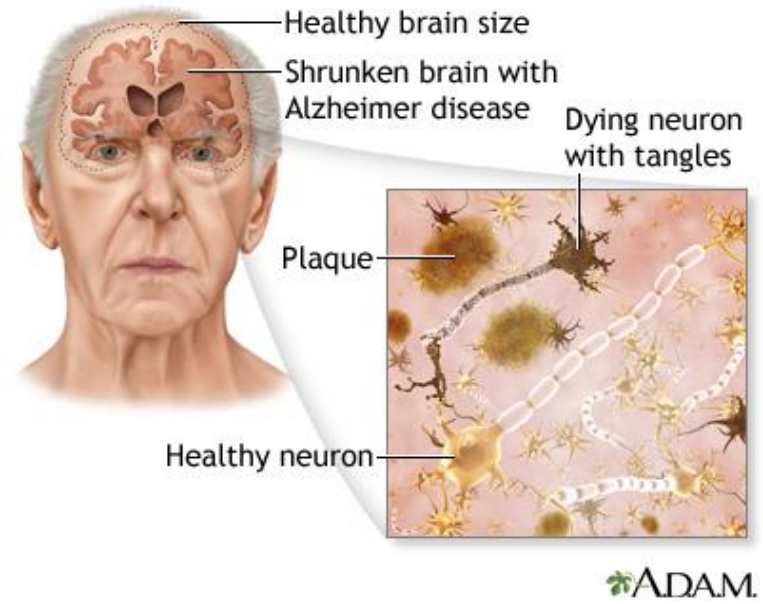
- This work focuses on classifying MRI images using machine learning models to identify Alzheimer's disease (AD), the most common form of dementia, at an early stage.
- It is now possible to identify and forecast the onset of AD by analyzing brain scans collected through Magnetic Resonance Imaging (MRI) and using artificial intelligence (AI) technologies, classifying patients as either at risk or not.
- The main goal is to make precise predictions.
- Using machine learning methods such as Convolutional Neural Network (CNN), Support Vector Machine (SVM), and fastai—a user-friendly deep learning library and framework—we developed models using a dataset of 6400 MRI images from the Alzheimer's Disease Neuroimaging Initiative (ADNI) 4 class for the early detection and classification of AD .
- This study demonstrates a viable method for classifying and diagnosing Alzheimer's disease early on, utilizing MRI images and machine learning models.

PROBLEM DEFINITION

The problem definition is focused on how to effectively and promptly diagnose Alzheimers' disease using data from Magnetic Resonance Imaging (MRI) and machine learning methods.

INTRODUCTION

- Alzheimer's disease has no cure with it being the seventh leading cause of death in the world.
- MRI scans detect its early signs.
- Machine Learning Models effectively classify this images.
- Early detection of the disease allows for easy management and treatment of the disease.



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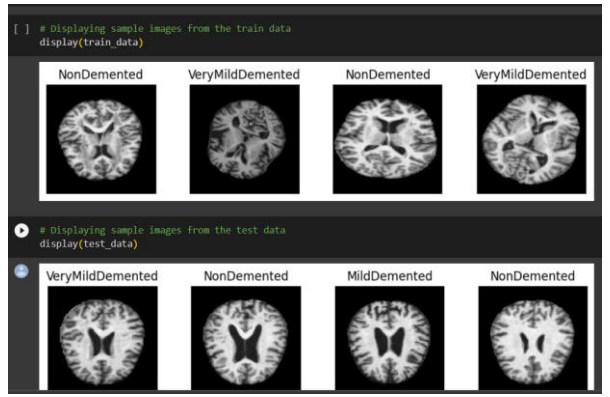
SYNERGY BETWEEN MACHINE LEARNING AND MRI

- Enhanced Image Analysis
- Feature Extractions
- Early Detections
- Pattern Recognition
- Accurate Diagnosis
- Predictive Modeling

DATASET

- Data Collection and Preprocessing:6400 data images was gotten from ADNI website
- It is contains 4 classes of images
- The data was gotten from Alzheimers' Disease Neuroimaging Initiative(ADNI)



