A Comprehensive Review On AL-Zheimer Disease

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Abstract

Older people are more susceptible to Alzheimer's disease (AD), a neurological illness. Alzheimer's dementia now affects those aged 65 and beyond. A forgetting of earlier conversations or occurrences is the disease's first symptom. Serious memory loss and decreased ability to do daily tasks occur as the illness progresses. The damage first shows up in the part of the brain that regulates memory, but it happens years before any symptoms develop. The brain eventually becomes much smaller as the loss of neurons spreads to other regions. Mild, Moderate, and Severe are the three stages of the sickness. The early stage, also known as the intermediate stage, features emerging problems. combination of positron emission tomography and magnetic resonance imaging data for neuroimaging. This new development in medicine calls for the use of cutting-edge instruments and the processing of massive volumes of data, where artificial intelligence is applied (AI), contributes significantly to the presentation of disease-patient dynamics, which is essential for timely/optimal diagnosis, monitoring, and action. The essential components are predictive models and algorithms. in this cutting-edge industry. In this study, we provide a summary of important subjects relating to the describing the algorithms and how they are used predictive of the progression of AD and AI's application to AD biomarkers, also. Precision medicine is a new method for treating and preventing disease that integrates multimodal data with elements including lifestyle, genetics, physiology, and environmental factors. Precision medicine uses AI algorithms. In this this study provides an overview of the key ideas relating to the application of AI in AD research, with a focus on ML and DL models. Each section's subjects will be chosen based on those that were most frequently used to describe AD.

Keywords: Artificial Intelligence (AI), Deep Learning (DL), (AD) Alzheimer's Disease, Mild Cognitive Impairment (MCI), , (SVM) Support Vector Machine, Normal Control (NC), Convolutional Neural Networks (CNN) ,Machine Learning (ML) , Area Under the ROC Curve (AUC)

1. Introduction

Alzheimer's disease is the sixth main prompt of death in the USA. The number of Americans suffering from Alzheimer's disease exceeds 5.4 million. Older persons (over 65) are affected. Alzheimer's disease is a neurological ailment that results in brain death due to memory loss and cognitive decline. It is currently the most prevalent type of dementia. A brain illness called dementia initially progresses more slowly and gradually gets worse In the United States, AD affects someone on a regular basis. Patients who are impacted have not yet received any treatment. Most AD prodromal stage patients are categorized as having Modest Cognitive Impairment (MCI). The researches have enhanced diagnosis to stop AD disorders at each stage. In that regard, preclinical, mild cognitive impairment, and dementia are three instances of AD. Preclinical refers to the early beginning of Alzheimer's disease, which affects those over the age of 65. In medical history, only 5% of persons have experienced these early Alzheimer's onsets. (MCI) Mild Cognitive Impairment is a stage of transition. This is linked to alterations in language, thinking, memory, and judgment relative to the usual state. Last but not least, dementia is a broad range of brain illnesses. There are several frequent signs of dementia in its early stages. It will have an impact on a person's lifelong everyday functioning and long-term language capacity [1]. Multiple illnesses, such as Huntington's disease, Creutzfeldt-Jakob Disease ,and Lewy body disease, can be brought on by dementia. Alzheimer's symptoms include: memory loss that interferes with everyday living, difficulties planning or solving problems, and confusion about time or location. Having difficulty comprehending visual representations and spatial connections, Reduced or bad judgment, as well as withdrawal from job or social activities) [2].

Medical imaging is crucial. Imaging biomarkers are a group of indicators that may be used to make an Early diagnosis of Alzheimer's disease. They are calculated using image modalities. Cerebra -Spinal Fluid (CSF), positron emission tomography (PET), single-photon emission computed tomography (SPECT), computerized tomography (CT scans), Magnetic resonance imaging (MRI), and Electroencephalogram (EEG) signal are some of the medical images that are frequently used to diagnose dementia at an early stage. It evaluates all brain messages. Radio waves and a magnetic field are used in structural MRI is used to scan the human body's tissues and organs. This approach has various advantages, including improved soft tissue contrast, lower costs, easier access, and less regional atrophy. A data set is created using structural MRI images from Alzheimer's patients.

The photographs in the series are divided into six categories, as previously mentioned:

1. (AD)Alzheimer's disease: the pictures in this category represent people who have been given this diagnosis.
2. (CN) Cognitively Normal: relates to people in good health (control).
3. (MCI) Mild Cognitive Impairment: This condition results in a modest but palpable reduction in cognitive skills.
4. (EMCI) or Early mild cognitive impairment, is a kind of MCI that has a lesser impairment of episodic memory.
5. (LMCI) or Late Mild Cognitive Impairment, an earlier stage of MCI than AD.
6. (SMC) or Significant Memory Concern: patients have significant self-reported memory concerns, which are measured utilizing the Cognitive Change Index and a CDR of zero Participants in the SMC achieve normal-range cognitive ratings, while the informant does not. We may create a progression graphic for Alzheimer's Disease using these classes [3].

