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Research Article

Early Prediction of Alzheimer's Disease with the Help of Machine Learning Approach

Manisha Chaudhari [1], Dr. Mukta Agrawal [2]
[1]*Research Scholar at indus university,Email-id: chaudharimanisha.21.rs@indusuni.ac.in*
[2]*Assistant Professor at indus university,Email-id: muktaagarwal.dcs@indusuni.ac.in*

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ABSTRACT

Introduction: Alzheimer's Disease is kind of neurodegenerative disorder under neurological disorder.Neurological disorder is disease of the central nervous system.Nervers,brain and spinal cord all working together and control whole the working of human body.Alzheimer's disease is brain related disease. if it is not cured within time limit. it getting crucial to preventing and controlling its progression.

Objectives: various approaches for diagnosis of alzheimer's disease and also examine various algorithm of machine learning approaches for prediction of alzheimer's disease.Classification and daignosis that have been applied on different datasets.

Methods: two different kind of dataset for the research.one is image dataset is used for the research and text dataset used as well.machine learning algorithms like 3D CNN and ANN applied on both the dataset.we try to prove that for the prediction of alzheimer's disease with the help of machine learning approaches gives better and faster result.so the patient's medication start immediately without any dealy.it is beneficial for the patient and doctor as well so patient to get medication in early stage and recover fastly.

Results: We demonstrated the effectiveness of our method empirically in terms of sensitivity, specificity, and accuracy. Although the obtained results (more than 90% accuracy) are superior to those of the majority of prior research, more development and extensive enhancements are required to improve the model for the diagnosis of AD. Similar to a diagnostic tool, the suggested modeling technique can find its appropriate use. Additionally, when assessing AD treatment procedures

Conclusions: The ML classifier employed in this study has no bearing on the extraction and selection of text data or MRI features.Consequently, the doctors are given a combination of several characteristics that are suggestive of the identification and thorough observation of the condition. Our strategy chose the neural network instead of the traditional way. Consequently, the utmost precision is achieved.

Keywords: Alzheimer Disease,ML,CNN,ANN.

INTRODUCTION

Alzheimer's disease is neurological disorder.it is common type of dementia. It get worsens over time.Alzhseimer's disease is also consider under neurodegenerative type of disorder. Alzheimer's disease started with destroys memory slowly and thinking ability, and eventually, the ability to carry out the simplest tasks in routine. In most of the people Alzheimer's,spread its symptoms later in their life. Estimates vary, more than 6 million Americans, most of them age 65 or older, may have Alzheimer's. that progresses expert suggest that.It starting with mild memory loss and perhaps conclude with loss of capacity to respond to surroundings and carry on a conversation. Alzheimer's disease affects the parts of the brain involved in cognition, memory, and language. It could seriously hinder someone's ability to perform daily routines. Alzheimer's is currently ranked as the seventh leading cause of death in the United States and is the most common cause of dementia among older adults.. In year 2020 Alzheimer's disease affected Up to 5.8 million American people . Alzheimer's disease is not so much common in younger people, while it is still possible to young generation affected by alzheimer's ..By 2060 the number of individuals with the illness doubles every five years. The risk increases with age, and symptoms might not come up until after the age of 60.This study looks into the application of machine learning (ML) algorithms to predict the onset and progression of Alzheimer's disease using a range of datasets, including neuroimaging, genetic data, and clinical assessments data.

Alzheimer's disease (AD) is popular type of dementia in the old aged people,it is a crippling neurological condition. It is manifested by behavioural alterations, memory impairment, and a continually decline in cognitive function. As people around the globe get older, Alzheimer's disease is expected to become significantly more widespread.creating a serious public health concern. Alzheimer's disease currently has irrecoverable.and available therapies mostly focus on symptom relief rather than slowing the illness's progression.Effective intervention and therapy of Alzheimer's disease depend heavily on early diagnosis and precise prediction of the illness. It is possible to implement timely therapeutic strategies, make lifestyle improvements, and improve patient and family planning by identifying persons at risk prior to the beginning of clinical symptoms. Technological and scientific developments in the biomedical fields have produced an ampleness of data that can be used to enhance Alzheimer's disease prediction.