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DATA PREPOCESSING

- Train data gen was rescaled to 1./255 .the pixel values of the images to the range [0,1]
- The code "Validation split = 0.2" divides the training data into two parts: a training set and a validation set. The validation set comprises 20% of the original training data and is used to assess the model's performance during training..
- Valid data gen rescaled images to 1/255
- Test data gen Rescaled to 1/255

```
# Image Preprocessing

train_datagen = ImageDataGenerator(rescale = 1./255,
                                   zoom_range = 0.2,
                                   rotation_range=30,
                                   horizontal_flip = True,
                                   vertical_flip = True,
                                   validation_split = 0.2)

valid_datagen = ImageDataGenerator(rescale = 1./255,
                                   validation_split = 0.2)

test_datagen  = ImageDataGenerator(rescale = 1./255)
```

DATA PREPOCESSING

- Training data:4098
- Images belongs to 4 classes
- Validation data:1023 images belongs to 4 classes
- Test data:1279 images belongs to 4 classes

```
# Accessing the training data
train_data  = train_datagen.flow_from_directory(directory = "/content/Alzheimer_s Dataset/train",
                                                target_size = (224,224),
                                                class_mode = 'categorical',
                                                subset = 'training',
                                                batch_size = 20)
```

```
Found 4098 images belonging to 4 classes.
```

```
# Accessing the validation data
valid_data = valid_datagen.flow_from_directory(directory = "/content/Alzheimer_s Dataset/train",
                                               target_size = (224,224),
                                               class_mode = 'categorical',
                                               subset = 'validation',
                                               batch_size = 20)
```

```
Found 1023 images belonging to 4 classes.
```

```
# Accessing the test data
test_data  = test_datagen.flow_from_directory(directory = "/content/Alzheimer_s Dataset/test",
                                              target_size = (224,224),
                                              class_mode = 'categorical',
                                              batch_size = 20)
```

```
Found 1279 images belonging to 4 classes.
```

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DATA PREPOCESSING AND EXTRACTION

- There are 6,400 images in all.
- 3,200 of which are labeled as Demented
- 2,240 of which are very mildly demented.
- 896 of which are mildly demented.
- 64 of which are moderately demented.
- The images were divided into two directories one for training images and the other for testing images.

MACHINE LEARNING APPROACH
What is Support Vector Machine?

- Handles High-dimensional data
- Has Ability to capture Complex patterns
- Robust against overfitting
- Works well with limited training samples

```
model_svm = grid.best_estimator_


y_pred = model_svm.predict(test_images)


accuracy = accuracy_score(test_labels, y_pred)
precision = precision_score(test_labels, y_pred, average='weighted')
recall = recall_score(test_labels, y_pred, average='weighted')
f1 = f1_score(test_labels, y_pred, average='weighted')
print("Accuracy score:", accuracy)
print("Precision score:", precision)
print("Recall score:", recall)
print("F1 score:", f1)
```

```
Accuracy score: 0.7
Precision score: 0.48999999999999994
Recall score: 0.7
F1 score: 0.5764705882352941
```

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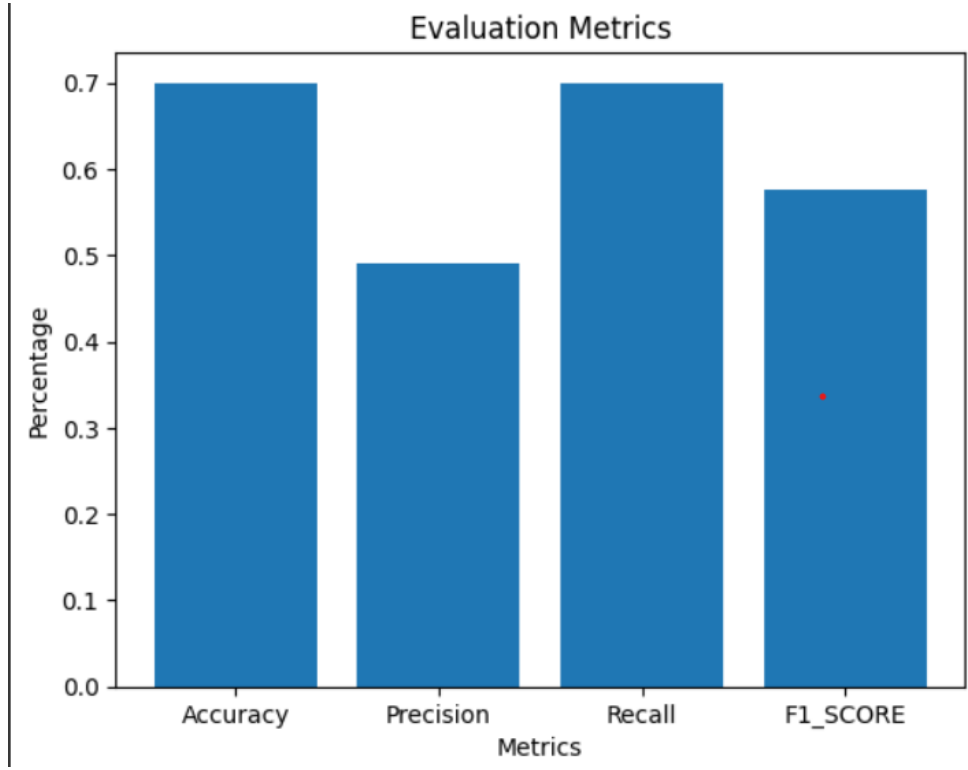
SVM EVALUATION