2. literature Review

Because early identification of Alzheimer's disease is critical, some impressive research has been done for automated Alzheimer's disease detection and categorization. The bulk of them made use of the ADNI and OASIS datasets. As an example**.**

- **Moein Khajehnejad et al., 2017**," Alzheimer's Disease Early Diagnosis Using Manifold-Based Semi-Supervised Learning". A novel strategy for diagnosing extremely early stages of AD was proposed using an efficient categorization of brain MRI data., The researchers first used voxel morphometry to determine some of the most important AD-related features of brain imaging from raw MRI volumes as well as (GM) Gray Matter segmentation volumes. Following that, We provide a hybrid manifold learning strategy that embeds feature vectors in a subspace, as well as a dimension reduction based on principal component analysis (PCA) on the recovered features, allowing for quicker yet adequately accurate analysis. Then, using a little amount of labeled training data, In the constructed manifold space, we used a label propagation approach to The remaining photos were identified and classified as moderate Alzheimer's or normal condition (MCI/NC). When compared to the best current approaches, the proposed strategy has a classification OASIS" Open Access Series of Imaging Studies" library of MRI brain pictures has an accuracy of 93.86% , representing a 3% reduction in error rate. [4].
- **Md Rishad Ahmed et al. 2018**:" Neuroimaging and Machine Learning for Dementia Diagnosis: Recent Advancements and Future Prospects " presented a detailed review of automated dementia diagnosis techniques based on medical image analysis and machine learning algorithms Based on a thorough analysis of the available literature, they discovered that, While most studies focused on Alzheimer's disease, current study has shown that it is capable of identifying other types of dementia, which is still a major worry. The following are the primary contributions of this review paper: 1. This study describes neuroimaging processes for dementia diagnosis based on a careful examination of the available literature, and 2. It systematically explains the most recent machine learning techniques, including deep learning approaches for early detection of dementia., The accuracy: 90.0/64 [5].

- **Lee Kuok Leong et al. 2019**:"Prediction of Alzheimer's disease (AD) Using Machine Learning Techniques with Boruta Algorithm as Feature Selection Method".Based on the initial pre-processing stage, essential attribute selection, and performance evaluation of five proposed supervised machine learning algorithms, the optimum predictive machine learning model is selected. Other 12 models were outperformed by Random Forest Grid Search Cross Validation (RF GSCV)., including conventional and fine-tuned models, using the Boruta algorithm, with 94.39 percent accuracy, 88.24 percent sensitivity, 100.00 percent specificity, and 94.44 percent AUC, even for the small OASIS-2 longitudinal MRI dataset. [6].
- **Karaglani, Makrina, et al. 2020**:"Accurate Blood-Based Diagnostic Biosignatures for Alzheimer's Disease via Automated Machine Learning", used the Auto ML tool (JADBIO) Just Add Data Bio to evaluate openly accessible datasets from high-throughput low-sample -omics AD blood investigations in order to build precise prediction models to be used as diagnostic biomarkers. Taking into account information from AD patients and age-sex matched they developed the three most effective diagnostic biomarkers specific for the existence of AD in cognitively healthy people:" A. A 506-feature dataset from 48 AD and 22 controls", as well as Using three miRNA predictors and SVMs, we created a biosignature based on miRNAs. (AUC 0.975) (0.906, 1.000)), B. A 38,327-feature transcriptome dataset from 134 AD and 100 controls yielded six novel findings. A 9483-feature proteome dataset from 25 AD and predictors (AUC 0.846 (0.778, 0.905)) was used to generate statistically equivalent signatures utilizing 25 mRNA and classification random forests. There are 36 controls. [7].
- **Lin, Weiming, et al. 2021"** Multiclass diagnosis of stages of Alzheimer's disease using linear Discriminant Analysis scoring for multimodal data" , Provide a AD multiclass diagnosis framework utilizing a scoring system based on linear discriminant analysis to more efficiently incorporate multimodal data (LDA). Age correction, feature selection, and feature reduction were initially Magnetic resonance imaging, positron emission tomography, and cerebrospinal fluid biomarkers are all utilized to assess genetic characteristics, After each participant was examined using LDA, the scores representing the progression of the AD disease in multiple modalities were obtained. Lastly, a multiclass diagnostic Using these scores, an extreme learning machine-based decision tree was created. The trials were performed using accuracy rates of 66.7 and 57.3 percent, as well as F1-scores of 64.9 and 55.7 percent, were obtained from the AD Neuroimaging Initiative dataset. Percent, respectively, were found for categorization in three and four dimensions. Additionally, the outcomes showed that the suggested Earlier research methodologies and techniques that did not score multimodal data were surpassed by the framework, demonstrating that the LDA scoring strategy is a dependable instrument for combining multimodalities in AD multiclass classification [8].
- **Kavitha, C., et al. 2022**: "Early-Stage Alzheimer's Disease Prediction Using Machine Learning Models" . The most effective A variety of algorithms have been used to calculate parameters for Alzheimer's disease prediction, including Decision Tree, Random Forest, Support Vector Machine, Gradient Boosting, and Voting classifiers. The "Open Access Series of Imaging Studies" (OASIS) data is utilized to produce Alzheimer's disease forecasts. In circumstances ML algorithms have the ability to significantly reduce yearly Alzheimer's disease death rates by early detection.. On the test data of AD, the best validation average accuracy was 83%., the suggested study demonstrates improved outcomes. Comparing this test accuracy score to previous efforts reveals a substantial improvement [9].

