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Performance Analysis of Few Deep CNN Models on Classification of Alzheimer's Disease

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ABSTRACT:Urbanization and civilization have made people more susceptible to a wide range of ailments in the modern world. Diseases affecting the brain, heart, kidneys, and numerous other organs may be included. Alzheimer's disease is the most prevalent ailment that affects the brain. A degenerative neurologic condition called Alzheimer's disease results in the death of brain cells and brain shrinkage. It is the most frequent reason for dementia, which is another word for memory loss. Alzheimer's disease affects more than 35 million people worldwide, and this figure is rising, placing a significant burden on all nations. It benefits from early diagnosis and detection. Due to identical brain patterns and pixel intensities, the diagnosis of Alzheimer's in elderly individuals is rather challenging and necessitates a highly discriminative feature representation for classification. Through image processing, deep learning approaches are able to learn such representations from supplied data. The primary deep learning architecture used for image classification is the convolution neural network (CNN). For categorising Alzheimer's disease based on MRI data, we have employed a few Deep CNN (DCNN) models, specifically ResNet-50, ResNet-101, AlexNet, and VGG16 (Magnetic Resonance Imaging). It seeks to forecast the more accurate DCNN models for this classification.

KEYWORDS: Convolution Neural Network, MRI scan, Alzheimer's Disease, Deep CNN Models.

I. INTRODUCTION

A brain ailment, Alzheimer's disease. The disease is gradual, starting with mild memory loss and potentially progressing to the loss of communication and environmental awareness. The brain regions that are responsible for thought, memory, and language are affected by Alzheimer's disease. It can significantly impair a person's capacity to carry out daily tasks. Around the world, Asia has highest number of people suffering from dementia. Additionally, it is predicted that by 2050, 131.5 million individuals inhabit the world. Problems with memory, communication, and thought are possible signs. As far as dementia goes, Alzheimer's disease is the most prevalent. Alzheimer's disease symptoms start out mildly and worsen with time. It is unclear what causes Alzheimer's disease exactly. But on a fundamental level, brain proteins malfunction, which interferes with the operation of brain cells (neurons) and sets off a chain of harmful events. Damaged neurons lose their connections to one another and finally die. Most persons with Alzheimer's disease, according to scientists, have a combination of genetic, environmental, and lifestyle variables affecting their brains over time. When someone has Alzheimer's disease, their brain looks substantially different from a

healthy brain. The brain's cortex deteriorates. This indicates that the cerebral cortex of a normal brain shrinks, but this part of the brain does so in a way that is very different. The cerebral cortex is the brain's exterior. It controls every aspect of intellectual functioning. Magnetic resonance imaging (MRI) allows for the observation of two significant alterations in the brain: Less brain tissue is present in the gyri, the folds of the brain. The sulci, or gaps in the folds of the brain, are noticeably enlarged. Less brain tissue is present in the gyri, the folds of the brain. The sulci, or gaps in the folds of the brain, are noticeably enlarged.

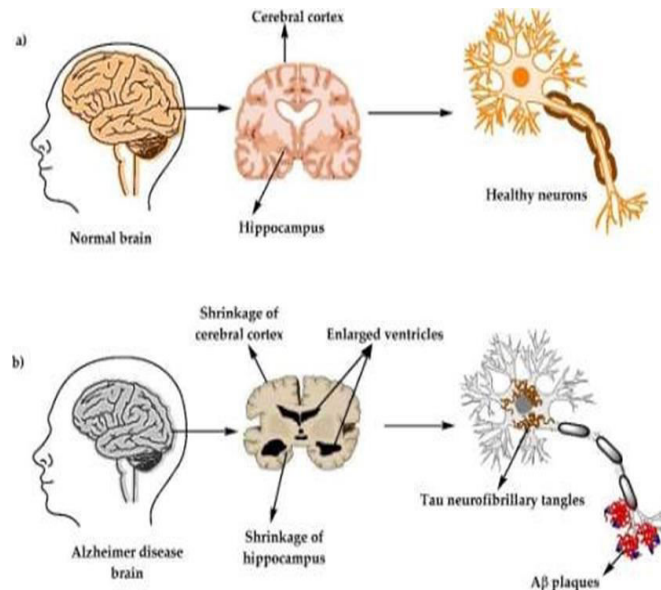


Figure 1: Appearance of Normal Brain and Alzheimer Disease Brain

It is very essential to identify earlier whether a person has Alzheimer disease or not if he/she come across with such symptoms. In this project, we developed a convolutional neural network (CNN)-based classification algorithm using magnetic resonance imaging (MRI) scans from AD patients. The model utilizes Magnetic Resonance Imaging (MRI) for classification and predicts whether a person has Alzheimer disease or not based on the MRI scan provided. If the model predicts that the person has Alzheimer disease then soon proper medication can be given to the person to reduce the chances of risk.

