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# Classification of Alzheimer's Disease Using Convolutional Neural Networks

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***Abstract:*** *Brain-related diseases are among the most difficult diseases due to their sensitivity, the difficulty of performing operations, and their high costs. In contrast, the operation is not necessary to succeed, as the results of the operation may be unsuccessful. One of the most common diseases that affect the brain is Alzheimer's disease, which affects adults, a disease that leads to memory loss and forgetting information in varying degrees. According to the condition of each patient. For these reasons, it is important to classify memory loss and to know the patient at what level and his assessment of Alzheimer's disease through CT scans of the brain. In this thesis, we review ways and techniques to use deep learning classification to classifying the Alzheimer's Disease The proposed method used to improve patient care, reduce costs, and allow fast and reliable analysis in large studies. The model will be designed using Python language for implementing the system, which is very useful for doctors, classifying the Alzheimer's Disease, was used. The model used 70% from image for training and 30% from image for validation, our trained model achieved an accuracy of 100% on a held-out test set.*

**Keywords**: Deep learning, Alzheimer's, classification, CNN

## Introduction

For every human, there are three basic memories: first, working memory, which is responsible for attention and focus while receiving data and information, secondly, short-term memory, which is responsible for storing data and the storage period does not exceed one day, finally long-term memory, which is responsible for recording and storing all the events that we experience for periods long beyond days.
Alzheimer's disease is a progressive brain disease that wreaks havoc on memory and thinking skills, as well as the capacity to carry out even the most basic tasks.
Artificial Intelligence (AI) can assist doctors in making more accurate and timely (Alfarra, 2021)diagnosis. It can anticipate the risk of a disease in advance, allowing it to be prevented. Researchers can use deep learning to examine medical data and treat ailments. Medical image analysis, on the other hand, can be a complicated and time-consuming operation.
In this study, we will implement a deep learning model to detect early Alzheimer's disease. There are 10,432 images (JPEG) and 4 categories (Mild Demented, Moderate Demented, Non-Demented, Very Mild Demented).

Machine learning (ML) is an application of artificial intelligence (AI) that provides systems the ability to automatically learn and improve from experience without being explicitly programmed [1-10]. ML is the study of computer algorithms that improve automatically through experience. Machine learning algorithms build a mathematical model based on sample data, known as "training data", in order to make predictions or decisions without being explicitly programmed to do so. Machine learning algorithms are used in a wide variety of applications, such as image recognition, Medical Diagnosis, and classification, where it is difficult or infeasible to develop conventional algorithms to perform the needed tasks [11-20].

Deep learning (also known as deep structured learning or hierarchical learning) is an artificial intelligence function that imitates the workings of the human brain in processing data and creating patterns for use in decision making. Deep learning is a subset of machine learning in artificial intelligence (AI) that has networks capable of learning unsupervised from data that is unstructured or unlabeled. It is also known as deep neural learning or deep neural network [21-30].

Deep learning, a division of machine learning, uses a hierarchical level of artificial neural networks to perform the process of machine learning. The artificial neural networks are constructed like the human brain, with neuron nodes linked together like a web [31-40].

In deep learning, each level learns to transform its input data into a slightly more abstract and composite representation. [41-50]. In an image recognition application, the raw input may be a matrix of pixels; the first representational layer may abstract the pixels and encode edges; the second layer may compose and encode arrangements of edges; the third layer may encode a nose and eyes; and the fourth layer may recognize that the image contains a face [51-60]. Importantly, a deep learning process can learn which features to optimally place in which level on its own [61-70]. (Of course, this does not completely obviate the need for hand-tuning; for example, varying numbers of layers and layer sizes can provide different degrees of abstraction)[71-76].

**Objectives**

- Develop a deep learning model for detecting four forms of Alzheimer's disease (Mild Demented, Moderate Demented, Non-Demented, Very Mild Demented) was implemented.
- Avoid diagnostic errors that can arise when images are examined manually.
- It helps clinicians make faster, more accurate diagnosis by improving their capacity to analyze medical images.