This work integrates multiple data sets, including neuroimaging results, and clinical assessments data, machine learning algorithms is use to evaluate for Alzheimer's disease. Because machine learning can uncover complex patterns and relationships across large datasets, it offers a powerful way to increase the accuracy and reliability of predictive models. The primary objective is to develop models that accurately detect individuals with Alzheimer's disease at varying stages of the illness as well as those with mild cognitive impairment (MCI), who is at a higher risk of getting the disease.We aim to develop robust predictive models by combining multimodal data.We will give a summary of the importance of early Alzheimer disease prediction, the state of predictive modelling in this area at the moment, and the possible outcomes of combining machine learning with multimodal data in this introduction. Our ultimate goal is to contribute to more efficient and individualized healthcare solutions by laying the groundwork for understanding the methods and ramifications of advanced predictive approaches in Alzheimer's disease.

AI analyzed medical data in the healthcare industry to prevent disease, diagnose conditions, monitor patients, and create novel procedures. AI has the potential to ease the burden of clinicians who are currently overwhelmed with data. From the beginning of the digitization of health care data in the mid-1960s to the introduction of the electronic health record From the middle of the 1960s until the electronic health record (EHR) was incorporated into the American

AI helps physicians analyze the clinically important data that is concealed within massive amounts of data. Deep learning is required to organize the vast quantity of data that is gathered annually in the field of neurology, help neurologists make early diagnoses, and improve care. AI has attracted a lot of attention due to neurological disorders because it can be used to identify, diagnose, and even prevent irreversible outcomes. An innovative method for treating and preventing disease is artificial intelligence (AI).

It could use a lot of processing power to find out. In the past 20 years, a number of AI-enabled tools, such as MRIs and CT scans, have been created to assist radiologists in diagnosing complex images. Health apps that use artificial intelligence (AI) to help patients take their medications as prescribed. New approaches to treating nerve illnesses and improving the general functional outcomes of patients are being made possible by artificial intelligence (AI).

LITERATURE SURVEY

IMAGE DATASET

The Alzheimer's Disease Neuroimaging Initiative is another name for the ADNI dataset. ADNI datasets are typically employed in medical research, especially in neurological illness research, anytime studies involving brain imaging are conducted.. (Stanislaw Adaszewski et al.,2013) employed the ADNI dataset in their study, wherein mild cognitive impairment was categorized as AD through automated computer-based diagnosis, to which support vector machines were employed.Further (Patrico Andre et al.,2017) designed a system with many classifiers.For the research, they employed the radial basis kernel function and the Adaboost algorithm in their system. (Garam Lee et al. ,2019) deployed a multimodal deep learning approach to forecast the association between AD and MCI in studies. Then, (Gokce Uysal, Mahmut Ozturk et al.,2020) Gaussian Naive Bayes, K-NN, SVM, Decision Tree, Random Forest, and

