Single Deep CNN Features to Detect Neurodegenerative Diseases and Context Behind the Detection: Alzheimer's, Parkinson's, Dementia

by

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Declaration

We do hereby declare that the research works presented in this thesis entitled “Single Deep CNN Features to Detect Neurodegenerative Diseases and Context Behind the Detection: Alzheimer's, Parkinson's, Dementia" are the results of our own works. We further declare that the thesis has been compiled and written by us. No part of this thesis has been submitted elsewhere for the requirements of any degree, award or diploma, or any other purposes except for publications. The materials that are obtained from other sources are duly acknowledged in this thesis.

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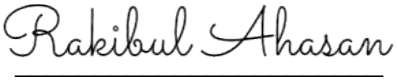

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Approval

We do hereby acknowledge that the research works presented in this thesis entitled "Single Deep CNN Features to Detect Neurodegenerative Diseases and Context Behind the Detection: Alzheimer's, Parkinson's, Dementia" result from the original works carried out by Mohammad Sabbir Ahmed, Syeda Nowshin Ibnat, Rakibul Ahasan, Nusrat Jahan Anka and Sk. Abu Hanif ID No: 17183103004, 17183103020, 17183103022, 17183103008 and 17183103043 Department of CSE, Bangladesh University of Business and Technology (BUBT) under the supervision of Milon Biswas, Assistant Professor, Department of Computer Science and Engineering (CSE). We declare that no part of this thesis has been submitted elsewhere for the requirements of any degree, award or diploma, or any other purposes except for publications.

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Abstract

Deep learning has recently been used for the analysis of neuroimages, such as magnetic resonance imaging (MRI), and it has achieved significant performance improvements over traditional machine learning. Modern neuroimaging has been defined by the development of magnetic resonance imaging (MRI) techniques. Besides, The amount of data generated by neuroimaging is both huge and complex. This thesis paper proposes a new model by stacking the Deep Convolutional Neural Network. Our method consists of convolution layers. By this model we can detect three neurodegenerative diseases: Alzheimer's, Parkinson's, Dementia at a time and Context Behind the Detection.

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List of Abbreviations

DL Deep Learning.

CNN Convolutional Neural Network.

DCNN Deep Convolutional Neural Network.

MRI Magnetic Resonance Imaging.

AD Alzheimer's Disease.

.

PD Parkinson's Disease.

DD Dementia Disease.

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2 Background

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Chapter 1
Introduction

Introduction

Neurodegenerative disease is an umbrella term for a range of conditions that primarily affect the neurons in the human brain. Neurodegenerative diseases occur when nerve cells in the brain or peripheral nervous system lose function over time and ultimately die. Alzheimer's disease, Parkinson's disease, and dementia are examples of neurodegenerative diseases. Alzheimer’s disease (AD), a chronic neurodegenerative disease causing the death of nerve cells and tissue loss throughout the brain [1]. Parkinson's disease (PD) is a non-curable progressive neurological disorder, which affects the motor system of the human brain [4]. Dementia disease is a neurological disorder that is characterized by a decline in memory, language, problem-solving, and other cognitive skills [11]. Deep learning methods have gained more popularity recently in medical image analysis [7], this work proposes a deep convolutional neural network (DCNN) that can detect three neurodegenerative disease using magnetic resonance imaging(MRI) samples. Deep-learning algorithms have notable advantages rather than machine learning methods. Many recent research studies that have used brain MRI scans and convolutional neural networks (CNN) achieved promising results [3]. In our work, we will build a new DL model to detect three neurodegenerative diseases at a time. Founding the suitable MRI dataset was the most difficult task for us so far.

Problem Statement

Neurodegenerative diseases detection is one of the unavoidable areas to treat patients at an early stage. Identifying neurodegenerative diseases with proper explanation is quite challenging. In this work, we will design a deep-learning-based disease detection model using the collected data which will detect Alzheimer's, Parkinson's, and Dementia diseases, including the context behind the detection. However, until now, our system hasn't been proposed yet so it will create a new path in the medical field.

Problem Background

The present neurodegenerative diseases detection system only detects one disease such as Parkinson’s, Huntington’s, Alzheimer's, Dementia, Schizophrenia at a time. In this modern era, the medical field is now updated technology-based while the existing system is quite backdated. Identifying neurodegenerative diseases and behind the reason of appearing is a deadly problem that needs to be solved. Diagnosis of Alzheimer's, Parkinson's, and Dementia diseases, including the context behind the detection, is very challenging due to the similarities in disease phenotypes, accurate detection. Most importantly, finding a proper dataset is the critical challenge of our research.

Research Objectives

The objectives of our research work are as follows:

- Identifying present difficulty to work with neuroimaging data.
- Build a new DL model to detect three Neurodegenerative Diseases named Alzheimer's, Parkinson's and Dementia.
- Get decent accuracy using a suitable MRI dataset.
- Use XAI to know the context behind the detection.
- Comparing the existing architectures with the proposed one for neurodegenerative diseases detection.

Motivations

Deep Learning (DL) is an emerging field that attracts researchers, specifically in the field of engineering and medical sciences. Deep learning techniques have opened up possibilities for enhanced analysis of neuroimaging data during the last decade. In this, we will provide deep learning architectures, applications, and the role of deep learning in the detection of neurodegenerative diseases like Alzheimer’s, Parkinson’s, Dementia disease. In general, we all know that using MRI to detect any of these three disorders is time-consuming and expensive. However, with our work, we can get results in a short period of time. As a result, we believe that detecting these three neurodegenerative diseases is essential in order to treat patients at an early stage. As a result, detection of neurodegenerative diseases is crucial in our society, as we have a significant number of elderly people who are suffering. So, in this work, we'll create a single model architecture that can detect Alzheimer's, Parkinson's, and Dementia diseases, including the context behind the detection.

Flow of the Research

The research work is developing into several steps. First, we have analysed the research topics and then studied the basic theory of neurodegenerative disease. Then we have investigated the application of neurodegenerative for the MRI dataset. We investigated the lack of present architectures and that motivated us to build a new architecture based on state-of-the-art deep learning approaches. Figure 1.1 illustrates the overall steps to the research procedure in the following diagram.

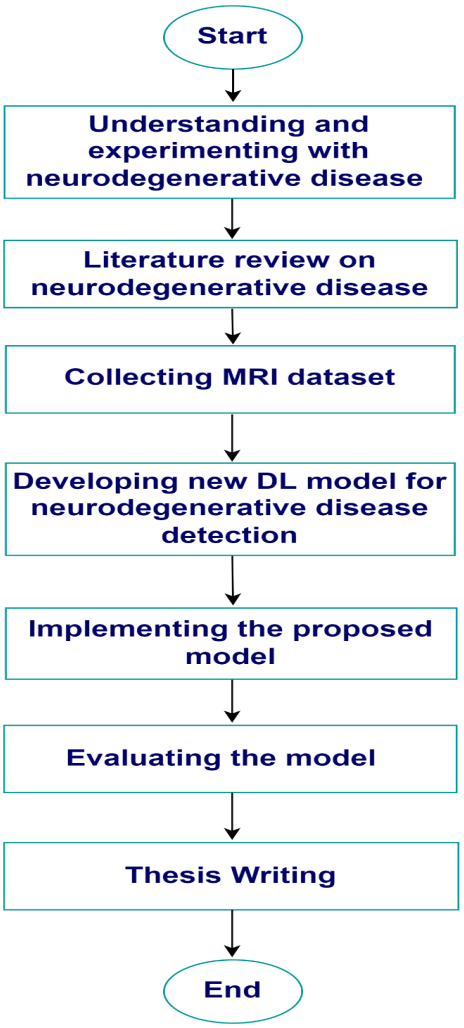

Figure 1.1. The figure illustrates the flow of the thesis work

Significance of the Research

We observe that most of the works of Neurodegenerative Disease (ND) are on a particular disease. Therefore this study introduces a new model to detect three Neurodegenerative Diseases named Alzheimer's, Parkinson's and Dementia. Also, we have planned to propose a CNN architecture that will give the best result. This neurodegenerative disease detection problem will become a state-of-the-art architecture to estimate the detection of neurodegenerative disease and significantly impact society and the country.