**Significance of the study:**

Deep learning is one of the most important research fields in medical imaging. Deep learning has been used to analyze CT, MRI, and X-ray images in dermatology, uterus cancer classification, Rare Diseases, mouth cancer detection, and pathology. Furthermore, deep learning is being used by researchers to train computers to spot malignant tissue at a level comparable to that of a trained physician.

**A Literature Review:**

The Organized of Pharmaceutical of the National Institutes of Science, Designing and Medication states that "symptomatic blunders contribute to around 10 percent of quiet passings", additionally account for 6 to 17 percent of clinic complications. Analysts' trait the cause of symptomatic mistakes to an assortment of diverse components not as it were the doctor's execution such as crevices in communication between patients' family & specialist & ineffectual participation of wellbeing data innovations. The objective of this thesis is to assist the speed and exactness of the conclusion.

Although AI has been around for decades, in machine learning, a machine can take a dataset, analyze it, and make a decision or prediction based on what it has learned. Deep learning is a more complex version of this, where there are several layers of process features and each layer takes some information, deep learning helps researchers analyze medical data to treat diseases such as OCT, MRl and CT images.

This study, multi-category Alzheimer's disease was detected and categorized through the use of brain MRI images. A very deep convolutional network was designed to display performance on the Open Access Chain of Imaging Studies (OASIS) database. The accuracy of this model is 73.75%.

This model is a deep learning-based segmenting method that uses SegNet to detect AD relevant brain parts features from structural magnetic resonance imaging (sMRI) and then classifies AD and dementia conditions accurately using ResNet-101. ResNet-101 is trained using SegNet features with the ADNI dataset. This model has a 95% accuracy rate.

To distinguish Alzheimer's brain from normal healthy brain, this model uses a convolutional neural network. The significance of classifying this type of medical data is that it can be used to construct a predict model or system that can distinguish type disease from normal people or estimate disease stage. The researchers successfully categorized functional MRI data of Alzheimer's patients from normal controls using Convolutional Neural Networks (CNN) using the well-known architecture LeNet-5 This model has a 96.85% accuracy rate (Saman Sarraf, 2016)

This approach suggests using multiple deep 2D convolutional neural networks (2D-CNNs) to learn various features from local brain pictures, which are then combined to create the final AD diagnosis classification. The whole brain image was passed through two transfer learning architectures, Inception version 3 and Xception, as well as a custom Convolutional Neural Network (CNN). The results of this model show that transfer learning approaches outperform non-transfer learning-based approaches for the binary AD classification task (Tufai, 2020)

This model demonstrates how the residual and plain 3D convolutional neural network designs can achieve equivalent performance by avoiding these feature extraction phases. On the Alzheimer's Disease National Initiative (ADNI) dataset of 3D structural MRI brain images, demonstrate the performance of the suggested approach for categorization of Alzheimer's disease against moderate cognitive impairment and normal controls. (Mittal, 2020)

This model developed an integrative framework that combines cross-sectional neuroimaging biomarkers at baseline and longitudinal cerebrospinal fluid (CSF) and cognitive performance biomarkers obtained from the Alzheimer's Disease Neuroimaging Initiative cohort (ADNI). When incorporating longitudinal multi-domain data. A multi-modal deep learning approach has potential to identify persons at risk of developing AD who might benefit most from a clinical trial or as a stratification approach within clinical trials. (S.Sudha, 2016)

This model proposes a deep convolutional neural network for Alzheimer's infection conclusion utilizing brain MRI information investigation. Whereas most of the existing approaches perform binary classification, our show can recognize diverse stages of Alzheimer's illness and gets prevalent execution for early-stage determination. Conducted adequate tests to illustrate that proposed show outflanked comparative baselines on the Open Get to Arrangement of Imaging Considers dataset, this show includes

a 77% exactness rate (Widianto, 2021)