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Logistic Regression were used to assess the diagnosis within the parameters of the right and left hippocampal volumes. As stated by (Tasic Lee et al.,2020), To find genes associated with AD from blood samples, a deep neural network is used for diagnosis based on blood samples. To support the hippocampus and the temporal lobe, (Esther E. Bron, Stefan Klein, et al.,2021) employed a deep convolutional neural network and Support Vector Machine. A deep neural network was found to be an accurate predictor of the consequences of amyloid accumulation on glucose metabolism and brain shrinkage (Patrick H. Luckett et al., 2021).In order to identify Alzheimer's disease early on, Serkan Savas et al. (2021) employed deep neural networks. (Kobra Etminani et al.,2021). The method developed by Tripti Goel et al. (2022) will assist medical professionals in accurately diagnosing AD in its early stages.They were using Resnet-50 for that.Further research was done to extract the features from the merged photographs after 2023. A random vector functional link (RVFL) with one hidden layer is used to classify the gathered features. An evolutionary technique is used to adjust the weights and biases of the original RVFL network in order to achieve the highest accuracy.A multimodal deep learning framework was proposed by (Shangran Qiu et al.,2022), which used a deep learning technique to.(Joseph Giorgio et al.,2022) captured early stage AD-related pathology using a linear support vector machine. (Hadeer A. Helaly et al.,2022) was classified as To do this, they employed 3-D CNN throughout the four AD steps.(Guangming Wang Zhengyao Bai; Yuee Xu et al.,2024) used transfer learning to lessen the AD diagnosis model's reliance on data. The model's specificity, sensitivity, and accuracy are excellent when applied to a small sample of the ADNI dataset. (Baiying Lei a, Yafeng Li a, et al.,2024) extracted interaction information at various levels of local and global salient multi-modal features using a special dual multilevel graph neural network (DMGNN) and feature induction learning.Neuroimaging was categorized into two main groups as a common method for assessing brain pathology and ruling out structural abnormalities (such cancers and infarctions). Structural imaging methods include computed tomography (CT) and magnetic resonance imaging (MRI). While CT uses X-rays to show the brain's two-dimensional structure, MRI creates images of the brain's tissues by combining radio waves with a powerful magnetic field.CT is enough to identify progressive cognitive decline when the neurologic examination yields no abnormal findings. However, in cases where a patient has motor impairment, an MRI can identify ischemic changes that a CT scan cannot.Functional imaging techniques include Positron Emission Tomography (PET) and functional magnetic resonance imaging (fMRI). (Cristian R. Munteanu et al., 2015) used ANN to classify AD utilizing spectroscopy HMRS data. (Giulia Fiscon et al., 2018) examined the process for classifying EEG signals from a sample of people with neurodegenerative diseases. The supervised learning approach was applied for that. (Ziqi Tang and others, 2019) A deep learning method improves the knowledge and analysis of a skilled neuropathologist.In 2020, Afreen Khan, Swaleha Zubir, and others A classifier system, data transformation, and feature selection are all components of an ML pipeline.Multiple taupathies are distinguished by a deep learning model based on the identification of lesion types in AD, PSP, CBD, and PiD (Shunsuke Koga, Akihiro Ikeda, et al., 2021). High performance was attained by (Doaa Ahmed Arafa Hesham A. Ali et al.,2022) using deep learning with preprocessing pictures. (Nitika Goenka et al.2022) Use a convolutional neural network to classify Alzheimer's disease into three groups based on a neuroimaging biomarker termed T1w-MRI.(Apeksha Koul, Yogesh Kumar, et al.,2023) Artificial intelligence techniques were used to diagnose maladies such as Alzheimer's, cancer, diabetes, chronic illnesses, heart disease, stroke, and cerebrovascular disease, as well as hypertension, skin disorders, and liver diseases.Modern AI methods can be used to more effectively detect and predict a variety of illnesses, such as cancer, heart, lung, skin, genetic, and neurological issues (Nafiseh Ghaffar Nia • Erkan Kaplanoglu et al.,2023).in contrast to experts who don't make mistakes.Tripti Goel and Rahul Sharma et al., 2023 presented common imaging modalities; talked about early biomarkers for AD diagnosis using neuroimaging scans; reviewed widely used online data sets; methodically described the different DL algorithms for precise and early AD assessment; talked about the benefits and drawbacks of the DL-based model for AD diagnosis; and gave a prediction for future trends based on our critical evaluation.(Melanie Champendal, Henning Müller et al.,2023) used XAI algorithms to classify and forecast brain and lung diseases in MRI, CT, and radiography. The most common output formats are numerical and visual. Standardizing terminology is still difficult because words like "explainable" and "interpretable" are occasionally used interchangeably.Accurate disease diagnosis was created by (Xingyu Gao; Hongrui Liu et al.,2023) using a brain status transferring generative adversarial network (BrainStatTrans-GAN).Early detection of MCI and dementia may encourage earlier implementation of supportive or assistive services and facilitate life planning, such as driving reduction and cessation, to ensure the well-being and safety of those affected (Xuan Dia,b, Yiqiao Yinc et al.,2023). This was accomplished by using an interaction-based classification method based on a statistic named Influence

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Score (also known as the I-score).Brain-wide genome-wide localization study for genetics, molecular and cellular signatures, regional brain morphologic end phenotypes, and AD diagnosis (Jingxuan Bao a, Junhao Wen b c et al.,2023), offering fresh perspectives on the disease's mechanistic understanding (Madhusudan G Lanjewar et al.,2023) etiology discovery based on genetic data, computer-aided diagnosis (CAD), computer-aided prognosis (CAP) of AD using multi-modality data (genetic, neuroimaging, and linguistic data), and pharmacological or non-pharmacological approaches for treating AD by Qing Zhao, Hanrui Xu 2024)

