

Efficient Machine Learning Techniques to Diagnose and Predict Alzheimer's disease



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Abstract: Recent research in computational engineering have evidenced the design and development numerous intelligent models to analyze medical data and derive inferences related to early diagnosis and prediction of disease severity. In this context, prediction and diagnosis of fatal neurodegenerative diseases that comes under the class of dementia from medical image data is considered as the challenging area of research for many researchers. Recently Alzheimer's disease is considered as major category of dementia that affects major population. Despite of the development of numerous machine learning models for early diagnosis of Alzheimer's disease, it is observed that there is a lot more scope of research. Addressing the same, this article presents a systematic literature review of machine learning techniques developed for early diagnosis of Alzheimer's disease. Furthermore this article includes major categories of machine learning algorithms that include artificial neural networks, Support vector machines and Deep learning based ensemble models that helps the budding researchers to explore the scope of research in predicting Alzheimer's disease. Implementation results depict the comparative analysis of state of art machine learning mechanisms.

Keywords: Alzheimer's disease, Dementia, Deep learning, Machine learning, Artificial neural networks, Ensemble methods.

I. INTRODUCTION

Dementia is a health condition which is linked with memory thinking, behavior and the ability perform daily activities. Alzheimer's disease (AD) comes into the category of dementia which is associated with conditions of thinking impairment and loss in the performance either in the middle age or old age in general. The conditions by which we can determine this problem is by the existence of neurotic plaques within the brain and damage of brain cells progressively. In these conditions signs of dementia are progressed slowly and start troubling the daily life with highest impact. Even though in Alzheimer's disease the effects are higher in elderliness but it is not considered to be an old age condition. In the primary stages patients has a very little loss of memory eventually it will disrupt harmony of daily life. Available treatments cannot hold Alzheimer's disease (AD) from enhancing but due to early days of treatment can prevent the severity in their elderliness followed with healthy old age life. It is stated that the patients count with AD will double in the coming two decades [1], it is estimated that 1 in 5 will be affected in 2050 [2].

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Due to this treatment with precision is required in early stages of AD. Alzheimer's disease is the reason for the 70% of dementia, which is creating havoc in the public health among developed and developing countries. Dementia which is due to Alzheimer's disease is medically distinguished based on cognitive and executive dysfunction, psychiatric symptoms and behavioral problems. It results in trouble in daily functions which lead to deaths. In the last few years detecting Alzheimer's disease has become possible but it is confirmed only after complete postmortem in relation to brain autopsy.

Methods to treat the Alzheimer's disease patients are available since the 20th century end via authorized ideas for cholinesterase inhibitors which shows ranges of disease affected in Alzheimer's disease D. Regular and constant medical supervisions help in coping up with the dementia symptoms but it will not change disease direction. In this decade there has been an incredible progress observed among the Alzheimer's disease of biomarkers discovery. Calculating these biomarkers in the existence of amyloid beta (A β) plaques in brain or in the cerebrospinal fluid, which is a regular practice observed in research. Due to biomarkers discovery we could differentia between dementia and Alzheimer's disease types. By observing the high levels of Alzheimer's disease biomarkers in the non-availability of medical signs it is stated to recognize the potential Alzheimer's disease patients in the early stage. This is the only in treatment of Alzheimer's disease before medical intervention as the as the last trials where failed.

When the drugs used are not successful it will make a fall out with the disease's modification in the initial stages. Major change is observed when change in the course of Alzheimer's disease could be observed clearly. This transformation towards secondary prevention from the indications of diseases can be termed as getting in between the pre-symptomatic at risk individuals in stopping or enhancing the disease onset. Due to the enhancements in the technology we can reach out to the large number of Alzheimer's disease patients and treat them in their enhancing stages as a preventive act. It is important to have a clear knowledge on machine learning before using it for analysis of Alzheimer's disease prognosis. Machine learning is part of artificial intelligence which has many features under its belt. Based on the past it estimates the new events and divides based on the obtained result. It obtains exact results in machine learning deep and thorough understanding of the techniques used is essential. Obtaining the methods and implementing it has a greater chance of seeing positive results when executed accurately and noting out every detail observations.