3. Dataset

Data used was found in the ADNI database Alzheimer's Disease Neuroimaging Initiative is abbreviated as ADNI., which can be found at https://adni.loni.usc.edu/adni/adni/adni/adni/ This ADNI began in 2003 as a public-private partnership directed by Michael W. Weiner, MD, the primary researcher. The ADNI's main objective has been to determine if serial Particle emission tomography, other biological indicators, MRI, and clinical evaluation, and also neuropsychological evaluation may be combined to determine how MCI is developing and late AD. Also used The initiative known as (OASIS), or" Open Access Series of Imaging Studies", produced MRI-related data. The publicly accessible data from the OASIS-1 cross-sectional and OASIS-2 longitudinal MRI data sets were used. [9].

to use different machine learning models for testing and training. Those involved in the longitudinal dataset consist of 88 women and 62 men, all of whom are dominantly right-handed, and A single MRI scan presented three or four T1-weighted MRI brain imaging images Session. Each patient in the longitudinal dataset was scanned on average for 373 imaging sessions. two or more distinct occurrences separated by at least a year, with a 719-day median delay Between visits, there is often a (normal lag time of 183–1707 days) [10].

Table1. Feature measures counted in the dataset

Feature	Definition
Age	Age at time of image acquisition (years)
Gender	Gender F or M
SES	Socioeconomic status is divided into categories from 1 (highest status)
Education	Years of education
MMSE	Mini-Mental State Examination (from 0 [worst] to 30 [best])
CDR	Clinical Dementia Rating. (0= no dementia, 0.5= very mild AD, 1= mild AD ,2=moderate AD
ASF	Atlas Scaling Factor computation changes native - space brain and skull to atlas target.
eTIV	Estimated total intracranial Volume (cm^3)
Nwbv	Normalized whole brain volume ,using automated tissue segmentation process to be represented as a proportion of all voxels in the atlas-masked picture designated as grey or white matter

4. Alzheimer's disease early detection:

A variety of techniques were highlighted in this review for the early identification of AD. Different AD diagnosis methods have been put out in the past. The approaches are described in the next sections. This section discusses several imaging methods.

1. (SPECT) SINGLE PHOTON EMISSION COMPUTED TOMOGRAPHY ,The major purpose of functional imaging modalities like SPECT and PET is to make an early diagnosis. The development of Computer-Aided Diagnosis tools That can give a meaningful comparison in the functional brain picture in comparison to normal instances (analysis of particular aspects in the image) regarding the appearance of the abnormalities is needed in order to make valid judgements about the existence of such anomalies. To obtain the final categorization, use the strategic vision picture database as the source data., these (CAD) tools are made up of many steps[2].

2. (**PET**) Positrons Emission Tomography PET is a non-invasive medical imaging method that generates three-dimensional models of the brain's glucose uptake rate. Since brain activity and glucose intake are connected, PET scans can be used to diagnose a number of disorders, including AD [2].

3. **(MRI)** , Magnetic Resonance Imaging The structural MRI characteristics are retrieved [11,12]. The classification techniques currently in use may be categorized into three groups: 1) voxel-wise tissue probability Secondly, cortical thickness 3) hippocampal sizes It is really taken from the hippocampus, entorhinal cortex, and cingulated to uncover more efficient characteristics for AD or MCI categorization. In order to determine Cerebrospinal Fluid (CSF) level in brain pictures, it offers extensive information. Spatial normalization is applied to the pictures . (SPM) Utilizing Statistical Parametric Mapping, this approach produced normalized pictures. In MRI segmentation, the white matter (WM), cerebrospinal fluid (CSF), and gray matter (GM) that are present on a normal brain are distinguished [13].