Research Contribution

The overall contribution of the research works are:

• Identifying present difficulty to detect Neurodegenerative Disease (ND) using neuroimaging dataset.

• A new DL model to detect three neurodegenerative diseases.

• A novel CNN approach to detect neurodegenerative diseases.

Thesis Organization

The thesis work is organized as follows. Chapter 2 highlights the background and literature review on the field of Neurodegenerative Disease (ND) detection. Chapter 3 will contain the Neurodegenerative Disease (ND) detection's proposed architecture and a detailed walk-through of the overall procedures. Chapter 4 will include the details of the tests and evaluations performed to evaluate our proposed architecture. Chapter 5 will explain the Standards, Impacts, Ethics, Challenges, Constraints, Timeline, and Gantt Chart. Finally, Chapter 6 contains the overall conclusion of our thesis work.

Summary

This chapter includes a broad overview of the problem that we aimed explicitly at our research work's objectives, the background, and the research work's motivation. This chapter also illustrates the overall steps on which we carried out our research work.

Chapter 2

Background

2.1 Introduction

Neurodegenerative diseases are illnesses that involve the death of certain parts of the brain. The majority of existing approaches focus on classifying common diseases such as Parkinson's, Huntington's, Alzheimer's, Dementia, Schizophrenia. Some existing proposed models concentrate on the diagnosis of the diseases. However, before this study, no work has introduced the context behind the detection of three neurodegenerative diseases at a time. In this paper, We are going to present a single model architecture that can detect Alzheimer's, Parkinson's, and Dementia diseases, including the explanation of why that disease occurs using MRI images.

2.2 Literature Review

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Aspects	**Paper # 1**
Title / Question	Convolutional neural networks for classification of Alzheimer's disease: Overview and reproducible evaluation.
Objectives/ Goal	They found 3 problems and their goal is to solve these problems: 1. The classification performance is difficult to compare across studies due to variations in components such as participant selection, image preprocessing, or validation procedure. 2. These studies are hardly reproducible because their frameworks are not publicly accessible and because implementation details are lacking.

	3. Some of these papers may report a biased performance due to inadequate or unclear validation or model selection procedures.
Methodology/ Theory	They proposed a solution: 1. Performed a systematic literature Review. To do so, they Identified four main types of approaches: i) 2D slice-level, ii) 3D patch-level, iii) ROI-based and iv) 3D subject-level CNN 2. Their second contribution is the extension of an open-source framework for the classification of AD using CNN and T1-weighted MRI. The framework comprises previously developed tools to automatically convert ADNI, AIBL, and OASIS data into the BIDS standard, and a modular set of image preprocessing procedures, classification architectures, and evaluation procedures dedicated to deep learning. 3. Finally, they used this framework to rigorously compare different CNN architectures.
Software Tools	image preprocessing procedures were implemented with Nipype, The DL models were built using the Pytorch library, TensorboardX was embedded into the current framework to dynamically monitor the training process. The linear SVM was implemented using Scikit Learn
Terminology	Convolutional neural network Reproducibility Alzheimer's disease classification Magnetic resonance imaging

Aspects	**Paper # 2**

Title/ Question	Classification of MRI images for Alzheimer's disease detection
Objectives/ Goal	To develop an early diagnosis, which would allow people with dementia to plan ahead while they still have the capacity to make important decisions about their future care as well as it would allow them to access available drug and non-drug therapies that may improve their cognition and enhance their quality of life.
Software Tools	SPM5 toolbox, MATLAB,
Simulation/ Test Data	They used ADNI Dataset
Result/ Conclusion	This paper deals with the important challenge of identification of Alzheimer's disease and the condition prior to dementia which is Mild Cognitive Impairment (MCI), developing intelligent classifiers, which using the information of magnetic resonance imaging, can successfully classify different patients according to their condition
Obstacles/ Challenges	They identified the identification of Alzheimer's disease and the condition prior to dementia which is Mild Cognitive Impairment (MCI) as a challenge for them.
Terminology	Support Vector Machine (SVM); Alzheimer's Disease; Mild Cognitive Impairment (MCI); PCA; Wavelets; MRI

Aspects	Paper # 3
Title / Question	A CNN based framework for classification of Alzheimer's disease.
Software Tools	Google Colab, Python, Kears package for deep learning, ReLU, SoftMax
Result/ Conclusion	Their proposed framework achieved 99.6%, 99.8%, and 97.8% classification accuracy on Alzheimer's disease Neuroimaging Initiative (ADNI) dataset for the binary classification of AD and Cognitively Normal (CN). In multi-classification experiments, the proposed framework achieved 97.5% classification accuracy on the ADNI dataset
Terminology	AD-classification, Convolutional neural network (CNN), Magnetic resonance imaging (MRI), Adaptive momentum estimation (Adam), Glorot uniform weight initializer

Aspects	Paper # 4
Title / Question	Detection of Parkinson Disease in Brain MRI using Convolutional Neural Network.
Software Tools	software package to convert DICOM-to-JPEG, MATLAB,

Simulation/ Test Data	They used PPMI Dataset which contains 250 MRI scans of PD while 250 for HC. Furthermore, these data are divided into training, validation and testing sets with a ratio of 70%, 10%, and 20% respectively.
Obstacles/ Challenges	During the experimentation, they found that the limited dataset was a major issue, leading the CNN model towards overfitting.
Terminology	Parkinson Disease, MRI, Deep Learning, Convolutional Neural Network, CNN

Aspects	**Paper # 5**
Title / Question	Automated MRI-Based Deep Learning Model for Detection of Alzheimer's Disease Process*
Software Tools	Think Server TS560, UBUNTU, Python , TensorFlow, Keras,
Simulation/ Test Data	They used ADNI Dataset. They randomly assigned the samples according to the proportion of 85% in the training group and 15% in the validation group and ensured that the proportion of patients in the two groups was similar

Aspects	Paper # 6
Title / Question	Deep learning to differentiate parkinsonian disorders separately using single midsagittal MR imaging: a proof of concept study
Objectives/ Goal	To evaluate the diagnostic performance of deep learning with the convolutional neural networks (CNN) to distinguish each representative parkinsonian disorder using MRI
Methodology/ Theory	They used CNN to find the solution.
Software Tools	Python, Keras, EZR software ver. 1.33 for statistical analyses
Test/ Experiment	They trained the CNN to distinguish each parkinsonian disorder using single mid-sagittal T1-weighted MRI with a training group to minimize the differences between predicted output probabilities and the clinical diagnoses; then, we adopted the trained CNN to the validation data set.
Result/ Conclusion	The accuracy of diagnostic performances regarding PD, PSP, MSA-P, and normal subjects were 96.8, 93.7, 95.2, and 98.4%, respectively. The areas under the receiver operating characteristic curves for distinguishing each condition from others (PD, PSP, MSA-P, and normal subjects) were 0.995, 0.982, 0.990, and 1.000, respectively
Terminology	Artificial intelligence . Parkinson disease . Magnetic resonance imaging . ROC curve . Deep learning

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Aspects	Paper #7
Title / Question	Deep Learning-Based Alzheimer Disease Detection.
Objectives / Goal	The objective of this work is to present a framework based on deep convolutional neural networks for Alzheimer's disease detection in terms of accuracy.
Methodology/ Theory	The proposed methodology consists of two steps- preprocessing and network training. 1) For preprocessing, MRI samples were converted into JPEG slices in the MATLAB tool. 2) For network training, the architecture consists of three sets of convolutional and max-pooling layers.
Software Tools	Anaconda, Keras,Tensor- flow
Test/ Experiment	Experiments are conducted using ADNI dataset.
Simulation/ Test Data	A total of 9540 images were used for training the network and 4193 images for testing.
Result / Conclusion	Model accuracy is 98.57% and the validation accuracy is 87.72%.
Obstacles/ Challenges	Fails to interpret the reasoning behind the result obtained.