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To consider, all the methods involved in machine learning are little bit different when related to the general procedures.

For example few are designed based on certain data or on applications which is irrelevant for the different type of data. Due to this reason it is essential to contemplate multiple methods on a training data. There are three types of learning algorithms which are part of machine learning techniques they are: 1. Supervised

learning 2. Unsupervised learning [3] 3. Reinforcement learning. For the given data the method which tries to draw a output by learning is known as Supervised learning. Understanding from a unclassified and unlabeled data by an self developed learning is known as Unsupervised learning. Coincidentally all the algorithms used in Alzheimer's disease are of supervised learning.

It is evidenced in several computations based literature studies that applications of machine learning techniques have been demonstrating significant progress in diagnosing and predicting the symptoms of Alzheimer's in the past few years. Several research studies indicated that application of artificial neural network (ANN) and support vector machine (SVM) and deep learning have demonstrated are extensively used for diagnosing Alzheimer's disease. The major difference in the context of ANN and SVM is optimization level of the solution generated. In case of ANN the solution id locally optimal and in SVM it is globally optimal [4]. It is suggested in few research studies that integration of autonomous and intelligent agents along with neural networks will demonstrate significant impact in diagnosing medical images. In the context of handling larger datasets deep learning could enhance the performance of prediction as it incorporates feature extraction as it primary step. Few researchers also used ensemble methods to enhance the accuracy of prediction. Henceforth there is need of a systematic study of various research articles in the context of analyzing the progress of research in the application of machine and deep learning techniques in diagnosing Alzheimer's disease in early stages.

The rest of this article includes a pragmatic research methodology [5] in section 2 that is adopted to execute the process of the systematic literature review of various studies

that are experimentally implemented in diagnosing the Alzheimer's disease. Section 3 includes the necessity of Alzheimer's disease prediction techniques and classification of distinct prediction mechanisms. Furthermore includes detailed review and systematic analysis of various tools and techniques in diagnosing the Alzheimer's disease. Section 4 details about the research gaps and open research issues that are remained unaddressed.

II. RESEARCH METHODOLOGY

Pragmatic research methodology adopted in this article includes the process of systematic review (SLR) that is identified from [6]. Selection of the highly related research articles from the existing scientific databases viz IEEE, Springer, Science Direct, ACM and most cited articles from Scopus database is considered as a critical aspect in process of implementing a literature study. In this scenario, systematic study helps us to identify the most relevant articles to be reviewed relative to the Alzheimer's disease prediction. This systematic study enables the researchers to determine, validate and amalgamate the experimental studies deduced by various researchers working on Alzheimer's disease prediction. The research protocol followed in the SLR process is detailed as follows:

- Designing a review protocol that depicts complete process involved in the SLR Process that explores various dimensions of research in diagnosing the symptoms and predicting Alzheimer's disease in early stages.
- Formulate Research Questionnaire based on the evidenced PICO strategy to sort out evidence based research articles.
- Selection of the most relevant research articles relative to the Alzheimer's disease prediction.
- Generate synthesis of various selected literature studies to answer the research questionnaire.

Identify the unaddressed research challenges, open issues and research gaps intend towards diagnosing the Alzheimer's disease in medical image data.