Table2. Comparative of different technique [2]

Methods	Advantages	Disadvantages	Specific Issues in Technique Selection
Magnetic Resonance Imaging (MRI)	MRI can be used to detect and scan soft tissue irregularities, such as cartilage, as well as soft organs, such as the brain or the heart.	MRI scanners are very expensive.	To identify changes in tissue atrophy, MRI was used. More specifically, grey matter
(PET) Positron Emission Tomography	Can aid in the diagnosis, treatment, or prediction of a wide range of illnesses	Some people may experience allergy or injection-site responses when exposed to radioactive substances.	It is used to monitor changes in cerebral perfusion.
(SPECT) Single Photon Emission Computed Tomography	Monitoring blood flow and metabolic activity, as well as enabling brain functions	Radioactive substances are highly costly.	It is employed in the detection of changes in glucose metabolism.
(NMF) Non-Negative Matrix Factorization	Reduce the incoming data's high dimensionality.	Non-negative restrictions can limit accurate clustering to non-negative data alone.	NMF is a valuable decomposition method for multivariate data since it finds non-negative data with reduced linear representations
(PLS) Partial Least Squares	Feature extraction is more effective at obtaining specific information from data.	More complicated measuring procedure.	PLS improves the out-of-bag error rate significantly.
(GMM) Gaussian Mixture Model	GMM requires fewer feature vectors while producing decent results.	GMM requires additional time and samples.	GMM is mostly used for traditional clustering, but it is also extensively utilized for density estimation.
(PCA) Principal Component Analysis	Reduce the data's redundant characteristics and high dimensionality.	PCA only considers pair-wise correlations between voxels in brain pictures.	PCA is a technique for extracting the most important characteristics from a dataset.
(FCM) Fuzzy C Means	It is used to partition a finite set of items into a set of fuzzy clusters based on supplied rules.	The picture has noise and the segmentation is not obvious.	FCM algorithm considered as efficient clustering method.
(CGMM) Constrained Gaussian Mixture Model	It displays the intricate spatial architecture of individual tissues.	It takes a long time to examine geographical information and data decision making.	Gray Matter, White Matter, and CSF are all represented by multiple 4D Gaussians.

4. Methodology

ML, a key subfield of AI, is a collection of data analysis techniques with the goal of developing predictive models through data-driven learning, gradually enhancing the capacity for prediction through practice (see glossary; Table3). In DL, a branch of machine learning, highly nonlinear interactions are modelled ln order to understand connections between inputs and outcomes, into higher abstraction-level representations (see glossary). Additionally, supervised and unsupervised prediction models using ML or DL approaches fall into two basic types. In supervised learning, algorithms develop models that can predict the output variable by learning to link an input (such as cortical thickness measurements) with a certain output (such as the presence or performance on a neuropsychological test or absence of a disease). Unsupervised learning algorithms, in contrast to supervised learning, learn from unlabeled data in order to discover groups observations together based on comparable features (see glossary); The method's goal is to find structures among variables. [14].

AI approaches have found several uses in the attempt to automate, standardize, and optimize a number of clinical and biological operations. A number of AI algorithms have found In an effort to standard and automated, and increase the precision of early prediction, applications in the clinical and biological sectors are being developed. (Regression work), patient categorization (classification job), or data-driven subject stratification (see glossary). A label, such as "AD diagnosis," is used to train an algorithm. With a collection of characteristics, such as clinical signs, during a classification exercise (such as genotypes, cognitive state, biochemical markers, imaging, and so on), for the purpose of making forecasts. When the model is complete, it may forecast a specified class[15].

Fig 1 depicts a subset of ML called "deep learning" An algorithm that can learn without being explicitly designed is known as (ML) Machine Learning. the use artificial intelligence, it is possible to make machines function and act like people. During the learning phase, an artificial neural network is used in(DL) Deep Learning. The architecture The layers of an artificial neural network are stacked on top of one another. (CNN) Convolutional Neural Networks, (RNN) Recurrent Neural Networks, and autoencoders are a few examples of the various DL kinds as show in Fig2. Whether the forecast is accurate or not, the model method is adaptable and self-learns from the features. Even while the effectiveness of ML models has improved over time in many areas, they still require supervision (such as human experts) to make certain issues better. If inaccurate forecasts are given, developers should improve the design or algorithm. However, a DL model method, regardless of whether the prediction Its adaptable and self-learns from the characteristics [16,17,18].

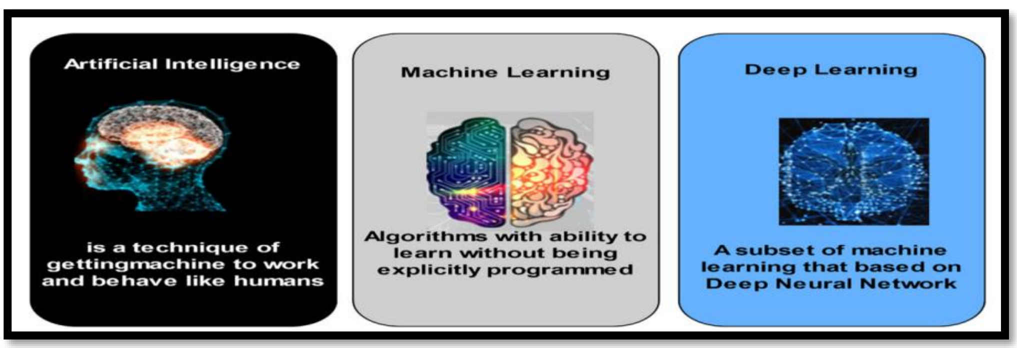

Fig.1 (AI) , (ML), and (DL)