Terminology	Alzheimer's Disease, Convolutional Neural Network, Deep Learning, MRI, DCNN.
Review Judgment	From this article we got to know about AD detection using CNN. The accuracy rate is decent for this model but slightly less than some other work.
Review Outcome	In this article, they used deep convolutional neural networks for Alzheimer's disease detection in terms of accuracy. From this work, we got an overview of how to gain the utmost accuracy.

Aspects	**Paper # 8**
Title / Question	A CNN Model: Earlier Diagnosis and Classification of Alzheimer Disease using MRI.
Objectives/ Goal	The objective of this work is to make the best prediction and detection tools for the help of radiologists, doctors, caregivers to save time, cost, and help the patient suffering from this disease.
Methodology/ Theory	A plan was created for each step that customized the needs and the steps included MRI data collection, preparing of collected data, training, and testing of the data.
Software Tools	The implementation of the model has been done using Anaconda for Python and TensorFlow.
Test/ Experiment	Both training along with a testing set containing a total of 7635 number images. Randomly select 80% of training data, and 20% of remaining data is used for validation of the model.

Simulation/ Test Data	This model achieved the test accuracy rate of 0.99% and low percentage of test loss with the rate of 0.0571 and the train and test model using 7635 images.
Result/ Conclusion	A significant accuracy of 99% has been achieved.
Obstacles/ Challenges	MRI data collection and data processing.
Terminology	Alzheimer's Disease, Deep Learning, Convolutional Neural Network, Magnetic Resonance Imaging, ADNI.
Review Judgment	From this article we gained knowledge of earlier diagnosis and classification of Alzheimer Disease. The accuracy rate is decent for this model and slightly more than other works.
Review Outcome	From this work we got an overview of how to gain the utmost accuracy from a model. We can use this knowledge for our own work.

Aspects	**Paper # 9**
Title / Question	Deep learning based diagnosis of Parkinson's disease using convolutional neural network.
Objectives / Goal	The objective of this work is to classify the MR images of healthy control and Parkinson's disease subjects using deep learning neural networks.
Methodology/ Theory	For this work, the AlexNet model is used as the CNN architecture which comprises different layers. Transfer learning is applied to the pre-trained AlexNet model, and the classification accuracy measures to evaluate the model for a given input image dataset.

Software Tools	Python, tensorflow.
Test/ Experiment	For the experiment, AlexNet has been pre-trained with color images of size 227 X 227 pixels and processed in their respective layers, from input to output. The image dataset with 80% of the input data is used for training and the remaining 20% is used for testing.
Simulation/ Test Data	The PPMI cohort used in this study consists of 182 subjects with 82 Healthy Control and 100 Parkinson's disease subjects. The model accuracy is 88.90%. Sensitivity and specificity values of 89.30% and 88.40% are exhibited by this architecture respectively.
Result/ Conclusion	The model is trained to learn the low level to high-level features and the classification results are validated. An accuracy of 88.90% is achieved for classifying the HC and PD subjects.
Obstacles/ Challenges	The proposed methodology is not extended on deep fine-tuning of the AlexNet model to obtain improved performance levels.
Terminology	Parkinson's Disease, MRI, Deep Learning, AlexNet, Convolutional Neural Networks, Deep Learning.
Review Judgment	This work got less accuracy than some other models.
Review Outcome	Transfer learning gives better result for parkinson's disease detection.

Aspects	**Paper # 10**
Title/ Question	Diagnosis of Parkinson's disease using deep CNN with transfer learning and data augmentation.
Objective/ Goal	The objective of this work is to propose a method that offers an improved diagnosis of Parkinson's disease compared to state-of-the-art research.

Methodology/ Theory	1. Accommodate the variety of contrasting images and reduce some noise. 2. Data augmentation procedures to address the issue of the dataset's limited size and to improve the performance of the proposed approach. 3. Transfer learning is applied to the pre-trained Alex-Net, and the last few layers are replaced to accommodate new categories of images for our application. 4. The performance of the model proposed is evaluated on test MR images of HC and PD patients.
Software Tools	Keras software with Theano, Python 2.7.0.
Test/ Experiment	The approach proposed is analyzed using 72 MR images of HC and PD patients with a proportion of 1:1. The test images are only used once for a single said purpose.
Simulation/ Test Data	A total of 504 images are collected, and 360 images are used to augment data. The increased data set of this model is as many as 4200 images.
Result/ Conclusion	The deep learning model proposed here shows an excellent differential fluency by reporting the 0.9723 AUC value from the ROC curve. The scope of the proposed model can be further expanded to bring the AlexNet model fine-tuning within its ambit for obtaining superior working results.
Obstacles/ Challenges	Data processing.
Terminology	Parkinson's disease, GenerativeAdversarial Network, Alex-Net, Transfer learning, Overfitting.
Review Judgment	For this work AlexNet model has been used which made it diffferent from other works.

Review Outcome	We have to do data processing carefully for our own work.

Aspects	Paper # 11
Title / Question	Dementia Detection and Classification from MRI Images Using Deep Neural Networks and Transfer Learning.
Objectives/ Goal	The objective of this work is to present a new approach in the field of Deep Machine Learning, that comprises both DCNN (Deep Convolutional Neural Network) model and Transfer Learning model to detect and classify dementia disease.
Methodology/ Theory	The methodology of this work includes the following steps: (1) Image pre-processing, (2) feature extraction, and (3) Learning classification model.
Software Tools	All the experiments are performed using Keras software with Theano as a deep learning backend in python 2.7.0 software
Test/ Experiment	In this paper, MRI images from the OASIS 1 dataset are being used for the detection of dementia . Each class contains 14 subjects that were used to train the DCNN training model.
Simulation/ Test Data	This data set consists of a cross- sectional collection of about 416 subjects, who are aged between 18 to 96 years and in a total of 436 imaging sessions.
Result/ Conclusion	DCNN model produced an important classification accuracy of 81.94%. In opposition, the Transfer Learning model resulted in an accuracy of 68.13%. Results showed that the DCNN model achieved significant accuracy for better Dementia diagnosis.

Obstacles/ Challenges	This work did not use a large brain dataset in a wide range of subjects which could improve the accuracies of these Learning models by yielding better results.
Terminology	DCNN, Transfer Learning, Dementia, MRI, Bag of features, K-means.
Review Judgment	This work makes a comparison between CNN and Transfer learning as per the objective of their work which differentiates this work from the other works.
Review Outcome	DCNN model achieved significant accuracy for better Dementia diagnosis.