II. RELATED WORK

LinLiu, ShenghuiZhao, HaibaoChen, AiguoWang, 2020[1] "A new machine learning method for identifying Alzheimer's disease" proposed a method that uses the spectrogram features extracted from speech data to identify Alzheimer's Disease, which can help families to understand the disease development of patients in an earlier stage, so that they can take measures in advance to delay the disease development. In this study, the researchers gathered a brand-new speech dataset from both Alzheimer's sufferers and healthy controls. Then they have compared the speech data. Among the tested models, Logistic Regression model exhibited the best performance.

Ammarah Farooq, SyedMuhammad Anwar, Muhammad Awais, Saad Rehman, 2017[2] "A deep CNN based multiclass classification of Alzheimer's disease using MRI" proposes a deep convolutional neural network based pipeline for the diagnosis of Alzheimer's disease and its stages using magnetic resonance imaging (MRI) scans. The diagnosis of Alzheimer's in elderly people is quite difficult and requires a highly discriminative feature representation for classification due to similar brain patterns and pixel intensities. Deep learning techniques learn this representation from data provided. In this a 4-way classifier is implemented to classify Alzheimer's (AD), mild cognitive impairment (MCI), late mild cognitive impairment (LMCI) and healthy persons. Experiments are carried out using ADNI dataset and the proposed technique results in a prediction accuracy of 98.8%.

Harshit Parmar, Brian Nutter, Rodney Long, Sameer Antani, Sunanda Mitra, 2020[3] "Spatiotemporal feature extraction and classification of Alzheimer's disease using deep learning 3DCNN for fMRI data" proposes a method which uses modified 3D convolutional classification and feature extraction of Alzheimer's disease using resting-state fMRI data and neural networks (CNN) (AD). However, the primary goal of this research is to make advantage of the clinical

potential of deep learning methods for fMRI data. CNN uses fMRI data with much less preprocessing, preserving both spatial and temporal information. Once trained, the network can distinguish between fMRI data from AD patients and healthy controls. CNN is able to recognise and distinguish between MCI and AD in their early and late phases.

Katia M. Poloni, Italo A. Duarte de Oliveira, Roger Tam, Ricardo J. Ferrari, 2021 [4] "Brain MR image classification for Alzheimer's disease diagnosis using structural hippocampal asymmetrical attributes from directional 3-D log-Gabor filter responses" proposes a method that uses the attributes showing statistically mean differences among the classes (CN, MCI, and AD), were selected for classification. Hippocampus is the first brain structure to present atrophy hence, they are commonly used for the AD classification task. As a result of the classification using clinical MR images accuracy values of 69.44% and 82.59% was obtained. The statistical analysis of Assymetry Index has shown a significant increase in hippocampal asymmetry as disease progress (CN < MCI < AD).

Jiang, Xianwei, Chang, Liang, Zhang, Yu-Dong, 2020 [5] "Classification of Alzheimer's Disease via Eight-Layer Convolutional Neural Network with Batch Normalization and Dropout Techniques" proposes a eight-layer convolutional neural network with batch normalization and dropout techniques for classification of Alzheimer's disease. After data augmentation, the training dataset contained 7399 AD patient and 7399 HC subjects. Our eight-layer CNN-BN-DO-DA method yielded a sensitivity of 97.77%, a specificity of 97.76%, a precision of 97.79%, an accuracy of 97.76%, a F1 of 97.76%, and a MCC of 95.56% on the test set, which achieved the best performance in seven state-of-the-art approaches. The results strongly demonstrate that this method can effectively assist the clinical diagnosis of Alzheimer's disease.

Marcia Hon, Naimul Mefraz Khan, 2017 [6] "Towards Alzheimer's disease classification through transfer learning" proposes a state-of-the-art architectures such as VGG and Inception which are initialised using pre-trained weights from sizable benchmark datasets made up of real-world images, and the fully-connected layer is re-trained with only a small number of MRI pictures. Through experimentation on the OASIS MRI dataset, it shows that with training size almost 10 times smaller than the state-of-the-art, they have reached comparable or even better performance than current deep-learning based techniques.