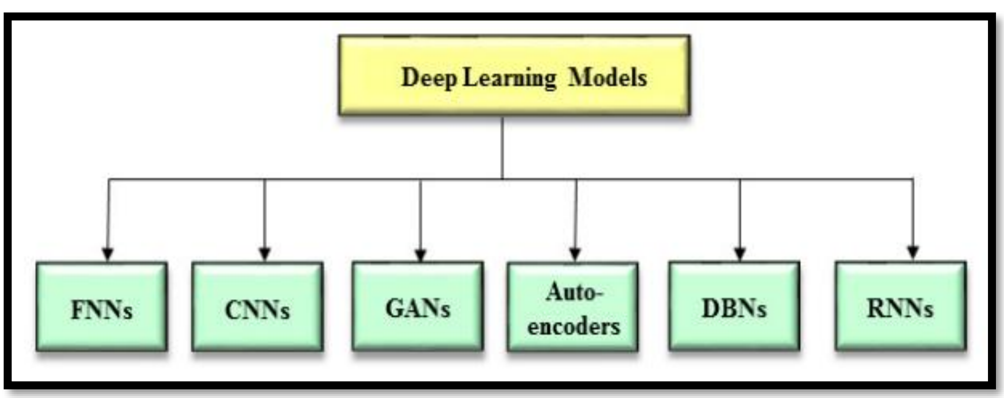

Fig. 2 Deep Learning model variants. (DBNs) Deep Belief Networks.
(GANs) Generative Adversarial Networks; (RNNs) Recurrent Neural Networks;(FNN) Fully Connected Neural Networks; (CNNs) Convolutional Neural Networks;

Table3. Glossary(Table of contents)

Method	Concept	Describes
Machine Learning	A collection of data analysis methodologies intended at producing new ideas by learning from data and increasing their capacity to foresee and anticipate via experience.	ML models are thought to be shallow learners. Raw data must be pre-processed before an ML system can be built, which needs domain expertise in order to continue feature extraction and engineering and properly train the algorithm
Deep Learning	A branch of machine learning that employs methods for learning connections by simulating very non-linear interactions between inputs and outcomes	Models of DL They can elaborate raw data with minimal to no feature engineering, as opposed to shallow learners. and they can do this because they can model complicated functions and recognize important features in the distribution of the data. The core of deep learning (DL) algorithms is Artificial Neural Networks, which were influenced by the human mind and can simulate very complex jobs.. ANNs can detect significant parts of characteristics and suppress unimportant ones. A Convolutional Neural Network is a type of DL method that consists of nodes arranged in layers. It can distinguish between two or more groups by taking an image as input, enhancing its attributes across its layers, and outputting a class attribution.
Supervised machine learning	A machine learning, The usage of labeled data sets for algorithm training defines the job.	With labels applied to the data in the ground truth set, the algorithms learn to provide the correct response. A supervised learning-trained algorithm is an SVM that performs the classification job.
Unsupervised machine learning	A collection of algorithms designed to find hidden patterns or data groupings without requiring human participation.	There are no correct or incorrect replies in unsupervised learning, unlike supervised learning ; instead, the algorithm seeks patterns in data. The algorithms operate on unlabeled data. Principal Component Analysis and clustering algorithms are two popular unsupervised techniques (PCA).
Task of classification	To predict a class label, the algorithm is trained.	The categorization of patients with an illness in comparison to healthy controls is a famous example. The algorithm's performance may be assessed using measures like accuracy score as it learns to oversee the association between input data and an output label.
Task of Regression	The algorithm was trained to predict the value of a continuous variable.	The algorithm learns to correlate input data with an output value in a supervised method, and the efficacy of its outputs may be examined using metrics such as the Root Mean Squared Error (RMSE).
Grouping (Clustering)	Clustering is the process of splitting a data collection into groups of data points.	Clustering is a critical unsupervised learning strategy. Its major purpose is to uncover subgroups in diverse data so that higher-level connections may be highlighted. uniformity within clusters (rather than between clusters). Even the most experienced physician may miss some patterns among patients or themes, but clustering techniques can improve.
Overfitting	It is overfitted and too dependent. Using training data to make accurate predictions about test data	Overfitting occurs when a model's learnt ability to differentiate between two classes does not adapt effectively to new data, limiting its usability in real-world applications.
Ensemble machine Learning	The process of combining numerous machine learning models to build a model ensemble produces predictions that are more	A single model by itself may not be very good at making predictions. Multiple models can be combined to overcome each one's shortcomings.

	accurate than any of the individual components alone.	
Transfer learning	a method of supervised learning where solving related problems requires the use of previously learned information from a model.	in the framework of a transfer learning technique The input and output data relationships should be comparable across the source and target tasks. During the pre-training phase, the model really learns important knowledge for the planned job.