TEXT DATASET

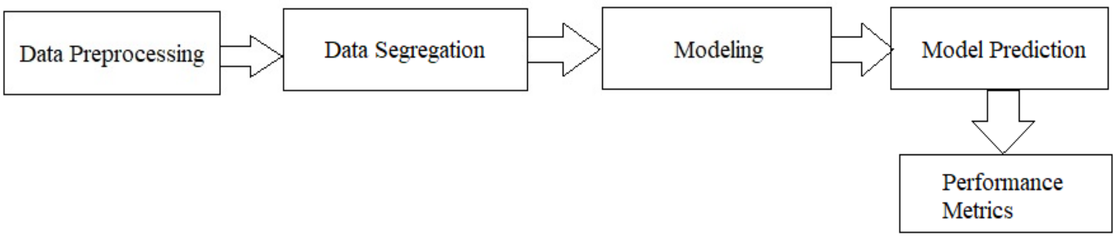
Text data is one of the most often used and extensive information sources for machine learning models. However, pre-processing, feature extraction, and modeling are made very challenging by the unstructured, noisy, and complex nature of text data.

In order to identify the onset of AD, (Tingyan Wang et al., 2018) combined LSTM and a recurrent neural network to mobilize a variety of medical data for the patient's next consultation. By increasing the number of features that can be gathered from a single test, reducing errors brought on by human judgment, and further automating dementia screening, other AI techniques improve the performance of dementia screening tests. (Xinyi et al., 2022; Renjie Li a). AI may improve the identification of AD patients and screen older people for preclinical AD, which is recognized before symptoms manifest, when

Chaitanuwong, Pareena, and others, 2023 The experimental results showed that the dynamic features of spontaneous speech time series may be inherited by the AD and HC groups for all three stages (VG.Mahda Nasrolahzadeh et al.,2023). Machine learning algorithms, including gradient boosting, logistic regression, gaussian naive Bayes, random forest, and support vector machines, can predict the correlation between sleep disorders and dementia (Joel Nyholm et al., 2024). Clinical judgments about the early categorization or exclusion of elderly patients with probable cognitive impairment are also supported by machine learning (Pablo Ormeno et al., 2024).

METHODS

Recently, ML has made notable advancements in numerous application domain, thereby, encouraging its demand efficiently by novices in ML (Feurer et . In addition, a powerful ML system is ought to solve the fundamental challenges by determining a specific ML algorithm to apply on a dataset, in what manner the preprocessing should be done, and how to tune its hyperparameters.In this paper, we propose a hybrid approach for AD classification as a tool to diagnose AD. The proposed model learns data using a ML algorithm and classifies data into healthy or nonhealthy AD patient. We used jupyternote book as an experimental environment, which employs Python libraries. The jupyternote book platform exhibits a well-defined skeleton for developers to process, build and assess their models. Python is an interpreted and higher-level programming language encompassing dynamic semantics



(Fig 1: Architecture of the proposed model)

A linear series of data transformations is taken into consideration by pipelines, which are connected in a way that results in a model that can be evaluated and used further. Making assured that every pipeline step is followed was the goal. Additionally, it was limited to the datasets that were accessible for the evaluation, such as the test and train datasets. There is a five-level sequential model in the suggested architecture. The sub-levels that make up each level are kept in a linear order.Following is the working program of the model employed (Fig. 1). The first stage comprised of data preparation, which involves the pre-processing of MRI data as well as text data. The processes of data

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gathering, data visualization, feature selection, and data transformation were all part of this.This first stage handled the data in a more straightforward manner. The method selects features based on their influencing potential, handles missing data, eliminates existing outliers, and normalizes to a particular range. Furthermore, by showing the distribution, correlation, and skewness of the data, the data visualization aids in our ability to see the raw data on a larger scale. The first level's output, or clean data, is used as the input for the second stage. The second level comprised of the data segregation, which involved the splitting of the dataset into train data, test data.The ratio of train and test data is 80:20. The split data is then used in the third level for model building. Model training, model assessment, cross-validation, and hyperparameter tweaking through model validation were the four sub-levels that were included in the third stage. This includes how machine learning actually operates, where several ML classifiers are trained, the model is assessed based on the accuracy it produces, cross-validation is carried out, and parameters are adjusted to increase accuracy.The evaluation of the model was carried out using a variety of machine learning methods for data classification and learning in order to generate the model. The model prediction level comes next, where the model created in the third stage is assessed. It classifies the group as either AD or non-AD patients based on its prediction of the model on the test set. The performance evaluation level, the final stage, or the fifth, offered insights into the model by graphically depicting its performance. Sequential adherence to the order preserved the pipeline's five-level workflow design.