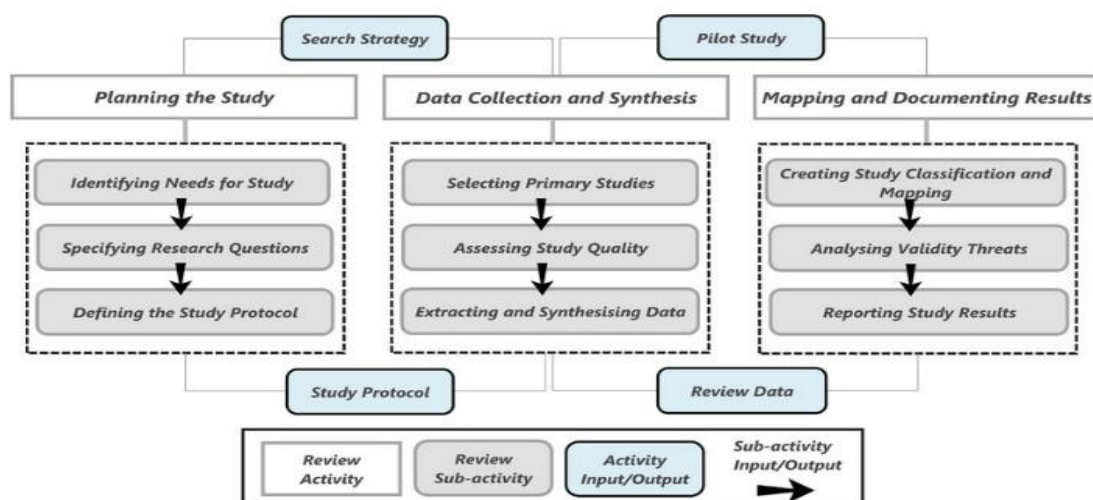


Figure 1: Research Methodology

RQ 1	In what way Machine Learning and Deep learning influences the accuracy of predicting Alzheimer's disease in early stages
RQ 2	Enumerate various existing techniques that are devised for accurate prediction of Alzheimer's disease
RQ 3	What are various datasets and tools utilized for experimental interpretation in existing research studies
RQ 4	What is the current research progression and open research challenges related to diagnosis of Alzheimer's disease symptoms in premature stages

A. Research Questions

The most important phase in the SLR process is developing a research questions that primarily sets and objective for the literature review. Formulating absolute research question streamline the study towards relevant research. In this article, PICO strategy [7] is applied in generating research questionnaire that elevates the quality of the study. The research questionnaire generated on Alzheimer's disease predictions as follows:

B. Search Strategy

The main intention of this study is to identify, analyze and accumulate the relevant research works related to the prediction of Alzheimer's disease in the medical image data using the principles of evidence based research stated in [8]. In this process, data collection and extraction will be executed on the well known scientific databases and indexed journals. The combinations of the search strings are notated as shown in Table 1.

Table 1: Search String employed to conduct SLR process

Alzheimer's disease OR Dementia OR thinking impairment
AND
Prediction OR multi-objective analysis OR multivariate analysis OR Optimization Or Diagnosis
AND
Classification OR Clustering
AND
Artificial intelligence OR Artificial Neural networks OR Time series prediction models
AND
Hybrid Models OR Deep learning Models OR Machine learning Models OR Fuzzy Models
AND
Systematic Study OR SLR OR Mapping Study OR Review

In the preliminary searching mechanism, on using above combination of search strings of the scientific databases that include Springer, IEEE, Science Direct, ACM and Scopus indexed with high citations around 172 research articles are identified in specific to the diagnosing the dementia and Alzheimer's disease symptoms in medical image data based on various technical indices. Table.2 enumerates the quantity of the research papers obtained from various scientific databases.

Table 2: No. of Research articles obtained from various scientific databases

Database	No. of Papers
IEEE	34
ACM	22
SPRINGER	36
SCIENCE DIRECT	35
GOOGLE SCHOLAR	45
Total	172

C. Selection of the relevant research articles

In the previous phase of the data collection, around 172 relevant research articles are extracted from scientific databases based on the interpreted search strings. It is observed that, there is a need of a data filtering mechanism that scrutinizes the relevant research articles based on the relevancy rate of the title and abstract related to problem statement. Furthermore in the initial stage it-self the articles are to be scrutinized based on the inclusion and exclusion criteria specified in Table 3. Finally 32 most relevant research articles are considered for conducting the systematic review.

