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Prediction of Alzhimers Disease from 4 Class of MRI Images Using Inception V3 Model in Deep Learning

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ABSTRACT

Today, Alzheimer's Disease (AD), a degenerative neurological disorder, is the most common cause of dementia. Although it can affect anyone, older folks are often the ones who are affected. Alzheimer's disease (AD) is distinguished by a gradual decline in cognitive function, memory loss, atypical behaviour and personality, and difficulties with daily activities. Although the exact cause of AD is still unknown, a combination of genetic, environmental, and lifestyle factors are thought to be responsible. Several techniques, including machine learning and data analysis, are used in the prediction of Alzheimer's disease (AD), either to identify those who are at risk of contracting the illness or to predict how patients will fair over time. Treatments may be more effective, and patient outcomes may be improved, thanks to early detection and management made possible by AD prediction. There are numerous methods for predicting AD, and they usually include information from the clinical, genetic, and neuroimaging fields. Since the Inception module of the V3 network combines a max-pooling operation with multiple simultaneous convolutional operations with different filter sizes (1x1, 3x3, and 5x5), we attempt to identify AD using the Inception V3 model in this paper. By performing many actions simultaneously, the network can collect properties at different sizes and minimise spatial dimensions, allowing for more efficient representation learning. By running numerous tests on the Inception V3 model using a variety of MRI pictures as input, we eventually outperformed several other models with an accuracy of 77.08%.

Keywords : Alzheimer's disease, Inception V3 Model, Neuro Imaging, Aetiology, Personality Abnormalities, Cognitive Function.

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I. INTRODUCTION

With early detection and management made possible by AD prediction [1], treatments may be more efficient and patient outcomes may be enhanced. Different strategies for predicting AD exist, and they frequently draw from a combination of clinical [2], genetic, and neuroimaging data. Here are a few typical techniques and variables taken into account in AD prediction:

Clinical Examinations: To spot early indications of cognitive decline related to AD, medical practitioners employ a variety of clinical evaluations, such as cognitive tests and evaluations of memory, language, and executive skills. These evaluations aid in determining the likelihood that AD will develop.

Genetic Elements: Variations in the apolipoprotein E (APOE)[3] gene have been linked to an increased risk of developing Alzheimer's disease (AD). Particularly in people with a family history of AD, genetic testing can offer useful information for AD prediction.

Biomarkers: Biomarkers can reveal the presence of AD-related pathology in the brain by measuring levels of certain proteins (such as beta-amyloid and tau) in cerebrospinal fluid or by using neuroimaging methods (such as positron emission tomography[4] (PET) and magnetic resonance imaging (MRI)). These biomarkers can be used to track the development of the disease and forecast the risk of AD.

Machine Learning: To create predictive models for AD, machine learning algorithms may analyse huge datasets, including clinical, genetic, and neuroimaging data. These algorithms discover patterns and connections in the data and are able to forecast a person's probability of acquiring AD or the course of the disease.

Although AD prediction research has shown promise, it is still an active area of study, and additional research is required to increase the precision and dependability of prediction models. For AD, early detection and intervention are essential because they may allow for lifestyle changes, medication therapy, and clinical trials that may be able to postpone the development or reduce the progression of the illness. However, it is always advised to speak with medical experts for a precise assessment and diagnosis of AD. In order to increase diagnosis precision, forecast disease progression, and advance our understanding of the disease's underlying mechanisms, deep learning techniques have been applied to research on Alzheimer's disease (AD). Here are some examples of how deep learning has been applied to Alzheimer's:

1) Deep learning models have been created to help with the diagnosis of AD utilising a variety of forms of data, including neuroimaging, genetic data, and clinical evaluations. Convolutional neural networks (CNNs) have been particularly useful for examining brain MRI scans for anomalies associated with AD, such as structural alterations to the brain or the presence of biomarkers.
2) **Disease Progression Prediction:** Patients' AD progression has been predicted using deep learning algorithms. These models can give insights into the rate of illness progression and identify signs linked to quicker or slower decline by analysing longitudinal data, such as cognitive evaluations and imaging scans over time.
3) **Image Analysis:** Deep learning algorithms have been used to analyse brain pictures, including those from MRI and PET scans, in order to find patterns and biomarkers associated with AD. This can aid in the early detection and monitoring of illness development. For instance, deep learning models have been used to identify tau tangles and amyloid plaques, two defining signs of AD, in brain scans.
4) **Drug Discovery:** Deep learning has been used to find new AD drugs. Models have been developed to forecast how well possible therapeutic molecules will work against particular AD-related proteins or pathways. This can assist in locating prospective treatment candidates for additional research.