Aspects	**Paper # 12**
Title / Question	DEMNET: A Deep Learning Model for Early Diagnosis of Alzheimer Diseases and Dementia From MR Images.
Objectives/ Goal	The objective of the proposed model is to detect the dementia stages from MRI and also predict AD classes in order to assess the efficacy of the proposed model.
Methodology/ Theory	This model contains four main steps: data pre-processing, balancing the dataset using SMOTE and classification using DEMNET.
Software Tools	Anaconda, TensorFlow.
Test/ Experiment	The confusion matrix of DEMNET architecture with SMOTE technique to classify the dementia stages to predict AD.

Simulation/ Test Data	The AD dataset consists of 6400 MR Images. Dataset distribution after SMOTE tech- nique increased to 12800 images, with each class containing 3200 images.The dataset is divided into 80% training, 10% validation, and 10% for testing.
Result/ Conclusion	This model is tested with testing data consisting of 4 classes and achieved an overall accuracy of 95.23% with 97% AUC when compared to the existing methods.
Obstacles/ Challenges	Major class imbalance problem of the dataset.
Terminology	Deep learning, Alzheimer's Disease, MRI image, Convolutional Neural Network.
Review Judgment	The objective of the proposed model is to detect the dementia stages and to predict AD classes. The model achieved a descent accurecy when compared to the existing methods.
Review Outcome	For our work we can use the SMOTE technique to eradicate the class imbalance problem of the dataset.

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Aspects	Paper # 13
Title/ Question	Auto-Detection of Alzheimer's Disease Using Deep Convolutional Neural Network
Objectives/Goal	The objective of this work is to present a DCNN for diagnosing the diseases of AD/MCI and Achieve a high level of accuracy.
Methodology/Theory	For this work, Firstly, the structural MRIs are pre-processed in a strict pipeline.Then, instead of parcellating regions of interest, Each volume is re-sliced and resliced images put into a DCNN directly.Finally, four stages of Alzheimer's are identified.
Software Tools	Adni database, grinder pipeline(data processing framework), FSL-BET toolbox(brain extraction),3.0 tesla SIEMENS scanners,SPM toolbox (segmented brain into GM, WM, and CSF)
Test/ Experiment	When downloading data from the ADNI database, NII has selected the format data. In order to obtain the data with the same parameters to avoid many other problems in processing procedure, the pre-processed data were preferred here. The steps of pre-processing include gradient unwarping and a nonparametric non-uniformed bias correction (N3) algorithm, both can be done with Grinder Pipeline. The structural MR images were obtained from 3.0 tesla SIEMENS scanners.
Simulation/ Test Data	http://adni.loni.usc.edu/ Data has been selected from different phases of ADNI.In the first group 785 normal controllers, 542 MCI patients, and 336 AD patients from ADNI1 and ADNI-GO were picked. In the second

	group, 1106 normal controllers, 1583 early mild cognitive impairment (EMCI), 1304 late mild cognitive impairment (LMCI), and 336 NC were picked. The age of all the subjects ranges from 60 to 85 years old.There is no noticeable difference between these three groups in terms of gender and age.
Result/ Conclusion	The accuracy of classifying NC with AD is 95.45%, the accuracy of classifying NC with MCI is 95.39% and the accuracy of classifying NC with AD is 93.97%.The convolutional neural network framework implemented here offers much more accuracy.The results show that the DCNN outperforms existing methods. AD patients are much smaller than the groups of EMCI, LMCI, and normal controllers.
Obstacles/ Challenges	The Challenges in this paper, Selecting data from different stages of ADNI, AD/MCI detection using DCNN, MRI data collection, and data processing.
Terminology	Deep Learning; Alzheimer's Disease; MRI; Early Diagnose;
Review Judgment	From this article, we got to know about AD/MCI detection using DCNN. The convolutional neural network framework implemented here offers much more accuracy and the results show that the DCNN outperforms existing methods.
Review Outcome	In this paper, In order to achieve the best result, They tried several activation functions. Finally, the Relu activation function was adopted. 3 classes of tasks including AD versus NC, AD versus MCI, and MCI versus NC are considered. Each task was repeated 10 times in order to check the robustness of the performance. From this work, we got an overview of how to gain the utmost accuracy.

Aspects	Paper # 14
Title/ Question	Early Diagnosis of Alzheimer' Disease with Deep Learning
Objectives/Goal	Diagnosis of AD and MCI based on deep learning architecture. To overcome the bottleneck and aid the diagnosis of AD and its prodromal stage, Mild Cognitive Impairment (MCI). Analyzing multiple classes in one setting, and requires less labeled training samples and minimal domain prior knowledge.A significant performance gain on the classification of all diagnoses, groups achievement in these experiments
Methodology/Theory	Extracted the grey matter volumes from MRI and CMRGlc patterns from PET. The features were further selected with Elastic Net before each classification task.To support the sigmoidal decoder, all the features are normalized to zero-mean and between 0 and 1.
Software Tools	ADNI database,Elastic Net,MATLAB 2013a,LIBSVM library,
Test/ Experiment	Extracted the grey matter volumes from MRI and CMRGlc patterns from PET. The features were further selected with Elastic Net before each classification task.To support the sigmoidal decoder, all the features are normalized to zero-mean and between 0 and 1. Implemented the deep learning framework described in this paper on Matlab 2013a. A random search in a log domain was applied to choose the hyper-parameters. Used single-kernel SVM (SK-SVM) and multi-kernel SVM (MK-SVM) were chosen to compare with the proposed method.
Simulation/ Test Data	Used the neuroimaging data obtained from Alzheimer's disease Neuroimaging Initiative (ADNI) database.Recruited the MRI

	images of 311 subjects from the ADNI baseline cohort, including 65 AD subjects, 67 cMCI subjects, 102 ncMCI subjects and 77 normal control subjects.All the MRI images are nonlinearly registered to the ICBM_152 template and further segmented into 83 functional regions.
Result/ Conclusion	The deep learning method produced a better overall accuracy (87.76%) in binary.
Obstacles/ Challenges	neuroimaging data processing,
Terminology	Alzheimer's disease, neuroimaging, classification
Review Judgment	From this article, we got to know how to diagnose AD and MCI based on deep learning architecture.To overcome the bottleneck and how to aid diagnosis of AD..
Review Outcome	The SVM method conducts AD diagnosis as a multi-class classification task, with minimal prior knowledge dependency in the model optimization. The proposed method also performs dimensionality reduction and data fusion at the same time to reserve the synergy between data modalities.

Aspects	**Paper # 15**
Title/ Question	Deep Learning-based Pipeline to Recognize Alzheimer's Disease using fMRI Data
Objectives/Goal	Diagnosis of Deep Learning-based Pipeline to Recognize Alzheimer's Disease using fMRI Data. Deploying a convolutional neural network to distinguish an Alzheimer's brain from a normal,

	healthy brain.
Methodology/Theory	Employ a convolutional neural network to distinguish an Alzheimer's brain from a normal, healthy brain and the most problematic aspect has always been selecting the strongest discriminative features. Using the Convolutional Neural Network (CNN) and the famous architecture LeNet-5, successfully classified functional MRI data of Alzheimer's subjects from normal controls.
Software Tools	FMRIB Software Library v5.0, LeNet-5,convolutional neural network (CNN)
Test/ Experiment	Employ a convolutional neural network to distinguish an Alzheimer's brain from a normal, healthy brain and the most problematic aspect has always been selecting the strongest discriminative features. Using the Convolutional Neural Network (CNN) and the famous architecture LeNet-5, successfully classified functional MRI data of Alzheimer's subjects from normal controls.Classified AD data from normal control data using CNN deep learning architecture (LeNet), which was trained and tested with a massive number of images. First, anatomical scans were performed with a 3D MP-RAGE sequence (TR=2s, TE=2.63 ms, FOV=25.6 cm, 256 x 256 matrix, 160 slices of 1mm thickness). Next, functional scans were obtained with an EPI sequence (150 volumes, TR=2 s, TE=30 ms, flip angle=70, FOV=20 cm, 64 x 64 matrix, 30 axial slices of 5mm thickness, no gap).
Simulation/ Test Data	In this work, 28 Alzheimer’s disease (AD) patients and 15 normal control (NC) subjects (24 female and 19 male) with a mean age of 74.9 5.7 years were selected from the ADNI dataset.
Result/ Conclusion	The accuracy of testing data reached 96.85%. The rate of accuracy achieved in this work was very high. and confirming that the network architecture was correctly selected.