RESULTS

input_layer_1 (InputLayer)	(None, 28, 28, 3, 1)	0
conv3d_4 (Conv3D)	(None, 28, 28, 3, 8)	224
conv3d_5 (Conv3D)	(None, 28, 28, 3, 16)	3,472
max_pooling3d_1 (MaxPooling3D)	(None, 14, 14, 1, 16)	0
conv3d_6 (Conv3D)	(None, 14, 14, 1, 32)	13,856
batch_normalization_1 (BatchNormalization)	(None, 14, 14, 1, 32)	128
flatten_1 (Flatten)	(None, 6272)	0
dense_3 (Dense)	(None, 204)	1,279,692
dropout_2 (Dropout)	(None, 204)	0
dense_4 (Dense)	(None, 512)	104,960
dropout_3 (Dropout)	(None, 512)	0
dense_5 (Dense)	(None, 4)	2,052

Total params: 1,404,384 (5.36 MB)
Trainable params: 1,404,320 (5.36 MB)
Non-trainable params: 64 (256.00 B)

(FIG : 2)

The figure represents the summary of a 3D Convolutional Neural Network (CNN) model, most likely created using TensorFlow/Keras. Shape: (None, 28, 28, 3, 1).The input has a spatial size of 28×28 with 3D depth of 3 channels and 1 sample depth. Fully connected layer with 4 output neurons (probably for a classification task).Parameters: 2,052. This architecture suggests a 3D CNN-based classification model, likely for tasks such as medical imaging (CT scans, MRI), video classification, or volumetric data processing.