5) **Disease Subtyping:** Based on patterns in clinical and imaging data, deep learning has been used to distinguish between several subtypes or stages of AD. Understanding the diversity of the condition will aid in developing more individualised treatment plans.

II. LITERATURE SURVEY

In this section, we attempt to define a list of many models or strategies that are discussed in relation to AD and how many models or methods are discussed earlier by several authors on Alzheimer's Disease.

Suk et al., (2014) [5] proposed an article on "Convolutional Neural Networks for Multimodal Neuroimaging Data Analysis".In this article the authors proposed a convolutional neural networks (CNNs) are used for the first time in the processing of multimodal neuroimaging data, including the classification of AD. It demonstrates how CNNs can effectively combine various imaging modalities, such MRI and PET, for better AD diagnosis.

Liu et al., (2014)[6] proposed an article on "Automatic Classification of Alzheimer's Disease and Mild Cognitive Impairment Using a Deep Learning Approach".In this article the authors proposed a concept The automatic classification of AD and mild cognitive impairment (MCI) based on MRI data is presented in this article utilising a deep learning strategy using stacked autoencoders. The study shows how deep learning can be used to identify between healthy controls, MCI, and AD patients.

Cheng et al., (2016) [7] proposed an article on "Deep Learning-Based Classification of FDG-PET Data for Alzheimer's Disease Staging".In this article the authors proposed the automatic classification of AD and mild cognitive impairment (MCI) based on MRI data is presented in this article utilising a deep learning strategy using stacked autoencoders. The study shows how deep learning can be used to identify between healthy controls, MCI, and AD patients.

Shen et al., (2017)[8] proposed an article on "Deep Learning for Brain MRI Segmentation: State of the Art and Future Directions".In this article the authors The deep learning methods utilised for brain MRI segmentation, including the segmentation of AD-related structures, are described in this survey work. It talks about different architectures and approaches and emphasises where the field is headed in the future.

Khvostikov et al., (2021) [9] proposed an article on "Machine Learning in Alzheimer's Disease Diagnosis, Classification, and Progression Prediction".In this article the authors proposed the use of machine learning algorithms in the diagnosis, classification, and prognosis of AD is covered in this review study. It includes information on the possibilities of machine learning in AD research and covers a variety of data modalities, such as neuroimaging, genetic data, and clinical assessments..

Aniverthy Amrutesh et al., (2022) [10] proposed an article on "Alzheimer's Disease Prediction using Machine Learning and Transfer Learning Models". In this article the authors proposed The most efficient parameters are examined in this study utilising two different datasets: the longitudinal dataset, which contains text values, and the OASIS dataset, which contains MRI pictures, for the efficient detection of Alzheimer's disease. The OASIS Longitudinal dataset is processed using 14 machine learning techniques, with the Random Forest Algorithm having the highest accuracy (92.1385%) and the KNN Algorithm having the lowest accuracy (47.1910%) as a starting point. The InceptionV3 model and ADAM as the Optimizer produced the best accuracy when MRI pictures were run on several transfer learning models.

III. TAXONOMY OF ALZHEIMER'S DISEASE PREDICTION

In this section we mainly discuss about some taxonomy of AD which are categorized based on several factors. In this section we are going to discuss some key important aspects for AD prediction. They are as follows:

1) Data Type:

a) **Clinical Data** consists of patient demographics, medical history, cognitive tests, and clinical assessments.

b) **Neuroimaging Data:** This includes positron emission tomography (PET) scans, structural MRI, functional MRI, and diffusion tensor imaging (DTI) scans.

c) **Genetic Information:** This consists of gene expression patterns, single nucleotide polymorphisms (SNPs), and genetic variations.

2) Prediction Targets

a. AD Diagnosis: Predicting if a person has AD or not.

b. Disease Progression: Predicting the rate and severity of cognitive decline and illness progression is covered in section b.

c. Conversion Prediction: predicting the transition from mild cognitive impairment (MCI) to Alzheimer's disease (AD).