Obstacles/ Challenges	challenges in traditional medical image processing, data processing, Classifying clinical data in the medical conditions
Terminology	Deep learning; Alzheirmer's Disease; fMRI
Review Judgment	This experiment suggests that the shift and scale-invariant features extracted by CNN followed by deep-learning classification represents the most powerful method of distinguishing clinical data from healthy data in fMRI.This approach also allows for the expansion of the methodology to predict more complicated systems. This deep learning solution and the proposed pipeline not only open new avenues in medical image analysis, but also enable researchers and physicians to potentially predict any new data. This deep learning solution and the proposed pipeline not only open new avenues in medical image analysis, but also enable researchers and physicians to potentially predict any new data and classified AD data from normal control data with 96.86% accuracy using CNN deep learning architecture (LeNet).
Review Outcome	From this work we got an overview of how to gain the utmost accuracy from a model .The importance of classifying this type of medical data lies in its potential to develop a predictive model or system in order to recognize the symptoms of Alzheimer's disease when compared with normal subjects and to estimate the stages of the disease.We can use this knowledge for our own work.

Aspects	**Paper # 16**
Title/ Question	Detection of Parkinson Disease in Brain MRI using Convolutional Neural Network
Objectives/Goal	The objective of this work is the Detection of Parkinson's Disease in Brain MRI using a Convolutional Neural Network. This paper

	presents a Convolutional Neural Network (CNN) based automatic diagnosis system which accurately classifies PD and healthy control (HC).
Methodology/Theory	The proposed system receives MR images as input, which is eventually labeled as PD or HC. The model contains a total number of 8 major layers. Generally, these techniques work on hand-crafted features. CNN is implemented on the NVIDIA GeForce 940MX CUDA-enabled GPU using Keras. All the MRI scans are downloaded in DICOM format.convert images from DICOM to JPEG format by using software package of DICOM-to-JPEG.
Software Tools	python, keras,Theano - Tensorflow library, MATLAB
Test/ Experiment	The midbrain slices of 500, T2-weighted MRI are selected and aligned using the image registration technique. The performance of the proposed technique is evaluated using accuracy, sensitivity, specificity and AUC (Area Under Curve). Several experiments are performed with different network settings. Network settings include kernel size, batch size, stride, and padding. During the training of the model, validation and training accuracies are recorded after each epoch. Each time after training the model is tested on the test set. Furthermore, data is divided into training, validation and testing sets with a ratio of 70%, 10%, and 20% respectively.
Simulation/ Test Data	(http://www.ppmiinfo.org) The dataset used in this research is obtained from PPMI.The midbrain slices of 500, T2-weighted MRI are selected and aligned using the image registration technique. 22 is collected against each patient's data. The data contains 250 MRI scans of PD while 250 for HC.
Result/ Conclusion	CNN achieved a better performance from 3% - 9% in terms of accuracy, sensitivity, specificity, and AUC.Each time after training

	the model, is tested on the test set. In all experiments, the classification accuracy fluctuates between 95 to 98%. The green line shows the validation accuracy while the blue line represents the training accuracy. the training vs validation loss where the x-axis shows the number of epochs and the y-axis shows the loss.
Obstacles/ Challenges	The Challenges in this paper, Selecting data from different stages of ADNI, AD/MCI detection using CNN, MRI data collection, and data processing, limited dataset was a major issue.
Terminology	Parkinson Disease, MRI, Deep Learning, Convolutional Neural Network, CNN
Review Judgment	In the paper, a limited dataset was a major issue., leading the CNN model towards overfitting. The detailed comparison in the result section shows that CNN achieved a better performance from 3% - 9% in terms of accuracy, sensitivity, specificity, and AUC when compared to some existing techniques.
Review Outcome	From this work we got an overview of how to gain the utmost accuracy from a model. We can use this knowledge for our own work. In this paper, the limited dataset was a major issue. For our work, we can use dropout layers in the network for the overfitting problem.

Aspects	**Paper # 17**
Title/ Question	Early Diagnosis of Parkinson's Disease in brain MRI using Deep Learning Algorithm.
Objectives/Goal	Detection of PD is done using deep learning algorithms to discriminate between PD and controlled subjects. Using the

	Convolutional Neural Network (CNN) and the LeNet-5 architecture, the MRI data of PD subjects was successfully classified from the normal controls.
Methodology/Theory	The dataset was obtained from Parkinson's Progression. Markers Initiative (PPMI). The 3D MRI dataset was in DICOM format and NIFTI format.Afterwards, the images were labelled for the classification of PD vs control data. At the end, the last few slices of each image were discarded as they didn't contain any functional information.
Software Tools	MRIcro tool (preprocessing of the images) , Python
Test/ Experiment	The protocol contained T1-weighted (T1w) MRI images based on a scanner by Siemens . The 3D MRI dataset was in DICOM format and NIFTI format. Afterwards, the images were labelled for the classification of PD vs control data.At the end, the last few slices of each image were discarded as they didn't contain any functional information. The dataset containing useful images was then divided into training and testing data, 90% of the images was for training and the remaining 10% for testing.
Simulation/ Test Data	The dataset was obtained from Parkinson's Progression. Markers Initiative (PPMI).The model was trained using a big dataset containing 10,548 images. Loss function was used to measure how accurately the network identified the PD subjects. For this work, 30 PD subjects and 24 elderly controlled subjects (with ages from 60 to 75 years) were picked from the mentioned dataset.
Result/ Conclusion	97.92% accuracy was achieved using LeNet-5 architecture with batch normalization technique and dropout algorithm. No batch normalization was performed, training accuracy and test accuracy

	were 96.65% and 97.62% respectively. The model loss was 0.07%. Which batch normalization was performed, the training accuracy and test accuracy were 95.44% and 97.92% respectively. The loss was 0.05%.
Obstacles/ Challenges	MRI data collection, and data processing.
Terminology	LeNet-5, Parkinson's disease, Python, Deep Learning, Keras, CNN
Review Judgment	In this research, the chance of curing increases significantly if appropriate steps are taken early and precious time could be saved if the detection process is carried by a computer.The diagnosis of Parkinson's Disease data was successfully performed, with and without batch normalization. 97.92% accuracy was achieved.
Review Outcome	For our work, This research may open scope for analysing medical or neuro images.We can use this knowledge for our own work.