Table 3: Inclusion and Exclusion Criteria

Inclusion Criteria	Exclusion Criteria
Articles that include classification and clustering mechanisms along with ANN, AI, Fuzzy models and any other hybrid prediction mechanisms	Ambiguous articles without specifying implementation details of the proposed mechanisms and articles those are purely theoretic.
Evidence-based research articles with detailed description of implementation details along with its tools, datasets and test beds	Lecture notes, white papers and theoretic conference articles related to the Alzheimer's disease prediction
Articles that are primarily implemented in the electronics and computer engineering domain	Articles are written in other than the English language
Articles that are written in the English language	

III. MACHINE LEARNING TECHNIQUE FOR DIAGNOSING ALZHEIMER'S DISEASE

A. SVM based Techniques:

For classification and regression problems support vector machine is a notable method you find to use for its stability and wide usage. Good performance is achieved by SVM due to Structural Risk Minimization principle. It uses maximum margin principle to differentiate data points. Kernel functions are used to categorize non linear data to higher data points.

To increase the productivity numerous variants are introduced in relationship with generalization ability and training time.

Few computational efficient variants are twin support vector machines and Least squares based twin support vector machine.

a. Image modality using SVM:

In distinguishing MRI images image modality is a very important one. T1 images are considered mostly for structural images when compared to T2 images. Delineation found in the ventricular surface of brain because of atrophy can be detected accurately in T1-weighted images. Due to this researchers prefer to T1 images.

b. Feature selection and extraction with SVM

Lover et al. [9] stated that positron emission tomography (PET) scans will provide added source to MRI scans in which classification precision of CN vs MCI making use of SVM happens to be increased. Dukart et al. [10] have advantages on this proven fact that fluorodeoxyglucose-PET (FDG-PET) properties is differentiable once associated with MRI. Further, optimism try higher in CN vs AD [11] with PET photographs (100 %) whenever related to single photon emission determined with tomography (SPECT) photographs (97.5 %). Coherent answers are found for CN vs AD [12] with more accurate for PET images (96.67 %) when appropriate to images that are SPECT 94.5 per cent. Kamathe et al. [13] merged T1, T2 and proton occurrence (PD) goes through into areas for CN vs post. Hojjati et al. [14] used state that is resting MRI (rs-fMRI) to obtain the connectivity changes in brain for classification of MCIC vs MCInc, while Sheng et al. [15] utilized connection info from fMRI information. A parcellation that is enhanced is presented in [16] for identifying lesser alterations in grey point (GM). Magnin et al. [17] put forward an attribute option way which utilizes histogram of welfare (ROIs) for CN vs advertising. Gerardin et al. [18] with services of form qualities regarding hippocampus to differentiate CN, MCI and AD, and found summation shape that is stating functions were considerable in comparison to volumetric services. Normalized suggest square error (NMSE) properties can be used [19] in distinguishing CN with very early offer. A clustering oriented approach illustrated [20] for a combined band of adjacent voxels in division of CN, MCI and offer. Fisher discriminate ratio (FDR) is considered [21] in identifying voxels that are useful properties (VAF) from SPECT imagery Gaussian blend unit (GMM) is utilized in [22] for CN vs AD. GMM dependent feature draws the actual data linearly separable was proposed. PET and sMRI information is regarded as by Ortiz et al. [23] in knowing the best distinguishing the items utilized considering simple inverse covariance estimation (SICE) way with SVM. In classification of CN vs post, Non-negative matrix factorization (NMF) are optimum in comparison to PCA with SVM counting on their items.

Moreover, Abdulkadir et al. [24] described the total results of hardware heterogeneity on the category precision of SVM. They can find the confidence that is high of category abilities for large trials. SPM properties for CN, MCIC, MCInc, and advertising aren't competitive with DARTEL which can be recommended by Cuingnet et al. [25] significantly less classification reliability try obtained by function option tips when accomplished for sMRI photos for the reason that improvement of hyperparameters. Moreover levels situated features are thought to better than voxel based morphometry (VBM) as stated by Schmitter et al. [26].