Junhao Wen, Elina Thibeau-Sutre, Mauricio Diaz-Melo, Jorge Samper-Gonzalez, Alexandre Routier, Simona Bottani, Didier Dormont, Stanley Durrleman, Ninon Burgos, Olivier Colliot, 2020 [7] "Convolutional neural networks for classification of Alzheimer's disease: Overview and reproducible evaluation" proposes a four main types of approaches: i) 2D slice-level, ii) 3D patch-level, iii) ROI-based and iv) 3D subject-specific CNN. Classification of AD using CNN and T1-weighted MRI framework was used to compare different CNN architectures which automatically convert ADNI, AIBL and OASIS data into the BIDS standard. Only the training and validation sets were used for model selection once the data had been first divided into training, validation, and test sets. While the outcomes of the various 3D approaches (3D-subject, 3D-ROI, and 3D-patch) were comparable, those of the 2D slice approach were less successful.

Johannes Rieke, Fabian Eitel, Martin Weigandt, John-Dylan Haynes, Kerstin Ritter, 2018 [8] "Convolutional Network Imaging for MRI-Based Alzheimer's Diagnosis" is a 3D CNN model for Alzheimer's detection based on structural MRI scans of the brain. To suggest. Uses 4 different rendering methods based on gradients and occlusions by highlighting those areas in the input image. All four methods focus on areas of the brain known to be associated with Alzheimer's disease, such as the inferior temporal gyrus and the middle temporal gyrus. Occlusion-based methods focus more on specific areas, while gradient-based methods capture patterns of relevance distribution.

Diptesh Das¹, Junichi Ito², Tadashi Kadowaki², Koji Tsuda, 2019 [9] "An interpretable machine learning model for diagnosis of Alzheimer's disease" suggests the sparse high-order interaction model with rejection option as an interpretable machine learning model for medical diagnostics (SHIMR). The Alzheimer's disease Neuroimaging Initiative (ADNI) dataset of proteomics data from 151 participants shows that SHIMR is just as accurate as other non-interpretable techniques. SHIMR is enhanced by the inclusion of a rejection option when creating a multistage, cost-effective diagnosis framework. SHIMR has been shown to be efficient in building a patient-specific, affordable Alzheimer's disease (AD) pathology model. Using a baseline concentration of cerebrospinal fluid (CSF) and plasma proteins from a common cohort of 141 people.

Xin Xing, Gongbo Liang, Hunter Blanton, Muhammad Usman Rafique, Chris Wang, Ai-Ling Lin, Nathan Jacobs, 2021 [10] "Dynamic Image for 3D MRI Image Alzheimer's Disease Classification" offers to classify a 3D MRI image of Alzheimer's illness using a 2D CNN architecture. Training a 3D convolutional neural network (CNN) is time-consuming and computationally expensive. So they have used approximate rank pooling to transform the 3D MRI image volume into a 2D image to use as input to a 2D CNN. The suggested CNN model accomplishes 9.5% better Alzheimer's disease classification accuracy than the baseline 3D models and it also allows for efficient training, requiring only 20% of the training time compared to 3D CNN models.

III.METHODOLOGY

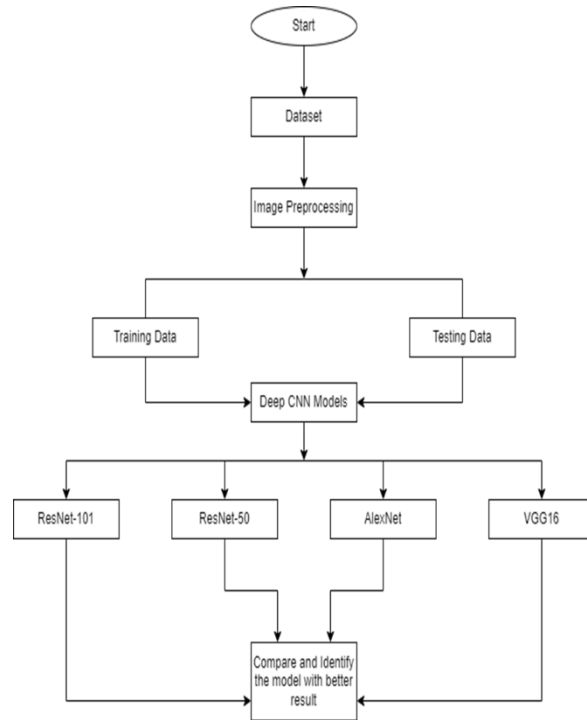


Figure 7: Methodology Diagram

The suggested methodology entails the following steps:

- Gather the necessary picture dataset and pre-process the photos to get them into the specific dimensions required by the model.
- After preprocessing, the data are separated into training and testing sets.
- The training data is used to train the model, and the testing data is used to verify that the trained model is producing the desired outcome.
- ResNet-101, ResNet-50, AlexNet, and VGG16 are the four distinct Deep CNN Models used in this research.
- The accuracy of each model is calculated after it has been trained and tested independently using the dataset that has been gathered.
- In order to determine which model provides greater accuracy, we will compare and evaluate each model's performance.

IV. EXPERIMENTAL RESULTS

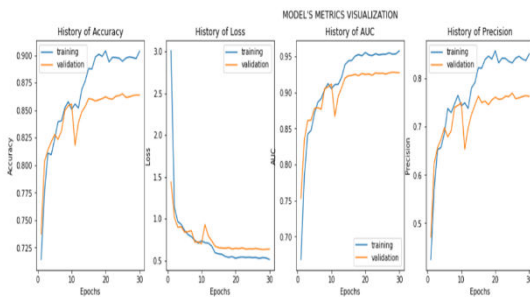


Figure 3: Metrics for VGG16

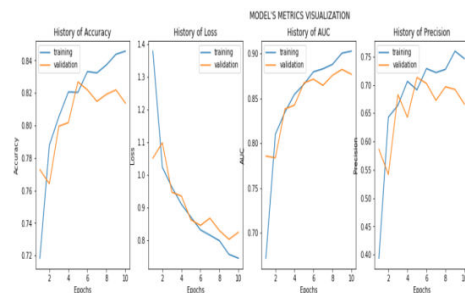


Figure 4: Metrics for ResNet50

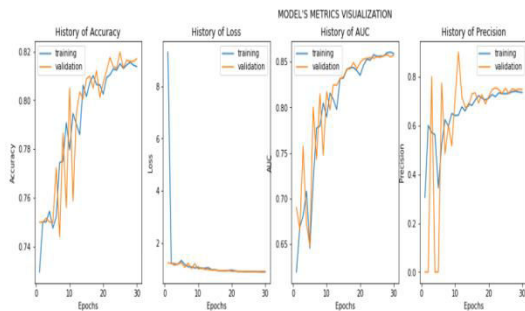


Figure 5: Metrics for AlexNet

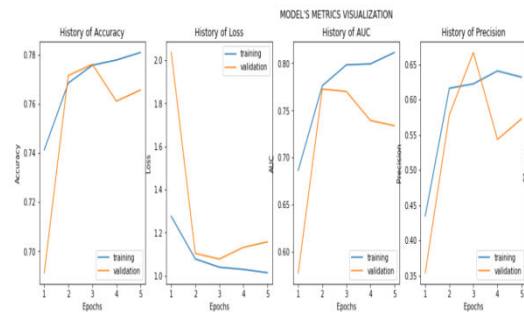


Figure 6: Metrics for ResNet101

	AlexNet	ResNet50	ResNet101	VGG16
Accuracy	0.37	0.54	0.72	0.54
Precision	0.13	0.54	0.36	0.66
Recall	0.37	0.54	0.16	0.54
F1_score	0.20	0.50	0.22	0.46

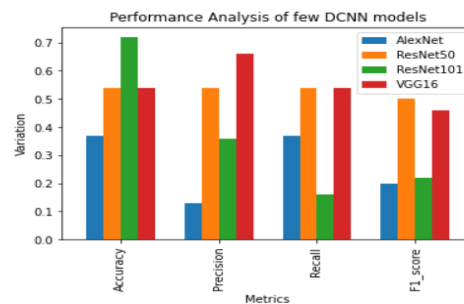


Figure 7: Performance Analysis of Deep CNN Models

V. CONCLUSION

Alzheimer is spreading around the world day by day. So, early detection and identification is necessary. We have chosen the project for performance analysis of different Deep CNN models based on identification and classification of Alzheimer’s disease. The literature review assisted us in comprehending the existing technology’s shortcomings. The problems were formulated based on the gaps identified. For the defined problem, we have set the objectives and methodology to be followed to identify and classify the Alzheimer’s Disease. Among 4 Deep CNN models, ResNet101 has given the better accuracy.

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