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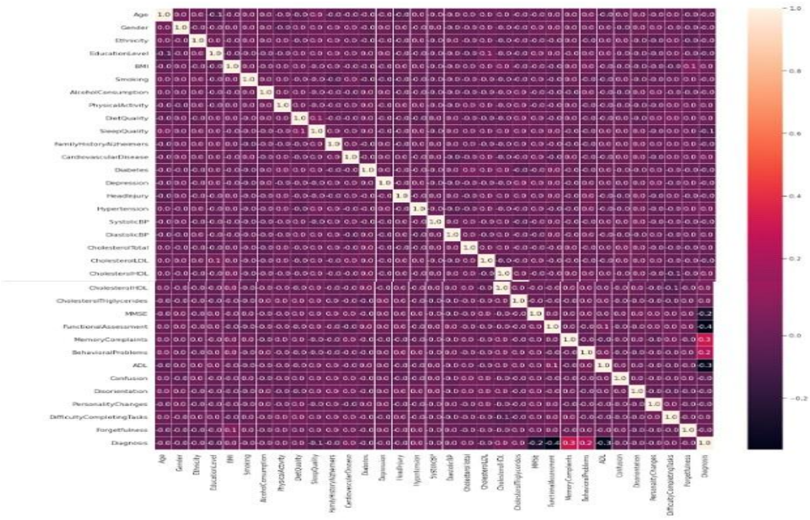
161/161 ━━━━━━━━━━━━━━━━━━━━ 17s 107ms/step - accuracy: 0.5719 - loss: 0.8876
Epoch 4/15
161/161 ━━━━━━━━━━━━━━━━━━━━ 0s 64us/step - accuracy: 0.0000e+00 - loss: 0.0000e+00
Epoch 5/15
161/161 ━━━━━━━━━━━━━━━━━━━━ 17s 106ms/step - accuracy: 0.6520 - loss: 0.7523
Epoch 6/15
161/161 ━━━━━━━━━━━━━━━━━━━━ 0s 0s/step - accuracy: 0.0000e+00 - loss: 0.0000e+00
Epoch 7/15
161/161 ━━━━━━━━━━━━━━━━━━━━ 17s 106ms/step - accuracy: 0.7560 - loss: 0.5720
Epoch 8/15
161/161 ━━━━━━━━━━━━━━━━━━━━ 0s 39us/step - accuracy: 0.0000e+00 - loss: 0.0000e+00
Epoch 9/15
161/161 ━━━━━━━━━━━━━━━━━━━━ 18s 109ms/step - accuracy: 0.8295 - loss: 0.4225
Epoch 10/15
161/161 ━━━━━━━━━━━━━━━━━━━━ 0s 11us/step - accuracy: 0.0000e+00 - loss: 0.0000e+00
Epoch 11/15
161/161 ━━━━━━━━━━━━━━━━━━━━ 17s 107ms/step - accuracy: 0.7819 - loss: 0.5067
Epoch 12/15
161/161 ━━━━━━━━━━━━━━━━━━━━ 0s 2us/step - accuracy: 0.0000e+00 - loss: 0.0000e+00
Epoch 13/15
161/161 ━━━━━━━━━━━━━━━━━━━━ 18s 109ms/step - accuracy: 0.9223 - loss: 0.2043
Epoch 14/15
161/161 ━━━━━━━━━━━━━━━━━━━━ 0s 71us/step - accuracy: 0.0000e+00 - loss: 0.0000e+00
Epoch 15/15
161/161 ━━━━━━━━━━━━━━━━━━━━ 17s 107ms/step - accuracy: 0.9357 - loss: 0.1639
<keras.src.callbacks.history.History at 0x1826c5924e0>
```

The figure represents the training log of a neural network using Keras, showing how the accuracy and loss change over 15 epochs. The model is training properly in some epochs but skipping updates in others. Final accuracy is high (93.57%), and loss is low (0.1639), which is a good sign.



(Fig : 4)

The figure is a correlation heatmap, which visualizes the relationships between different variables in a dataset. The color bar on the right indicates correlation values: Light colors (closer to white) → Strong positive correlation.Dark purple → Weak or no correlation.Black or dark red (if present) → Negative correlation.

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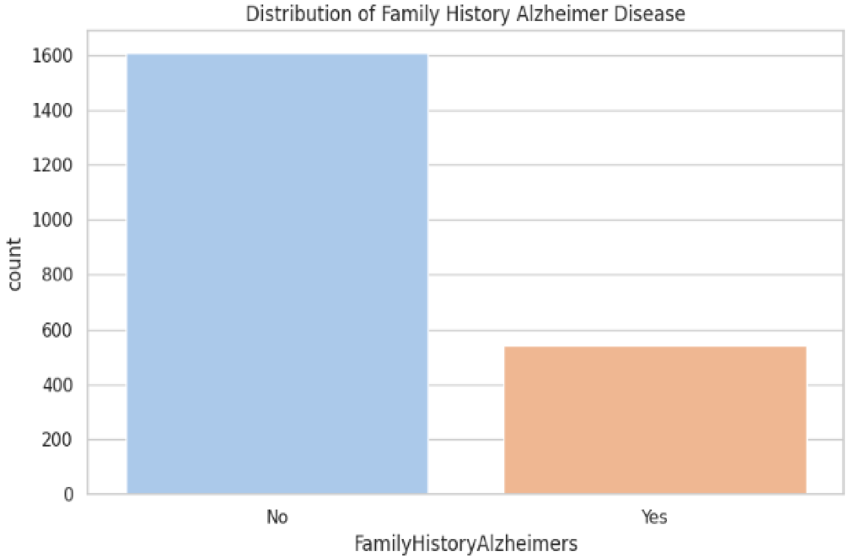

The figure is a bar chart that represents the distribution of individuals based on their family history of Alzheimer's disease.The "No" category (blue bar) has a significantly higher count (around 1600 individuals).The "Yes" category (orange bar) has a lower count (around 500 individuals).This indicates that a majority of individuals in the dataset do not have a family history of Alzheimer's disease.

DISCUSSION

In the Model Prediction for an unbiased comparison, the classification accuracies of all ML methods applied on MRI dataset as well as on text data have been stated. Out of which, neural network outperforms the other classifiers, which assert that our proposed approach in the detection of AD proves to perform better. The accuracy, recall and specificity of our model are significantly better than other approaches. Considering the fact that we are proposing a hybrid method, it can be comprehended that our approach is effective which can actually detect, perform an improved diagnosis and classify healthy and inflicted AD patients.five dense layers are used.we used relu activation function. Our method attains high performance i.e. an accuracy above 80%. Usually, when employing . computer-based methods for diagnosis, a little portion of data is present. Thus, in our modeling, we maintained the ratio of train-test through a random selection. The results of our work are promising. In our both dataset the in data preprocessing phase imputation of missing values significantly improved the diagnostic accuracy of the prevalence of AD. When we compared to the results with that of a non-imputation method of missing values,. This is due to high sensitivity, that our model gave much better results than previous methods applied by other researchers we were able to predict the correct classification of patients as healthy or unhealthy, with a maximum accuracy of the test that can be achieved. Only a handful of features from the longitudinal set of MRI data, contribute to the advanced diagnostic performance of the AD test significantly. Thus, this set of features should not be omitted from the analytical process.

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