In Table4, the main distinctions between ML and DL are listed. DL is a particular subset (or branch) of ML. A pertinent feature is manually extracted using ML from the supplied data. The model parameters are then updated using the extracted feature to aid in accurate prediction (i.e., classification) . With DL, this is not the case because pertinent characteristics are automatically extracted from the data. Furthermore, End-to-end learning is used in DL, in which data and the job to be done are transmitted to the network. As previously said, the learning process is carried out automatically from the features, therefore manual changes (i.e., upgrades) are no longer required. [16].

Table 4 the distinction between Deep Learning Techniques and Machine Learning

Aspects	**Machine Learning**	**Deep Learning**
Size of Data	Can handle small to medium datasets	Can handle large amounts of data
Training Period	Can take less time concerning the dataset size	Can take a long time concerning the dataset size
Interpretability	Easier to interpret the algorithms or models	Harder to interpret the algorithms or models

6- Diagnosis of (AD) Alzheimer’s Disease

Diagnosis of probable AD in an individual With the right information, a qualified neurologist can diagnose patients with moderate-to-severe cognitive impairment or indications of cortical atrophy. As a result, it comes as no surprise. showing an AI model can accurately categorize patients as NC or AD based on the outcomes of NPS tests or neuroimaging data. Numerous predictive models have been created to date, producing maximum accuracy scores of 100% in NC vs. AD categorization In contrast, given the shade disparities and overlapping symptoms in the clinical data, identifying people Persons with subjective or moderate impairment are more likely to acquire AD dementia than people with stable MCI or MCI not caused by AD, is difficult., is a considerably more challenging challenge for AI. As seen in Fig 4, the AD diagnostic process involves several phases in order to identify and diagnose the condition. Partition the diagnosis of AD into two key steps. First, methods for images preparation. Second, methods for learning and diagnosing disease. Depending on the type of input data and the problem the researcher is trying to address, one of these strategies should be used [16] .