Aspects	**Paper # 18**
Title/ Question	Alzheimer's Disease And Dementia Detection From 3D Brain MRI Data Using Deep Convolutional Neural Networks.
Objectives/Goal	Alzheimer's Disease And Dementia Detection From 3D Brain MRI Data Using Deep Convolutional Neural Networks Diagnosis. In this paper an alternative approach has been discussed, that is fast, costs less and is more reliable. 3D MRI Images Introduce a Sophisticated Deep Convulsive Neural Network to Detect Alzheimer's Disease and Dementia.
Methodology/Theory	This thesis work has been done using OASIS data. The problem this thesis work is trying to solve is a supervised classification problem

	problem. Clinical Dementia Rating or CDR score is the basis of the classification. The main concern here is the attribute named CDR. If the CDR score is greater than Zero then the person has Alzheimer's disease. And if CDR=0 then-No Alzheimer's disease. So it is now a binary classification problem. Our Xinput is a 3D MRI scan and Y input is whether the person has Alzheimer's disease or not (1 or 0). CDR scores for all subjects are not given. Some have NaN CDR scores. In this thesis NaN CDR score has been replaced by 1. Since Alzheimer's disease mostly affects the Gray matter of the Brain, while image pre-processing white matter and gray matter have been divided from each MRI using. Gray matter has been the main concern.
Software Tools	Python,OASIS data, Support Vector Machine (SVM)
Test/ Experiment	The main concern here is the attribute named CDR. If the CDR score is greater than Zero then the person has Alzheimer's disease. And if CDR=0 then-No Alzheimer's disease. So it is now a binary classification problem. Our Xinput is a 3D MRI scan and Y input is whether the person has Alzheimer's disease or not (1 or 0). CDR scores for all subjects are not given. Some have NaN CDR scores. In this thesis, the NaN CDR score has been replaced by 1. Since Alzheimer's disease mostly affects the Gray matter of the Brain, while image pre-processing white matter and gray matter have been divided from each MRI using. Gray matter has been the main concern.
Simulation/ Test Data	This thesis work has been done using OASIS data.The dataset has 416 Subjects cross-sectional brain MRI data and all of them were diagnosed from mild to severe dementia and non dementia.

Result/ Conclusion	Using Support Vector Machine (SVM) to detect Alzheimer's Disease with the OASIS dataset accuracy level of 80%. Another thesis using v-SVM an alternative formulation of SVM to detect Alzheimer's Disease with the OASIS dataset accuracy level of 92%
Obstacles/ Challenges	Most of the modern deep learning models can not represent uncertainty perfectly. So, the Challenge is how well the neural network performs in the case of 3D Neuroimaging data.
Terminology	Neural Networks, Deep Learning, 3D Brain MRI, Alzheimer's Disease And Dementia, Machine Learning, Big Data, High Dimensional Input.
Review Judgment	From this article, fast, costs less, and more reliable detection of Alzheimer's Disease and Dementia from 3D MRI images.
Review Outcome	For our work, we can use the Vector Machine (SVM) technique to detect Alzheimer's Disease with the dataset.We can use this knowledge for our own work.

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Aspects	Paper # 19
Title / Question	Application of deep learning in detecting neurological disorders from magnetic resonance images: a survey on the detection of Alzheimer's disease, Parkinson's disease, and schizophrenia.
Objectives / Goal	The main objective of the proposed model are - 1. To detect these disorders at the earliest stage possible so that their progress can be slowed down, if not fully stopped. 2. To critically examine and compare performances of the existing deep learning (DL)-based methods to detect neurological disorders—focusing on Alzheimer's disease, Parkinson's disease, and schizophrenia—from MRI data.
Methodology/ Theory	In this article, Recurrent Neural Network (RNN) and Long–Short Term Memory (LSTM), Deep Neural Network (DNN), and Autoencoder (AE) methods were proposed.
Software Tools	DL algorithms in computer vision.
Test / Experiment	DL methods in detecting neurological disorders from MRI datasets.
Simulation/Test Data	Free parameters are being used in this article.
Result/ Conclusion	The highest accuracy 98.09 of schizophrenia detection has been observed which has employed 3D-CNN-based classification. By using 3D-CNN achieved 100% accuracy on the validation and test sets for PD diagnosis. At the same time, the study in discriminated PD from typical parkinsonian syndromes had 85.7% test accuracy.

Obstacles/ Challenges	DL algorithms present impact and accurate solutions for large datasets. However, high-dimensional CNN such as 2D-CNN and 3D-CNN will provide high accuracy for the large and multimodal neuroimages. On the other hand, Generative Adversarial Networks (GAN) can generate synthetic neuroimages which may also be used along with CNN. Adversarial noise can add to the neuroimages and may reduce the classification accuracy. Thus, the cancellation of adversarial errors is a challenge.
Terminology	Machine learning, Alzheimer's disease, Parkinson's disease, Schizophrenia, Neuroimaging.
Review Judgment	In this article, it is shown that using 3D-CNN 100% accuracy can be achieved easily for PD diagnosis.
Review Outcome	I am going to prepare a new methodology which is single deep CNN. I am going to use it to detect the disease.

Aspects	**Paper # 20**
Title / Question	A review of Parkinson's disease.
Objectives / Goal	Collect the basic information on Parkinson's disease.
Methodology/ Theory	Although there is no cure, there are several management options for the early treatment of PD. As the disease progresses, further treatment options are available; however, the management of late-stage motor complications and non-motor symptoms remains particularly challenging and will benefit from further clinical research.
Software Tools	No software tools are being used.
Test/ Experiment	Google collab, Keras

Simulation/Test Data	Hyper-parameter optimization methods
Result/ Conclusion	A large number of agents together with surgical interventions are now available to treat early and late complications of PD. Increasing attention is being given to the diagnosis and treatment of non-motor complications in PD
Obstacles/Challenges	It's a review paper of previous papers which were related to Parkinson's disease. So no challenges came up.
Terminology	Parkinson's, disease, review, clinical diagnosis.
Review Judgment	This paper focuses on the basic information on Parkinson's disease.
Review Outcome	From this paper we learned the importance of detecting parkinson disease.

Aspects	**Paper # 21**
Title / Question	A Survey on Deep Learning for Neuroimaging-Based Brain Disorder Analysis
Objectives / Goal	This paper reviews computer-aided analysis of four typical brain disorders, including Alzheimer's disease, Parkinson's disease, Autism spectrum disorder, Schizophrenia, and importantly, the limitations of existing studies and present possible future directions discussed.
Methodology/ Theory	Deep learning methods using structural magnetic resonance imaging (MRI), functional MRI, and positron emission tomography (PET)
Software Tools	Platform - Linux, Windows, Android, Javascript. Language - C, C++, JAVA, Python, MATLAB. Caffe, Deeplearning4j, TensorFlow, Pytorch as open-source toolkits being used.
Test/ Experiment	Through analyzing and discussion using deep learning they do their work.

Simulation/Test Data	Hyper-parameter optimization methods, including manual (e.g., grid search and random search) and automatic (e.g., Bayesian Optimization), are proposed
Result/ Conclusion	This paper reviewed the most recent studies on the subject of applying deep learning techniques in neuroimaging-based brain disorder analysis and focused on four typical disorders.
Obstacles/ Challenges	It is difficult to trust these predictions based on features you cannot understand. The lack of sufficient training data in neuroimage analysis has been repeatedly mentioned as a challenge to apply deep learning algorithms. To address this challenge, a data augmentation strategy has been proposed, and it is widely used to enlarge the number of training samples. An effective fusion of multimodal data has always been a challenge in the field.
Terminology	Neuroimaging, Parkinson's, Alzheimer's, Deep CNN, MRI, PPMI.
Review Judgment	Through this approach we are able to understand the importance of deep learning over machine learning.
Review Outcome	This paper provides a comprehensive overview of deep learning techniques and popular network architectures by introducing various types of deep neural networks and recent developments. however, using deep learning for implementation was the best choice to get their desirable result.