3) Prediction Models

a. Machine Learning: Using different machine learning methods, such as logistic regression, support vector machines (SVM), random forests, or gradient boosting, are some predictive modelling and analysis techniques.

b. Deep Learning: Using deep neural networks to learn intricate patterns from data, such as convolutional neural networks (CNNs) or recurrent neural networks (RNNs).

c. Fusion Models: incorporating various data modalities (for instance, incorporating clinical, neuroimaging, and genetic data) to enhance prediction performance.

d. Feature Selection: To improve prediction accuracy and interpretability, choosing the most insightful characteristics or biomarkers from the input data.

E. Longitudinal Modelling: Taking into account data gathered at several time points to anticipate the course or conversion of a disease.

IV. PROPOSED SYSTEM & ITS ADVANTAGES

By taking into account all the potential parameters necessary for illness prediction, the suggested system aims to diagnose Alzheimer's disease based on the Inception V3 model. We are attempting to determine the patient's exact disease stage and accuracy in this application. There are several possible levels in our application, including Very Mild Demented, Non Demented, Mild Demented, and Moderate Demented. The suggested system has the advantages listed below. These are what they are:

ADVANTAGES

1) We can diagnose Alzheimer's illness with more accuracy by using the proposed Inception V3 model.

2) In this study, we review various papers that employ one or more algorithms for effective AD prediction.

3) Results show that it is quite accurate in identifying AD.

V. PROPOSED MODEL

The proposed system uses Inception V3 Model for identifying the Alzheimer’s disease prediction. In order to identify the AD, we need to take input as Brain MRI images and then try to apply Inception V3 model.

1) Input Image
2) Convolutional Layers
3) Pooling Layers

4) Auxiliary Classifiers
5) Fully Connected Layers
6) Softmax Activation
7) Training and Optimization
8) Transfer Learning

1) **Input Image:** The fundamental input for the Inception V3 model is an input image. The image should normally be adjusted to the model's specifications, which are typically 299x299 pixels.
2) **Convolutional Layers:** Several convolutional layers are applied to the input image to extract features. The Inception module, which combines multiple convolutional procedures of various filter sizes (1x1, 3x3, and 5x5) to capture characteristics at various scales, is introduced in Inception V3. These modules make it easier to quickly pick up a variety of features from the supplied image.
3) **Pooling Layers:** To minimise the spatial dimensions of the feature maps and capture the most important characteristics, max-pooling or average pooling operations are carried out after each set of convolutional layers.
4) **Auxiliary Classifiers:** At the network's intermediate layers, Inception V3 incorporates auxiliary classifiers. These auxiliary classifiers offer additional gradients for better learning and assist in preventing the vanishing gradient issue during training. They encourage the network to pick up more useful features that can differentiate users.

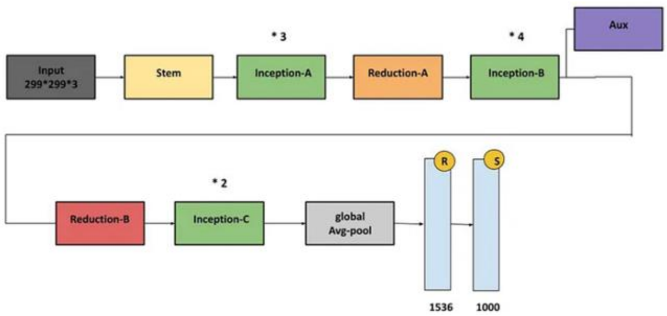


Figure 1. Represents the Inception V3 Architecture

5) **Fully Connected Layers:** At the network's end, fully connected layers take the collected features and map them to the appropriate output classes. These layers enable categorization based on the learnt features and give higher-level representation learning.
6) **Softmax Activation:** At the output layer of Inception V3, a softmax activation function is used to assign probabilities to each potential class label. The predicted class is the one whose label has the highest probability.

From the above figure 1, we can clearly identify the architecture of Inception v3 model and how that is applied in order to predict the AD.

VI. IMPLEMENTATION PHASE

The process of implementation involves turning the theoretical concept into a method that is based on programmes. At this stage, the application will be broken up into a number of components before being written for deployment. The application's front end is built using Google Collaboratory, while its back end data store is AD. The current application is being implemented in this case using Python. The application's main five modules are listed below. What they are these:

1. Import Necessary Libraries
2. Load Dataset Module
3. Data Pre-Processing
4. Train the Model Using Inception V3
5. Result Analysis

1) Load Libraries Module

In order to build the model, we must first import all necessary libraries into this module. Here, we make an effort to use every package that is accessible for effectively transforming data. We try to import the numpy module because the data in this case has been broken down into easily understandable numerical values, and we use the Matplot library to display the data in graphs and charts.