Morphological features of brain parts are used by Plocharsky et al. [27] to branch <blank> CN vs advertising, while extended et al. considered shape distinctions as issues' of mind in categorizing of CN, AD, sMCI, and pMCI.

Many performs come from the Wavelet established qualities. Chaplot et al. [28] utilized wavelet that is discrete (DWT) characteristics, while Zhang et al. [29] inferred that 3-D DWT and SVM become useful in identifying of CN, MCI and advertisement subjects. Segovia et al. [30] found least that is partial (PLS) equipment provides larger FDR rating whenever linked to principal component assessment (PCA) for CN vs AD using SPECT photos. Ortiz et al. utilizes self organizing maps (SOMs) [31] among unsupervised segmentation of sMRI images in distinguishing of CN vs post. However, Chaplot et al. [28] arrived to know that SVM performance is actually higher to SOM once identifying of Alzheimer's patients predicated on T2-weighted images. Techniques like SVM-RFE [32, 33] utilize feature that is optimized approach in [34] to select prominent brain characteristics for CN vs AD. Separate component research (ICA) employs works that are many, [36] for distinguishing of CN vs advertising using SVM. EEG information is furthermore ideal for distinction of CN vs advertising using SVM. Mazaheriet al. [37] used EEG tracks from phrase awareness oriented subject areas in category of MCIC from MCInc and CN.

B. ANN based Mechanisms

Artificial neural networks (ANN) presented considers machine learning models for highly nonlinear patterns of data. Here we reviews the methods which rely on ANNs and other methods.

a. Transfer Learning

Traditional machine training designs if the wide range of products offered is extremely lowest it considers samples of a unmarried domain name anywhere their performance is actually very impacted. The strategy in which types of target website and other reliable domains tend to be regarded is proven to be move reading. a manifold that is multimodal exchange studying (M2TL) is reported by Cheng et al. [38] with the purpose to convert understanding acquired from a reliable site (CN against AD) to simply help in mastering the mark domain (MCIC vs MCInc). Further jobs of Cheng et al. [39] directly came with an idea of a book multi-domain transfer learning model (MDTL).

Deep transfer learning is used by Hon et al. [40] to carry out sample that is small difficulty in teaching deep neural systems by changing two common pre-trained networks - artistic geometry cluster 16 (VGG16) and beginning from the target chore of classifying advertising and CN issues. TrAdaBoost formula is considered to transmit info TrAdaBoost formula by Zhou et al. [41]. Shifting insights without looking at problems leads to class and degradation labeling would be completely wrong. In passing these circumstances, Robust multi-label transfer learning (rMLTFL) approach which modifies the first labeling on to a multiple bit tag programming vector are suggested by Cheng et al. [41].

Li et al. [43] transfers' facts extracted from ADNI trials into the trials acquired locally through the subspace positioning algorithm.

b. Feature Selection Method

Most practices are reported for better feature selection (FS) from neuroimaging information. Ahmadlou et al. [44] suggested non-linear services which may reveal noteworthy distinctions among particular EEG sub-bands however may well not aid in categorizing the 2 teams (CN and advertisement) within band-limits of EEG. To take care of this, exposure graphs (VG) are considered in services extraction from EEG indicators. Short period of time Fourier change (STFT) and WT attributes include used Rodrigues et al. [45] to categorize according to ANN. a trait of AD is the reduction in GM and WM areas which leads in diminishment of varied parts and WM tracts loss of GM and WM volume. This is also followed closely by boost in size of ventricles and CSF levels. Yang et al. [46] created a category framework for which GM, WM are together. CSF volumetric properties can be found in ventricular 2D and shape that is 3D. Using surface formulated morphometry to get down features that are cortical choice method for removing properties from MR artwork. Making use of cortical depth data Cho et al. [47] stated robust classification method that is

incremental. Using manifold transform that is harmonic is changed into spatial regularity. Various other types of information like neuro-psychological and physiological studies, hereditary makeup and class tends to be examined beside with MRI SCANS.