- Accuracy of 70% shows the instances were correctly classified.
- Precision of 49% shows true positive predictions.
- Recall of 70%
- F1_Score of 55%



MACHINE LEARNING APPROACH
What is Convolutional Neural Network?

- Commonly used for analyzing visual data such as images or videos
- It has the ability to automatically learn and extract features from input data.
- Scans across images to detect patterns and features at different spatial scales
- It is a 9-layer model built with keras Tensorflow.
- CNNs have revolutionized the field of computer vision and have achieved remarkable success in various applications.

COMPARISON BETWEEN CNN AND VGG16

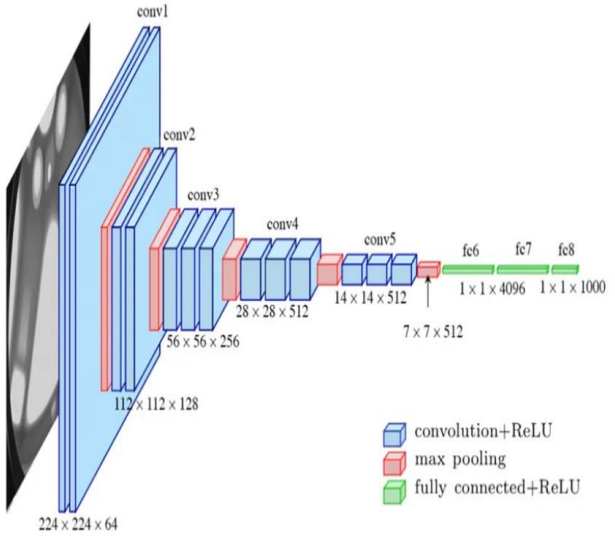
- CNN utilizes convolutional layers and pooling functions.
- VGG-16 uses a uniform structure with small 3 by3 filters and max pooling.
- CNN is a deep learning architecture mainly for image analysis and pattern recognition, while VGG-16 focuses on extracting features across various scales and complexities.
- VGG-16 has a total of 16 layers
- VGG-16 has 13 convolutional layers and 3 fully connected la

USING TRANSFER LEARNING IN CNN

- Takes Layers from a previously trained model
- Trainable layers on top of the frozen layers
- Freezes them to avoid destroying information they contain during training rounds
- Train new layers on a new dataset

VGG-16 ARCHITECHTURE IN CNN

- The model holds a sequential function .
- Dropout is a regularization technique that helps to prevent overfitting
- A dropout layer of 0.5 rate was added.
- Flatten layer flattens the multidimensional output .



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DENSE LAYER ARCHITECTURE

- A layer in a neural network that represents a fully connected layer
- It is placed after the convolutional and pooling layers
- Uses four neurons in the neural network model

SOFT-MAX ACTIVATION FUNCTION IN NEURAL NETWORK

- Soft-max predicts class probabilities in multi-class classification.
- e denotes the mathematical constant Euler's number
- Z_i represents the input to the SoftMax function for the i-th class
- Where the total sum of the exponential values of all the element in the input value is