2) Dataset Module

In this module, the user tries to load a dataset that was downloaded or gathered from the KAGGLE Repository. "alzheimers-dataset-4-class-of-pictures.rar" is the file name for the dataset, which contains a collection of pictures of the human brain.

3) Data Cleaning Module

To find any missing values or incomplete data, we attempt to pre-process the incoming dataset in this step. If such data are included in the dataset, the application will ignore them and just load the pertinent information. No other images will be used as input images in this programme; all input images will be acquired as MRIs.

4) Inception V3 Model

Here, we attempt to train the existing model using the Inception v3 model to identify the best algorithms for properly and efficiently identifying and classifying the input information. The goal is to determine which algorithms are most effective at predicting the onset of Alzheimer's disease. Here, we attempt to forecast Alzheimer's disease and the class to which it belongs using the Inception V3 algorithm.

5) Performance Analysis Module

In this module, we attempt to compare the provided dataset using the Inception V3 model and determine which of the following categories the data falls into:

1. Very Mild Demented
2. Non Demented
3. Mild Demented
4. Moderate Demented

By looking at the records, we were able to identify the following case in this instance.

VII. RESULT AND DISCUSSION

In this section, we attempt to develop our present model utilising Python as the programming language and Google Collab as the operating system. Now, we can assess how well our suggested application is performing as follows.

LOAD DATASET

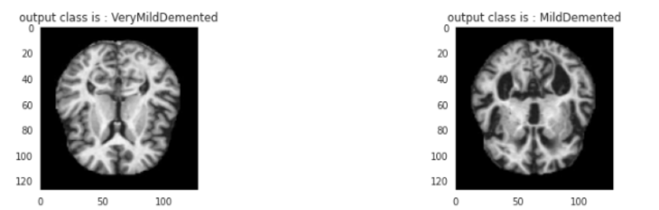
IMPORT LIBRARIES

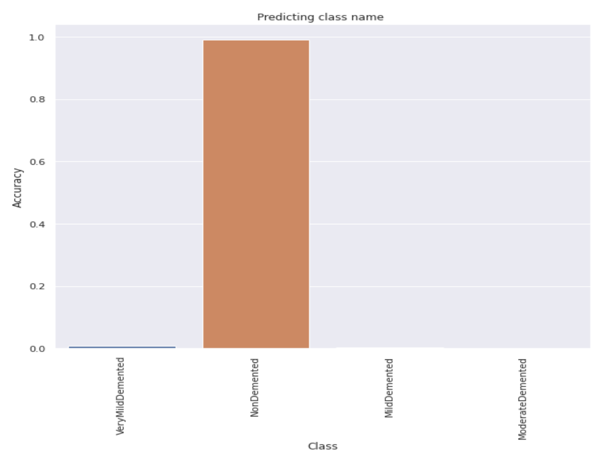
```
[ ] import pandas as pd
    import numpy as np
    import matplotlib.pyplot as plt
    import seaborn as sns
    import os
    import cv2
    import warnings
    warnings.filterwarnings('ignore')
```

PERFORMANCE ANALYSIS

```
import random
fig,ax=plt.subplots(5,2)
fig.set_size_inches(15,15)
for i in range(5):
    for j in range (2):
        l=random.randint(0,len(data))
        ax[i,j].imshow(data[l])
        ax[i,j].set_title('output class is : '+str(class_names[labels[l]]))

plt.tight_layout()
```





From the above window we can clearly see comparision of several factors which is categorized into four classes.

VIII. CONCLUSION

This study's automatic AD diagnosis method is based on deep learning using 3D brain MRI. The programme uses a convolutional neural network (CNN) to recognise AD. It stands out because the full 3D topography of the brain is included, ensuring accurate AD identification. The CNN used in this study consists of three sequential groups of processing layers, two completely connected layers, and a classification layer. Three layers make up each of the three groups in the structure: a convolutional layer, a pooling layer, and a normalisation layer. The system was trained and tested using MRI data from the Alzheimer's Disease Neuroimaging Initiative. The MRI scans of 34 healthy controls and roughly 47 AD patients made up the used data. The recommended algorithm has a high accuracy of AD recognition, according to the trial's findings, with a sensitivity of 1 and a specificity of 0.93. In the future, researchers will explore more CNN structures and hunt for more efficient ways to analyse data.

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