This study explores the effectiveness of Rs-fMRI for multi-class classification of AD and its associated stages and AD. A longitudinal cohort of resting-state fMRI of 138 subjects (25 CN, 25 SMC, 25 EMCI, 25 LMCI, 13 MCI, and 25 AD) To provide a better insight into deep learning approaches and their applications to AD classification, we investigate ResNet-18 architecture in detail. to consider the training of the network from scratch by using single-channel input as well as performed transfer learning with and without fine-tuning using an extended network architecture. We experimented with residual neural networks to perform AD classification task and compared it with former research in this domain. The performance of the models is evaluated using precision, recall, f1-measure, AUC and ROC curves. We found that our networks were able to significantly classify the subjects. We achieved improved results with our fine-tuned model for all the AD stages with an accuracy of 100%, 96.85%, 97.38%, 97.43%, 97.40% and 98.01% for CN, SMC, EMCI, LMCI, MCI, and AD respectively. However, in terms of overall performance, we achieved state-of-the-art results with an average accuracy of 97.92% and 97.88% for off-the-shelf and fine-tuned models respectively. The Analysis of results indicate that classification and prediction of neurodegenerative brain disorders such as AD using functional magnetic resonance imaging and advanced deep learning methods is promising for clinical decision making and have the potential to assist in early diagnosis of AD and its associated stages (Ramzan, 2020)

This study use two deep neural network techniques, AlexNet and Restnet50, were applied for the classification and recognition of AD. The data used in this study to evaluate and test the proposed model included those from brain magnetic resonance imaging (MRI) images collected from the Kaggle website. A convolutional neural network (CNN) algorithm was applied to classify AD efficiently. CNNs were pre-trained using AlexNet and Restnet50 transfer learning models. The results of this experimentation showed that the proposed method is superior to the existing systems in terms of detection accuracy. The AlexNet model achieved outstanding performance based on five evaluation metrics (accuracy, F1 score, precision, sensitivity, and specificity) for the brain MRI datasets. AlexNet displayed an accuracy of 94.53%, specificity of 98.21%, F1 score of 94.12%, and sensitivity of 100%, outperforming Restnet50. The proposed method can help improve CAD methods for AD in medical investigations. (Kapoor, 2020)

## Scope and Limitations

Each project has constraints and challenges that can be controlled and achieved by part. The system works to classify Alzheimer's disease through images only (CT, MRI, and X-ray) were selected from a network research center, The dataset has four different labels to be classified, let them be (Mild Demented, Moderate Demented, Non-Demented, Very Mild Demented) But in the training dataset, Mild Demented dataset with 2688 images, Moderate Demented, with 2304 images, non-Demented with 3200 images and Very Mild Demented with 2240 images.

## Methodology

Implementing deep learning features for Classification of Alzheimer's Disease through a group of images of patients there 10432 images as a JPEG and 4 categories (Mild Demented, Moderate Demented, Non-Demented, Very Mild Demented) The model is designing using Python language with Keras & Tensorflow libraries and the system is supported through Graphics Processing Units (GPU) with NVIDIA to make the execution of the deep learning algorithms faster.

## Dataset

The dataset used, provided by Kaggle contains a set of 10432 images, for testing belonging to from of Alzheimer's Disease these images there are 4 classes as follow:

- Class 0 " MildDemented"

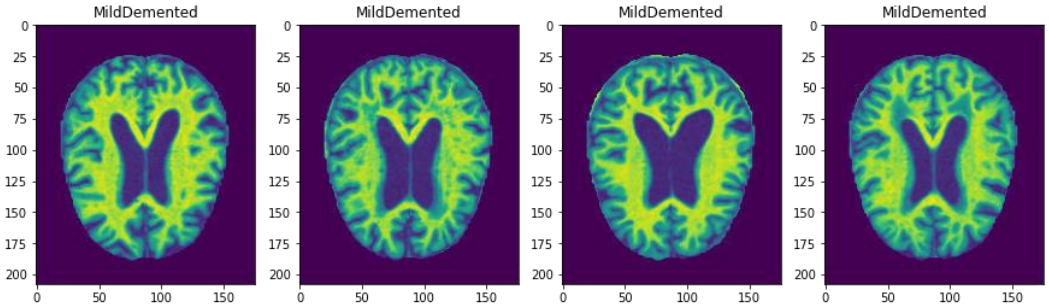


*Figure 1 Sample of Alzheimer's Disease images*

- Class 1 " ModerateDemented"