$$\sum_{j=1}^{K} e^{z_j}$$

Softmax activation function

$$\frac{e^{z_i}}{\sum_{j=1}^{K} e^{z_j}}$$

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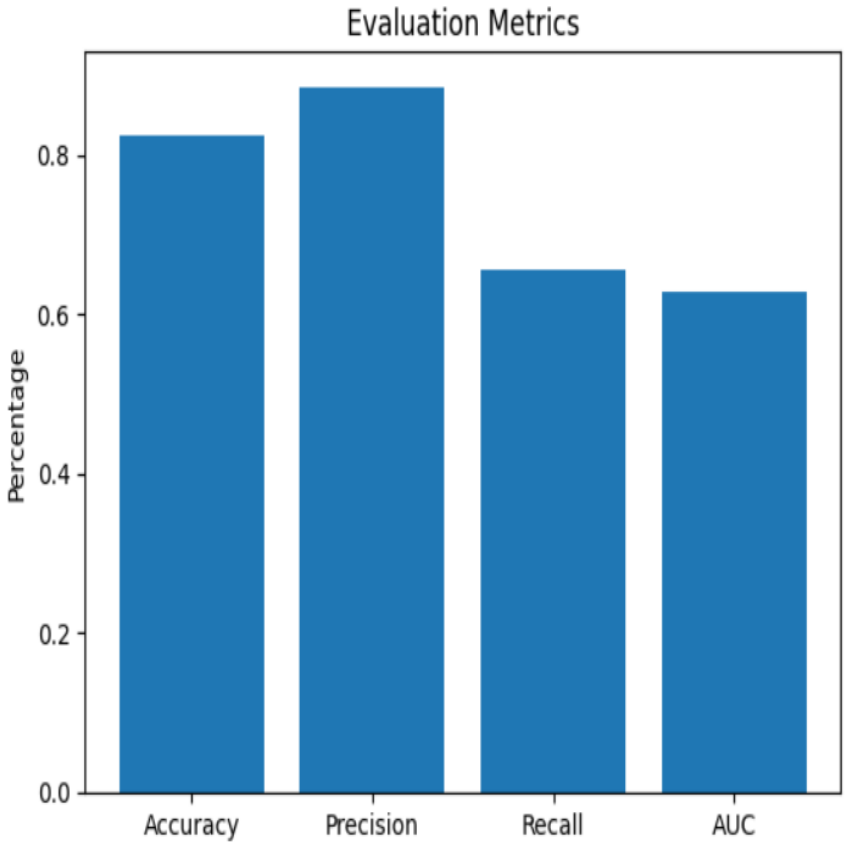
ACCURACY OF THE VGG-16 TRANSFER LEARNING ON A CNN

- Accuracy using VGG16 transfer learning on CNN 80.4% of the datasets
- Precision is 84.1%
- Recall is 62%
- Area under the Curve is 0.56



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RESULTS AND CONCLUSIONS

The primary objective of this research was to develop accurate algorithms for the early detection of Alzheimer's disease.

Our models achieved an accuracy of 80.4\%, with the convolutional neural network (CNN) and the incorporation of a pre-trained VGG layer into the sequential model emerging as the top-performing algorithms with 84.4\% accuracy.

Our approach involved a comprehensive exploration of various machine learning algorithms to identify those capable of timely and precise disease detection.

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REFERENCES

- “Combining deep learning with traditional machine learning to improve phonocardiography classification accuracy”, author={Chowdhury, M and Li, C and Poudel, K}, booktitle={2021 IEEE Signal Processing in Medicine and Biology Symposium (SPMB)}, pages={1--5}, year={2021}, organization={IEEE}
- M.Golmohammadi, V. Shah, S. López, S. Ziyabari , S. Yang, J. Camaratta, I. Obeid and J. Picone, “Proceedings of the American Clinical Neurophysiology Society Annual Meeting” title={{The TUH EEG Seizure Corpus}}, year={2017}
- title={Explainable Deep-Learning-Based Diagnosis of Alzheimer’s Disease Using Multimodal Input Fusion of PET and MRI Images}, Odusami, Modupe and Maskelinas, Rytis and Dama eviius, Robertas and Misra, Sanjay}, journal={Journal of Medical and Biological Engineering}, pages={1--12}, year={2023}, publisher={Springer}
- Hashmi, Arshad and Barukab, Omar,”Dementia Classification Using Deep Reinforcement Learning for Early Diagnosis”, JOURNAL = {Applied Sciences},VOLUME = {13},YEAR = {2023},NUMBER = {3},ARTICLE-NUMBER = {1464},URL = {https://www.mdpi.com/2076-3417/13/3/1464},ISSN = {2076-3417},DOI = {10.3390/app13031464}
- Salehi, Ahmad Waleed and Baglat, Preety and Sharma, Brij Bhushan and Gupta, Gaurav and Upadhya, Ankita}, booktitle={2020 International Conference on Smart Electronics and Communication (ICOSEC)}, title={A CNN Model: Earlier Diagnosis and Classification of Alzheimer Disease using MRI},

THANK YOU