Aspects	**Paper # 22**
Title / Question	Deep Learning Based Binary Classification for Alzheimer's Disease Detection using Brain MRI Images
Objectives / Goal	The proposed method classifies diseases like Alzheimer's disease (AD), mild cognitive impairment (MCI), and normal control (NC).

Methodology/ Theory	This paper methodology includes two steps preprocessing and network training.
Software Tools	Tensorflow
Test / Experiment	In this paper, the ADNI dataset is being used.
Simulation/Test Data	Hyper Parameters.
Result/ Conclusion	98.57% accuracy on the dataset without using any handcrafted features for training the network. Validation accuracy achieved is 87.72%.
Obstacles/ Challenges	To achieve the highest accuracy.
Terminology	Alzheimer's disease · Convolutional neural network · Deep learning · MRI · Neurological disorder
Review Judgment	Here, they were able to achieve the highest accuracy than other existing proposed systems.
Review Outcome	After reviewing their results we were inspired and decided that we will prepare a new methodology which is a single deep CNN to detect the disease.

Aspects	**Paper # 23**
Title / Question	Automatic Alzheimer's Disease Recognition from MRI Data Using Deep Learning Method.
Objectives / Goal	1. To get the highest accuracy. 2. Resulting in an accurate recognition.

Methodology/ Theory	convolutional neural network (CNN) with deep learning
Software Tools	Tensorflow, google collab etc.
Test/ Experiment	Testing CNN is being proposed to extract seven middle cross-sections as patches. Since not all patches are abnormal in AD cases, only when all seven patches were classified as NC, here, considered the data as NC.
Simulation/Test Data	The MRI data acquired from Alzheimer's Disease Neuroimaging Initiative (ADNI) database
Result/ Conclusion	This paper achieved sensitivity at a patch level is 0.69 and specificity is 0.98. When using the AD detection rule which was mentioned in the testing section, the case level sensitivity is 1 and specificity is 0.93.
Obstacles/Challenges	In the structure, every one of the three groups is made up of three layers, including a convolutional layer, a pooling layer, and a normalization layer which was really challenging.
Terminology	Alzheimer's Disease, AD, Recognition, Magnetic Resource Imaging, MRI, Deep Learning, Convolutional Neural Network, CNN
Review Judgment	This paper specifically defined each segment which is really important. The proposed system is built and tested with the MRI data acquired from Alzheimer's Disease Neuroimaging Initiative (ADNI) database
Review Outcome	This paper describes an automatic AD recognition algorithm that is based on deep learning on 3D brain MRI. From this work, we got an overview of how to gain the utmost accuracy.

Aspects	Paper # 24
Title / Question	Early Detection of Parkinson's Disease Using Deep Learning and Machine Learning
Objectives / Goal	Aims to contribute to the PD diagnosis process by using a convolutional neural network, a type of deep neural network architecture, to differentiate between healthy controls and PD patients. This paper focused on discovering deviations in patients' movements with the use of drawing tasks.
Methodology/ Theory	CNN model is being used in this paper.
Software Tools	Keras, Google collab
Test / Experiment	The compact model has the potential to be developed into an offline real-time automated single-task diagnostic tool, which can be easily deployed within a clinical setting.
Simulation/Test Data	Using three steps the simulation was done.
Result/ Conclusion	With 93.5% accuracy, a convolutional classifier, trained with images of the pentagon drawing task and augmentation techniques, can be used as an objective method to discriminate PD from healthy controls.
Obstacles/ Challenges	Although the accuracy of the model is competitive against other approaches to get the highest accuracy was a hard challenge for the authors. The limitations of this study include (1) its proof-of-concept nature; (2) the interpretability of the results typical of using a black-box optimization approach; (3) the relatively small size of the dataset and its imbalanced nature.
Terminology	Parkinson's, Disease, CNN, Optimization.
Review Judgment	This paper the focus has been on using increasingly complex predictive models to raise accuracy rates, with the best accuracies achieved using deep architectures and ensemble models.

Review Outcome	After analyzing this paper some problematic issue should be reminded that large datasets are very difficult to acquire and to detect Parkinson's disease CNN is best algorithm.

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Aspects	**Paper # 25**
Title/ Question	Deep learning based diagnosis of Parkinson's disease using convolutional neural network.
Objectives/ Goal	The objective of the work is to present a new approach in the field of deep learning models are able to help clinicians in the diagnosis of Parkinson's disease and yield an objective and better patient group classification in the near future.
Methodology/ Theory	The MR image database, pre-processing of the MR images, CNN AlexNet architecture, Transfer learning applied to the pre-trained AlexNet model and the classification accuracy measures to evaluate the model for given input image dataset
Software Tools	AlexNet, PET, SPECT, PPMI database.
Test / Experiment	MR image dataset used in this work includes the Healthy Control and Parkinson's disease subjects considered from the PPMI database. AlexNet architecture is able to achieve an accuracy of 88.90%.
Simulation/ Test Data	AlexNet has been pre-trained with colour images of size 227 X 227 pixels and process them in its respective layers, from input to output. The image dataset with 80% of the input data is used for training and the remaining 20% is used for testing.
Result/ Conclusion	The model is trained to learn the low level to high level features and the classification results are validated. An AUC value of 0.9618 is reported from the ROC curve which shows a better discriminative proficiency of the proposed deep learning model
Obstacles/	The proposed methodology is not extended on deep fine-tuning of the AlexNet model to obtain improved performance levels.

Challenges	
Terminology	Parkinson's disease , MRI , Deep learning , Convolutional neural networks, AlexNet.
Review Judgment	An accuracy of 88.90% is achieved for classifying the HC and PD subjects. The PPMI cohort used in this study consists of 182 subjects with 82 Healthy Control and 100 Parkinson's disease subjects.
Review Outcome	In this work, analysis of T2 weighted MR brain images for discrimination of healthy control and PD subjects is attempted using CNN model.

Aspects	**Paper # 26**
Title/ Question	Unified deep learning approach for prediction of Parkinson's disease
Objectives/ Goal	Internal representations of the trained DNNs constitute the extracted knowledge which is used in a transfer learning and domain adaptation manner, so as to create a unified framework for prediction of Parkinson's across different medical environments.
Methodology/Theory	Our approach starts by training a deep neural architecture, such as a convolutional, or convolutional-recurrent network to predict the status (PD, or NPD) of subjects. This is based on analysis of medical images, i.e. DaTscans and/or MRI images, collected in a specific medical centre, or hospital. we consider a CNN part that has a well-known structure, such as ResNet-50, generally composed of convolutional and pooling layers, followed by one, or two fully-connected layers.
Software Tools	ML, DaTscans, (PPMI) database, SWEDD, Tensorflow.
Test/ Experiment	The PPMI study includes a cohort of 423 patients with PD, who have been diagnosed for two years or less and do not take PD medications; 196 control subjects, with no PD (NPD). Other categories, such as subjects who have been consented as PD, but whose DaTscans do not reveal dopaminergic deficit (SWEDD), prodromal ones, or subjects with genetic mutations are also followed in the study. As a consequence, the medical image inputs to the DNNs consist of a DaTscan and/or three consecutive MRIs.