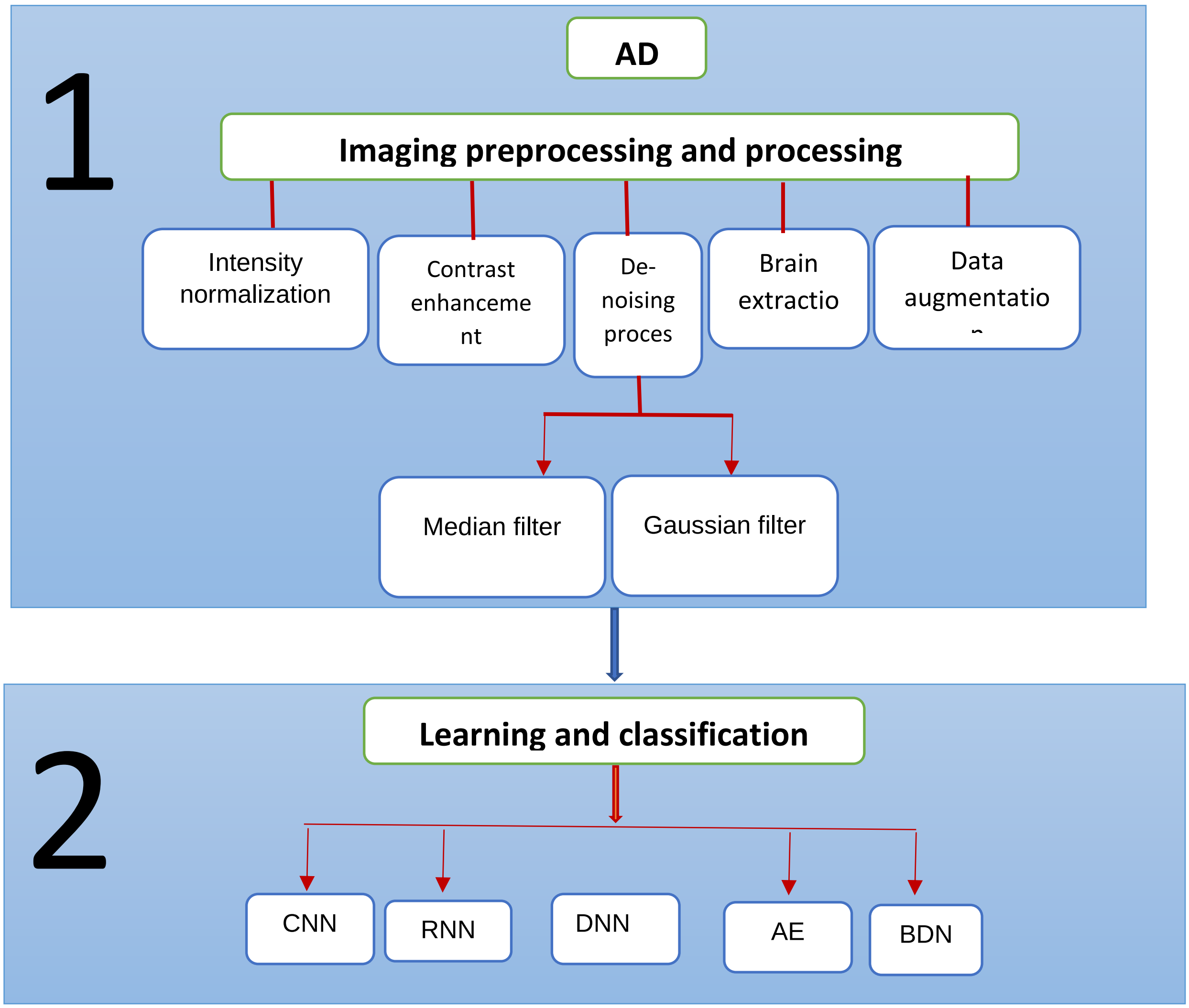

Fig.3 AD Framework for Approaches of Classification and Preprocessing

From fig (4) The process of acquiring the information needed for diagnosis is known as the data collection step. Preprocessing the dataset during the second step will increase its quality and the categorization task's efficacy. The dividing stage is the third step. Subsets for training, testing, and validation can be created from the dataset. The final phase involves learning. system with appropriate and precise methods for extracting information, data-driven learning, updating the categorizing illness and the parameters, into a certain class [16].

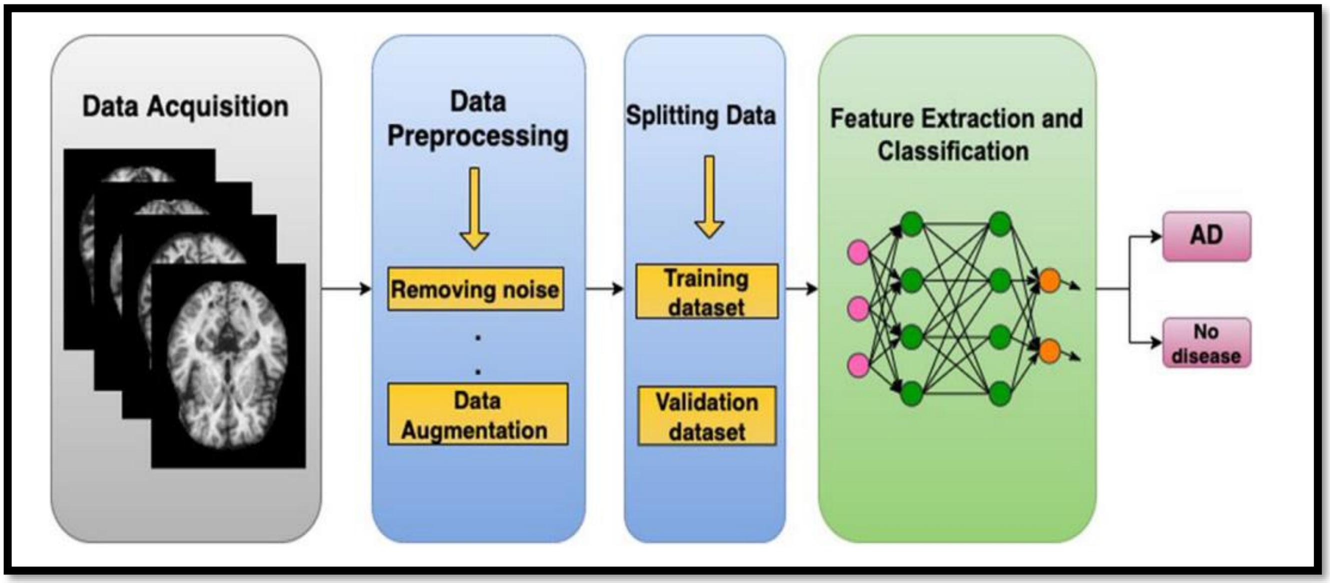

Fig 4. Alzheimer's Disease Diagnosis Process

7- Results and Limitations

more thorough comparison of current, pertinent studies. The Computer Aided Diagnosis of Dementia technique employing various medical imaging has now reached the accuracy criterion of 0.97 and incorporates six different steps in its categorization.

Table 5 Comparative research using Machine Learning .