Using ANN Quintana et al. [48] improved data from neuropsychological reports, era and training in differentiating MCI and post. a book wrapper feature choices method was claimed by Chyzyk et al. [49] which gather GA along serious training machine (ELM). Into the works that are continuous et al. [50] regarded volumetric and shape services like a team. A novel method is stated to select important ROIs using SOM by Ortiz et al. [51] Wang et al. [52] used a hybrid PSO with the artificial bee colony (ABC) optimization algorithm along with a feed forward neural network (FFNN) in pointing out the problems of prior knowledge in manual ROI selection and high dimensionality in whole brain multivariate analysis. Removing properties from particular ROIs with the mind is just a method that is famous dealing the difficulty of large dimensionality of entire head research to extract services from certain ROIs on the brain. Element past knowledge will come as being a drawback. Table 4 shows the summary of big studies in earlier three years

Table 4 in Summary of Significant studies in past three years

Year	Authors	Target	Modality	Feature extraction	Machine learning	Dataset	Validation	Performance		
								Acc (%)	Sens (%)	Spec (%)
2016	Moller et al.	CN vs AD	sMRI (T1)	VBM	SVM (Linear)	178 (94 CN, 84 AD)	LOOCV	85	83	87
2016	Plocharsky et al.	CN vs AD	sMRI (T1)	Morphological features (length, area, depth)	SVM (Linear)	210 (100 CN, 110 AD)	10-fold	87.9	90	86.7
2017	Alam et al.	CN vs AD	sMRI (T1)	VolBM+KPCA	SVM (Multiple kernel)	293 (102 CN, 102 MCI, 89 AD)	10-fold	93.85	92.1	94.45
		CN vs MCI						86.54	84.85	87.74
		MCI vs AD						75.12	73.92	77.24
2017	Khedher et al.	CN vs AD	sMRI (T1)	ICA	SVM (RBF)	818 (229 CN, 401 MCI, 188 AD)	k-fold	89	92	86
		CN vs MCI						79	82	76
		MCI vs AD						85	85	86
2017	Beheshti et al.	CN vs AD	sMRI (T1)	VBM+GA	SVM (Linear)	458 (162 CN, 65 sMCI, 71 pMCI, 160 AD)	10-fold	93.01	89.13	96.8
		pMCI vs sMCI						75	76.92	73.23
2017	Long et al.	CN vs AD	sMRI (T1)	MDS+PCA	SVM (Linear)	427 (135 CN, 132 sMCI, 95 pMCI, 65 AD)	10-fold	96.5	93.85	97.78
		CN vs pMCI						97.1	87.37	94.82
		sMCI vs pMCI						88.99	86.32	90.91
2017	Tangaro et al.	CN vs AD	sMRI (T1)	VolBM	SVM (Linear)	372 (117 CN, 86 MCIc, 71 MCInc, 98 AD)	10-fold	100	-	-
		MCIc vs MCInc						83.4	-	-
2017	Lu et al.	CN vs MCI	FDG-PET	VBM	RF-RSVM	272 (152 CN, 120 MCI)	3-fold	90.53	90.63	93.33
2017	Alam et al.	CN vs AD	sMRI	DTCWT/LDA	TWSVM	237 (130 CN, 137 AD)	10-fold	96.88	97.72	95.61
2017	Hojjati et al.	MCIc-MCInc	rs-fMRI	PCC+F-score	SVM (Linear)	80 (18 MCIc, 62 MCInc)	9-fold	91.4	83.24	90.1
2017	Kulkarni et al.	CN vs AD	EEG	ICA/ Wavelet/ Spectral	SVM	100 (50 CN, 50 AD)	LOOCV	96	-	-
2018	Sun et al.	CN vs AD	sMRI (T1)	VBM+PCC	Group lasso SVM	509 (162 CN, 134 sMCI, 76 pMCI, 137 AD)	5-fold	95.1	93.8	83.8
		CN vs MCI						70.8	72.1	69.1
		sMCI vs pMCI						65.4	67.6	64.2
		MCI vs AD						65.7	63.2	67.3