Simulation/ Test Data	Parkinson's database has been recently developed [11], based on anonymised data from 75 subjects, 50 subjects with PD and 25 controls, of the Georgios Gennimatas Hospital . It includes at least one DaTscan, in the form of colour image, and many MRIs per subject. In total, it includes 925 DaTscans, 595 of which come from subjects with PD and 330 from controls; and 41528 MRIs, 31147 of which represent PD and 10381 NPD.
Result/ Conclusion	During the last three years, ML techniques, such as support vector machines (SVMs), logistic regression, random forests (RFs), and decision trees have been used for PD diagnosis. Such methods have been applied based on patient questionnaires [16], reporting an accuracy over 95%.
Obstacles/ Challenges	MRI data collection and data processing.
Terminology	Parkinson, ML, DNN, MRI, deep learning, DaTscans, SVMs, RMs, Tensorflow.
Review Judgment	Use of Tensorflow as an interface for PD diagnosis based on medical imaging has been proposed [22], using a neural network model and providing an accuracy of 97.34%. This work high accuracy then some other models.
Review Outcome	At first, we extract appropriate internal features, say features v, from the DNN model trained with the data set developed.We also that the proposed approach can improve Parkinson's prediction in cases and environments where some input data types, e.g. DaTscans, are not available and prediction is made only through MRI analysis.

Aspects	**Paper # 27**
Title/ Question	Classification of MRI images for Alzheimer’s disease detection.
Objectives/ Goal	This paper deals with the important challenge of identification of Alzheimer’s disease and the condition prior to dementia which is Mild Cognitive Impairment (MCI), developing intelligent classifiers, which using the information of magnetic resonance imaging, can successfully classify different patients according to their condition.
Methodology/ Theory	This paper presents a new methodology for classification of Alzheimer’s disease from MR images for medical support. A large database with more than one thousand patients was used. Two different problems are tackled in this work: a first one where a classification

	method is developed to classify MR images as either normal or with the Alzheimer's disease and a second one for the identification and classification between normal subjects, MCI patients and AD patients.
Software Tools	MATLAB, SPM5.
Test/ Experiment	They used ADNI Dataset. ADNI is a multisite longitudinal clinical/imaging/genetic/biospecimen/biomarker study. Its goal is to determine the characteristics of AD as the pathology that evolves from normal aging to mild symptoms, to MCI, to dementia.
Simulation/ Test Data	Once they were normalized and some images with errors were eliminated, 1350 images (443 are from cognitively normal subjects, 448 from MCI subjects and 459 from AD subjects) are left with a size of 15.7 MB each one, which makes a database of normalized MR images with a size of approximately 21 GB.
Result/ Conclusion	Afterwards and as suggested in previous works [7][8][16], PCA was used to reduce the dimensions of features to a higher degree. Once the principal components and their associated variances were calculated, a number of them that preserves 95% of total variance was kept [16].
Obstacles/ Challenges	They identified the identification of Alzheimer's disease and the condition prior to dementia which is Mild Cognitive Impairment (MCI) as a challenge for them.
Terminology	Support Vector Machine (SVM); Alzheimer's Disease; Mild Cognitive Impairment (MCI); PCA; Wavelets; MRI
Review Judgment	Results show a very high performance in classification results in the NAD problem, higher than 95% for both types of wavelets transformations without the use of PCA feature reduction.
Review Outcome	We study on the optimal slices to perform the classification, the use of other dimensionality reduction algorithms which could attain a reduction in time complexity for the problem, and the study on other databases of the same algorithm proposed here.

Aspects	Paper # 29
Title / Question	Computer-Aided Classification of Multi-Types of Dementia via Convolutional Neural Networks
Objectives/ Goal	This paper proposes a deep learning- based computeraided diagnosis approach for the early detection of multi-type of dementia.
Methodology/ Theory	To show the performance of the proposed CAD algorithm, three conventional CAD methods are implemented for comparison. This architecture initially builds CNN whose first layer takes the preprocessed images as inputs, and then builds logistic regression model to classify all examples of dataset into one of different classes of dementia.
Software Tools	Python, pandas.
Test / Experiment	A classification of dementia was tested on MR images collected from 74 different subjects. These images have been stored in the dataset that has been chosen among many datasets available on the Open Access Series of Imaging Studies (OASIS) for conducting our experiment. All healthy control subjects had a clinical dementia rating (CDR) of 0. On the other hand, subjects diagnosed with dementia had a CDR of at least 0.5.
Simulation/ Test Data	To evaluate the performance of the proposed model when deployed to make prediction on a new unseen data, 7- fold cross validation is performed on 734 MRI images. After getting preprocessed dataset, seven random datasets are produced to repeat training and testing of model in which 60% of MRI images are assigned to the training set while 40% of images are used for testing the algorithm.
Result/ Conclusion	The proposed algorithm yields a 74.93% accuracy in early diagnosis of multi-type of dementia and outperforms the state of the art CAD methods.
Obstacles/ Challenges	The early diagnosis of dementia is a challenging task due to the image quality, noise, and human brain irregularities.

Terminology	Alzheimer's disease; Brain imaging; Computer-Aided Diagnosis; Convolutional Neural Networks; Dementia; Early diagnosis; Magnetic Resonance Imaging;
Review Judgment	This work got less accuracy then some other models.
Review Outcome	These investigations about the performance of our model could be improved in the future studies.

Aspects	**Paper # 30**
Title / Question	Deep learning based-classification of dementia in magnetic resonance imaging scans .
Objectives/ Goal	Deep learning is much preferred in image processing applications since it can give fast and important results. This research aims at developing an open source software for deep learning based-classification of dementia in magnetic resonance imaging scans.
Methodology/ Theory	https://www.oasis-brains.org/ In this research, Open Access Series of Imaging Studies-2 dataset includes longitudinal MRI scans in non-demented and demented elder individuals. 3 or 4 individual T1-weighted MRI scans achieved from one scan sessions are contained for each subject. The basic architecture of the concept of deep learning is considered as convolutional neural networks (CNNs).
Software Tools	TensorFlow, Keras, Sklearn, OpenCV, Pandas, NumPy, MatPlotLib, and Flask.
Test/ Experiment	The related individuals are all right-handed and comprise men and women. 72 of the individuals were defined as non-demented during the study. 64 of the subjects were defined as demented at the time of their early visits and ensuing scans were obtained.
Simulation/	The image dataset encapsulates 1592 MRI scans for demented and 2032 MRI scans for non-demented .

Test Data	
Result/ Conclusion	Deep-learning framework is performed with respect to accuracy, sensitivity, specificity, positive and negative predictive values together with 95% confidence interval (CI) levels in training and testing stages. 95% confidence interval values for all the metrics are calculated by our developed software.
Obstacles/ Challenges	The early diagnosis of dementia is a challenging task due to the image quality, noise, and human brain irregularities.
Terminology	Classification, deep-learning, dementia, Keras, magnetic resonance imaging.
Review Judgment	This work got less accuracy then some other models.
Review Outcome	In the researches that will be carried out in the following stages, it may be suggested to develop artificial intelligence based-classification models and softwares that can classify the types of dementia (i.e., vascular, Lewy bodies, frontotemporal, Alzheimer, etc.) and non-dementia status.

2.3 Problem Analysis

Through magnetic resonance imaging (MRI) neurodegenerative disease detection is a common process. Generally, the existing approaches can detect one disease at a time which is time-consuming and expensive. In this thesis work, we will discuss an explainable model while maintaining a high level of learning performance.

2.4 Summary

This chapter investigated and reviewed the latest techniques of neurodegenerative disease detection, including the drawbacks. The thesis's target is to eliminate the imperfections as much as possible and introduce a new model to detect three neurodegenerative diseases at a time.

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