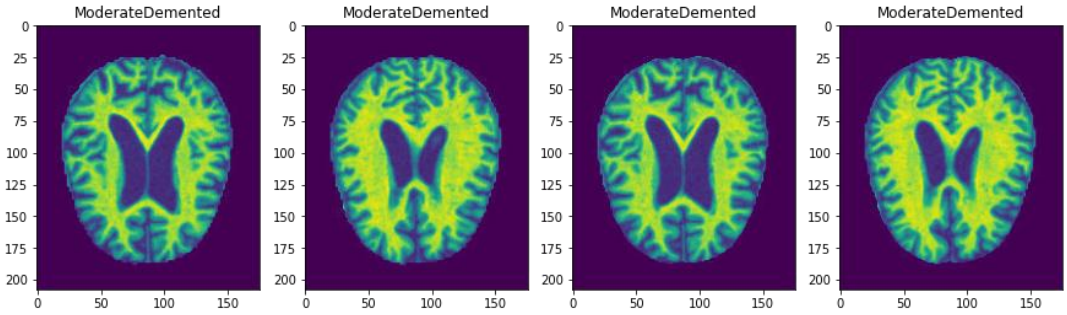


*Figure 2 Sample of Alzheimer's Disease images*

- Class 2 " NonDemented"

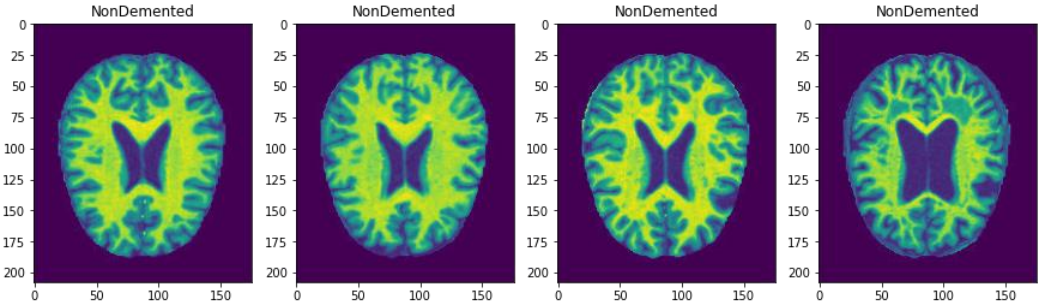


*Figure 3 Sample of Alzheimer's Disease images*

- Class 3 " VeryMildDemented"

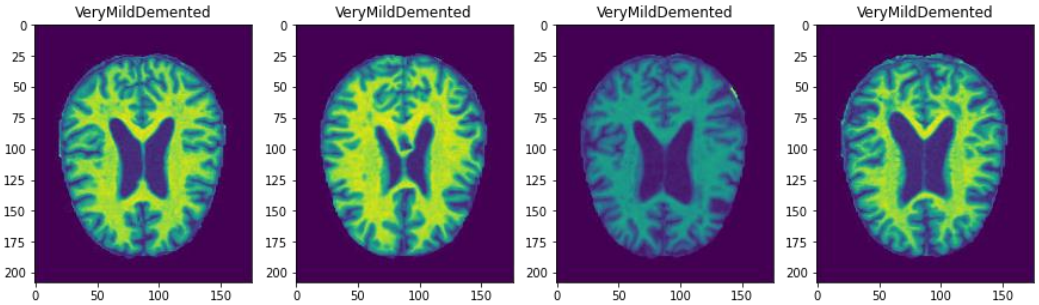


*Figure 4 Sample of Alzheimer's Disease images*

## Model

We used Convolutional Neural Networks - VGG16 application, and for optimizers: Adam and activation: softmax. As follows:

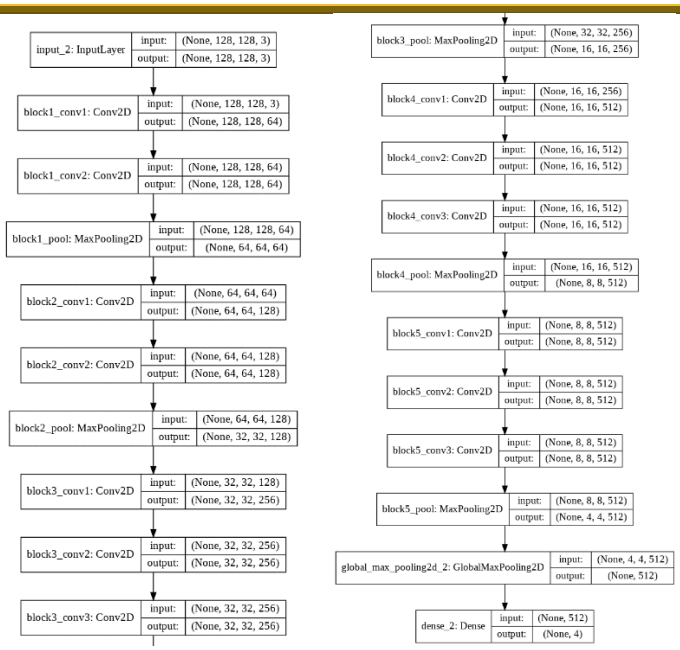


*Figure 5 Architecture of VGG 16 model*

## Results

We used the original Alzheimer's disease dataset that consists of 10432 images after resizing the images to 128x128 pixels. We divided the data into training (70%), validation (30%). The results come as following, after training this model the result was 100% training Accuracy, 0.0012 training loss, 97% Validating Accuracy, 0.0832 Validating loss

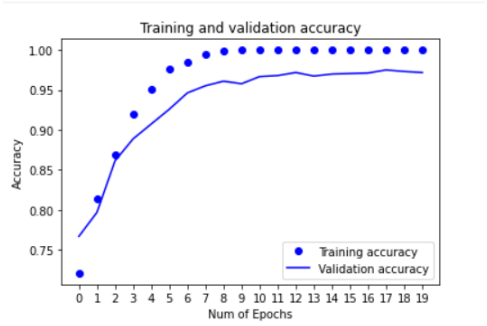


*Figure 6 Training and validation Accuracy*

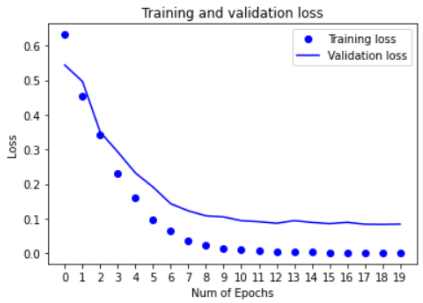


*Figure 7 Training and validation Loss*

**Conclusion:**

*Brain-related diseases are among the most difficult diseases due to their sensitivity, the difficulty of performing operations, and their high costs. In contrast, the operation is not necessary to succeed, as the results of the operation may be unsuccessful. One of the most common diseases that affect the brain is Alzheimer's disease, which affects adults, a disease that leads to memory loss and forgetting information in varying degrees. According to the condition of each patient. For these reasons, it is important to classify memory loss and to know the patient at what level and his assessment of Alzheimer's disease through CT scans of the brain. In this study, we review ways and techniques to use deep learning classification to classifying the Alzheimer's Disease. The proposed method used to improve patient care, reduce costs, and allow fast and reliable analysis in large studies. The model was designed using Python language for implementing the system, which was very useful for doctors, classifying the Alzheimer's Disease, was used. The proposed model used 70% from image for training and 30% from image for validation, our trained model achieved as testing accuracy of 100% on a held-out test set.*

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