C. Deep Learning technique for predicting Alzheimer’s disease

Diagnosis accuracy of post, MCI and MCIc can be improved as put on SAE as previously mentioned by Suk et al. [53] it reveals correlations that are nonlinear. Suk et al. [54] used patch-based characteristics of MRI, and PET in differentiation of advertisement and MCI from CN by strong Boltzmann maker (DBM). 3D-CNN performance is great in classification of AD, MCI from CN when SAE and CNN are positioned collectively through the learn of Payan et al. Suk et al. [56] made use of DL-based figures to describe advertisement, MCI, CN, and MCIc from MCInc having an classifier that is SAE-based. Obtaining advanced level

properties and soft-max logistic regressor Liu et al. [55] utilized SAE based DL architecture to cure AD in four levels. to differentiate advertisement and MCI fromCN, (LR). Hosseini et al. [57] claimed ahightly checked adaptive 3D-CNN (DSA-3DCNN) which is trained before by 3D convolutional autoencoder (3D-CAE) centered on MRI.. Ortiz et al. [58] Work by Ortiz et al. [58] is that dependent on mechanized anatomical naming (AAL) chart book 3D

patches are gotten and prepared DBNs.



At the point when highlights are separated utilizing DBN (FEDBN-SVM) engineering best characterization exactness is accomplished . Three biomarkers for Alzheimer's sickness determination for example X-ray, PET, CSF and so on are assembled to recognize solid and AD members by D. Zhang et al. (2011).Among 202 occasions, 51 were AD, 99 were MCI and 52 were controls that are solid is pattern information used by the creators. Numerous tests were held for MRI, PET and CSF and the blend of these utilizing 10 crease cross approval. 93.2% with 93% affectability is the precision for characterizations and 93.3% explicitness is because of the fellowship of these modalities when individual test has recorded most elevated exactness of 86.5%. Predictable robustis and improvement noted by multimodal characterization technique (utilizing all MRI, PET, and CSF) in view of the creator over number of chosen mind areas. The informational collection of 96 AD and 273 sound controls, marked by master doctors , FDG-PET can be costly and it is interesting to see how the system of Zhang et al. is applied with simply the two MRI and CSF, yet this data isn't displayed. Cuingnet R1, 2011 strategy has gotten most noteworthy when contrasted with the vaue of 91.8% consolidated to MRI and CSF. It is simpler to lead R. Chaves et al., (2010) to present a characterization strategy for starting finding than Single Modality Approach. The connections between properties of the pre-handled collections that are informational recovered by affiliation rule mining

IV. RESULTS AND DISCUSSION

While in the representation research, each unit carried out 68 occasions in the simulation experiment according to different tests sets, whenever VBSD dataset can be used 36 occasions and Dem@Care is employed 32 circumstances. Each fresh outcome is determined in line with the integration of all of the testing arranged identification listings. Figure shows that the visualization of this experimental outcomes of various metrics and sizes. Through the fresh results, it may be viewed that the LogisticRegressionCV, LinearSVC and MLP versions perform well in both the VBSD dataset while the Dem@Care dataset. Through the experimental effects, LogisticRegressionCV gotten the finest performance weighed against more category practices. Included in this, F1-Score achieved 86.9% throughout the VBSD dataset and 89.4% from the Dem@Care dataset.