Author	Dataset	Stages	Classifier	Accuracy
Moein Khajehnejad et al., 2017[4]	OASIS	CN , MCI , AD	PCA, VBM	93.86%
Md Rishad Ahmed et al.,2018[5]	OASIS ADNI	MCI, AD, and NC	SVM , SPECT	90.0/64 %
Lee Kuok Leong et al.,2019[6]	OASIS	CN, AD	RF GSCV	94.39%
Karaglani, Makrina, et al.,2020 [7]	JADBIO	MCI,CN, and AD	SVMs, random forests	97.5% 84.6%
Kavitha C et al., 2022[9]	OASIS	CN, MCI , AD	Rf and SVM	0.83 %

Fabrizio et al., 2021[10]	ADNI	MCI, AD	Based on multi-modal data, an ML ensemble approach for converting MCI to AD was developed.	82.4%
Chang et al., 2021[19]	ADNI (Metabolites Biomarkers with Machine Learning)	CN, AD	NCV CSF	0.85 % 0.78, 0.83 and 0.87% , respectively
Roobaea Alroobaea et al., 2021[20]	ADNI, OASIS	CN , MCI , LMCI, AD	Logistic regression, SVM , RF	99.10% 83.92%

applications of In genomics, deep learning models are used.. There are various studies for AD research that use genetic data and other methods. Deep learning models (Table5), as explained in the subsections that follow. These research include the prediction of Alzheimer's disease risk, the prediction of AD-specific nucleotide change sites (i.e., splicing sites), and the virtual illness/molecular development of Alzheimer's disease. [16]

Table 6 Comparative research using Deep Learning.

Author	**Dataset**	**Task**	**Model**	**Performance**
Ju et al.,2017 [21]	ADNI	Predict early diagnosis of AD	Autoencoders	The auto-encoder model outperformed linear discriminant analysis, logistic regression, and support vector machines (AUC = 0.916, 0.710, 0.765, and 0.789, respectively).
Ning et al.,2018 [22]	ADNI	Predict AD risk	FNNs	FNNs outperform logistic regression in differentiating between Alzheimer's disease and normal controls (AUC = 0.948, 0.945) and between Alzheimer's disease and mild cognitive impairment (AUC = 0.846, 0.824).
Maj et al.,2019 [23]	ADNI	Predict AD risk	FNNs, CNNs, RNNs	RNNs performed best in the adipose subcutaneous, artery aorta, and colon transverse tissues (AUC = 0.953, 0.951, and 0.946, respectively). CNNs performed best in the brain spina, thyroid, and whole blood (AUC = 0.943, 0.95, and 0.947, respectively).

Shen et al.,2019 [24]	ADNI	Predict early diagnosis of AD	DBNs	PCA and anatomical auto-Matic labeling were outperformed by DBNs (accuracy = 0.866, 0.795, and 0.631, respectively; no particular AUC values).
Zhou, P. et al.,2020 [25]	ADNI	Predict AD risk	Sparse-response DBNs	MCI and normal controls (AUC = 0.79, 0.60, 0.73), MCI and AD (AUC = 0.71, 0.60, 0.68), and AD and MCI (AUC = 0.71, 0.60, 0.68).

We summarize Previous studies, there are some similarity and variations between the research shown in the preceding parts. First, to carry out diverse tasks in Alzheimer's disease prediction, these research used several Deep learning-based models e.g.(DNN , CNNs ,FNNs, and RNNs). Second, these studies made use of diverse genomic information and neuroimaging data, such as DNA methylation and/or gene expression, as well as, MRI, SNPs and/or PET, Rarely is the use of illness progression used.

For optimal training accuracy, deep learning needs a lot of data samples, yet getting longitudinal data is a huge challenge. However, multi-step prediction issues frequently result in significant inaccuracies, i.e., the faults of the previous stages will compound in the next phases, finally affecting the total prediction impact. Even though RNN offers several benefits when working with time series data, there are still many challenges in the medical industry when it comes to illness prediction. As our RNNs describe non-linear relationships between relay data, a frequent issue is that RNN cannot handle sequential data with missing sections. RNN furthermore needs a set amount of time. In the context of medical testing, this presumption is incorrect. In addition, We can see that the CNN-based techniques surpassed the AD approaches in the NC classification. Finally, We focused the analysis to the most popular neuroimaging preprocessing methods (De-noising process ,intensity normalization, , brain extraction, data augmentation, and contrast enhancement).

8. CONCLUSION

Alzheimer's disease, in particular, has a significant influence on healthcare and society. To reduce the disease's course and prevent brain damage, early diagnosis of this condition is advised. Therefore, if such information is discovered early enough, it can both assist those who have Alzheimer's and the members of their families in leading healthy lives. The study reported here uses ML algorithms to recognize AD. The ADNI and OASIS datasets are used to evaluate the categorization models. Other illnesses might be the subject of future investigation. Being constrained on MRI will be intriguing as well. without any custom features, confined on MRI. The classification of SVM was used to differentiate Alzheimer's disease from normal, MCI, and AD. algorithm KNN, ANN, SOM, PCNN, and RF algorithm was reviewed in this study along with imaging modalities and methodologies for diagnosing AD. Table 1 above is a comparison of several strategies; it lists their benefits and drawbacks as well as any particular issues that may have arisen when choosing among them. We evaluated the effectiveness of freshly created algorithms. In the comparative section, high accuracy diagnoses of Alzheimer's disease (AD), elderly Normal Control (NC) , and mild cognitive impairment (MCI) are shown. These diagnoses were made using recently developed algorithms.

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