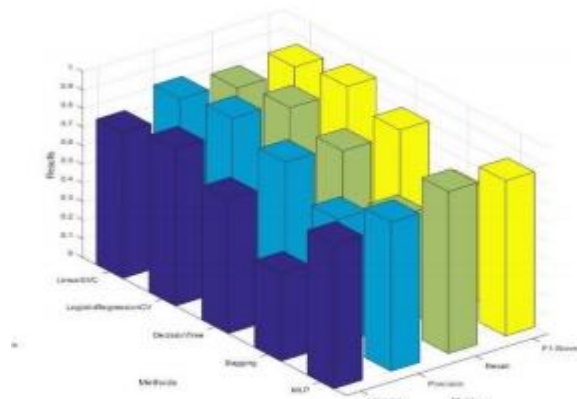


Figure 2: Simulation of Machine learning Models to predict Alzheimer disease

LinearSVC and MLP models play fairly really that their unique reliability attained above 70%. Nevertheless,

DecisionTree and Bagging obtained poor overall performance because DecisionTree can be so easily producing a model that is complex that renders the generalization potential conduct not really. Additionally, moreover it comes with the disadvantage of uncertainty. Limited changes of data can lead to different tree generation. The training sets and testing sets in this simulation experiment are located in continual modification, and decisionTree classifier performs thus badly within this simulation experiment. The bottom classifier of Bagging picks DecisionTree classifier, therefore the results of Bagging generally is dependent on the reliability associated with base classifier. Given that benefit, the classification efficiency of Bagging can also be bad. The distinctions in code and enunciation between countries aren't regarded as in mixing the two datasets in simulation experiment.

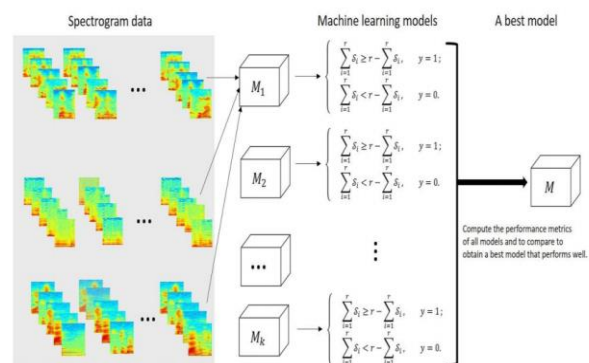


Figure 3: Deriving efficient machine learning model for predicting Alzheimer disease

V. CHALLENGING ISSUES AND RESEARCH GAP

The studies which are briefed in the last section are few examples stating the method to conduct machine learning experiments and the results are impressive. These studies claimed the procedure of validation on outcome and explained the prognosis and prediction of AD. Yet identifying the potential issues of input data for implementation and validation for various studies is essential. When the analysis of the described studies are reviewed the input size, attributes and validation are the most common problems by using small data sets higher accuracies can be obtained easily but those procedures are simple . Overtraining is prone with small data set and with large data size several results like robustness, accuracy and reproductivity is observed.

Research is principally on pathologically dubious information which can present equivocalness. The ascribes to example proportion have sway on results. In the past examinations, consideration is gesture paid on the number and general data of traits. Information quality and significant property determination are vital in AI for successful outcomes age. Sadly, the creators once in a while portrayed the strategies used to guarantee the information honesty and quality. Choice of highlight is significant for information quality. In any case, the highlights picked for some clinical information, for example histological evaluations may not be pertinent after some time.

VI. CONCLUSION

This article mainly focuses on presenting the detailed review of research works that includes various techniques and intelligent models developed for early diagnosis of Alzheimer's disease. In this study, research works based on major categories of machine learning techniques like artificial neural networks, Support vector machines and Deep learning based ensemble models are reviewed in detailed manner. Apart from that, techniques based on ensemble models and transfer learning is discussed. It is inferred from the systematic literature review that current trend of research in predicting Alzheimer's disease is focused on the feature extraction than the clustering and classification phase which can be considered a future scope of research for accurate diagnosing Alzheimer's disease.

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