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Thesis: “Alzheimer disease detection on MRI scans using Machine learning techniques.”

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Declaration

I, Jannatul Loba, hereby swear that the material provided below is my original work, and that it's not been published or submitted somewhere for a degree program prerequisite. Any references to literature or work done by others that are mentioned in this thesis have been acknowledged and listed in the reference section.

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Abstract

The brain is one of the most important organs of the human body and is involved in important functions of the human body. Many types of brain disease Alzheimer's disease is one of them. It's a very harmful and long-term illness. AD is a progressive neurological disorder. There is no cure for this disease, but early diagnosis and regular and correct treatment allow patients to lead a normal life. The disease is common in people who are under extreme stress and have been studying for a long time. The disease is more common in middle-class countries, but it is increasing in today's high-income countries. The immune system of patients with this disease gradually deteriorates, and as a result, patients suffer from a wide variety of complex illnesses. In this dataset, 400 brains were scanned by MRI scans. Using measurements from different parts of the brain of 165 people, we predict how accurately a person will develop AD through several machine learning algorithms. ML is a simple approach that can be used to determine a person's current state without human help. Due to the advantages of this approach, ML is very popular. This paper uses scans the brain via MRI and uses the score of the part that causes AD to identify whether a person with AD is infected via the Machine Learning approach. This paper details the machine learning model to be monitored.

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Chapter: 1 INTRODUCTION

1.1 Background

Dementia seems to be a neurological condition that primarily affects the elderly [1]. Abnormal rupture of brain tissue is the main cause. By 2050, the number of people living with this condition is expected to reach 152 million. Genetic problems are the cause of 1% of people and 2% of the younger generation. This disease affects 1 in 85 people. Hypertension does not impact all types of memory, such as situational memory, implicit memory, or semantic memory, and it does influence some of them. It does not significantly affect the memory of new things. [2]. Spreading depends on the methodology of 4,444 white blood cells, gray matter cells, and the thickness of the cortex of the brain. Although this disease is incurable and expensive to treat, early treatment can keep patients healthy for long periods. Elevated amyloid proteins inhibit the neurodegenerative process. As a result, signal conversion in the brain is stopped and the cells in the brain gradually dry out. The early stages of AD begin when the hippocampus is damaged. The hippocampus is involved in the conversion of limited attention span to questionable past. It also serves like a memory bank. [3]. White matter is the deeper tissue of the brain that is part of the sub cortex and is connected to the axons of neurons. Gray matter is the processing of the actual function of the brain, and white matter maintains connections between gray matter. The dendrites of neurons are made of gray matter. The thickness of the cerebral cortex contains one million nerve fibers that serve as the main conduit for information from the brain to the spinal cord. MRI can be used to monitor the condition of the hippocampus and ventricles [4]. Damage to the medial temporal lobe (entorhinal cortex and hippocampus) is

the main cause of this condition [5]. This disease gradually reduces glucose metabolism and hippocampal volume [6]. The ventricles function as a communication network, filled with fluid (CSF) and located in the parenchyma of the brain. Ventricles of the brain act as a communication network and are filled with cerebrospinal fluid (CSF) and reside in the parenchyma of the brain. Memory, navigation, and the perception of time are added here by acting as a hub in the entorhinal medial temporal. A patient cannot recognize, gesture, or understand because the fusiform gyrus of the brain is damaged. Patients with AD cannot remember family, friends, special moments, or even make the right decisions. Can't speak speed or keep the order right. The same question is asked over and over again. But basic information about the brain is very easily available through MRI techniques, which makes it easy for doctors to detect the disease at an early stage [7]. There is no cure for this disease but with proper treatment, the patient can be kept healthy for a long time. However, it is possible to keep the patient healthy for a long time only if the diagnosis is possible at an early stage. It is very challenging to detect this disease at an early stage [8]. Only 2% of young people have this disease [9]. The progression of moderate memory loss to vascular dementia can be illustrated using (MRI) [10]. Features of MRI give a perfect score of the parts of the brain like hippocampi, parahippocampal, and amygdalae which are responsible for AD disease [11]. MRI is the most effective and popular neuroimaging technique. This technique can detect early-stage or mild dementia of the patient and the best results are obtained. This disease is more likely to occur in people over 65 years of age. It has an impact on lower-middle-income countries. In high-income countries and its prevalence can be seen. Allele $\epsilon 4$ the Apolipoprotein E gene (APOE $\epsilon 4$) has also been reported. It is crucial in the development of Alzheimer disease. Whether a dataset contains Apo lipoprotein has been used to determine the accuracy of a person's brain. In most cases, patients

do not survive more than 5-6 years. However, by observing patients who have been found in the early stages of the disease and are receiving appropriate treatment, they can lead a healthy and normal life.

1.2 Research Objectives

The general goal was to determine the Alzheimer Disease Assessment purposes are of this study to compare the effects of various factors such as age, gender01 (0=male, 1=female), educational years, background, APOE4, APOE43, Tau80, Ptau protein, etc. with the development of Alzheimer Disease.

Specific objective is use in this article:

- Basics of MRI characteristics.

This is the impact of patient-related factors on the severity of AD. The goals play a role in this article on Alzheimer's disease.

1.3 Motivation

- In the future, study may improve in the understanding of Hypertension and its early stages.
- MRI scan allele $\epsilon 4$ also helps find Apo lipoproteins in each cranial nerve.
- This paper explores Receiver Operating Characteristic (ROC) Curve scores which is evaluate the accuracy of model.
- In This research also explores different types of supervised model evaluate and find out high accuracy this can be very helpful for those who want to write about this later.
- ML is evolving rapidly in the medical industry, from disease diagnosis to visualization to disease transmission research.

1.4. Limitations of this study

- Small number of data.
- There has unwanted outlier.

1.5. Problem Statement

Today, Alzheimer disease is a common sickness on the universe. This disease affects 1.5 billion people. This means that every 3 seconds one person with dementia becomes infected with Alzheimer's disease. As the number of people with Alzheimer's disease keeps rising, this will exceed 1 billion by 2040, which is a massive group of patients. Inside this long run, that there will ever be a cure for this illness.

1.6. Thesis Organization

This article is divided into several chapters. Where Chapter 1 introduced works related to this research. In Chapter 2, review all the materials that helped to write this article. In Chapter 3, the entire process was highlighted for completing this study. In Chapter 4 shows what we actually have in this study. And of last Chapter 5 refers to the summary of this study.

Chapter: 2 LITERATURE REVIEW

A new way to identify AD using spectrogram features extracted from audio data. This allows the family to understand the patient's disease progression early and take steps to delay the onset of the disease in advance [12, 25]. The proposed method of instance-based representation using multiple kernel learning enables the detection of mild cognitive impairment and the prediction

of conversion to Alzheimer's disease [13]. Purpose of this study is to consider the use of support vector machines (SVMs) in the prediction of dementia and to verify their performance through statistical analysis. The data come from a vertical collection of open access series imaging studies (OASIS2) of 150 subjects from 373 MRI data [14]. This article compares the strengths and weaknesses of using deep learning techniques in the field of Alzheimer's disease [15]. In this article, Support Vector Machine (SVM) model techniques are used to classify and predict various Alzheimer's disease processes based on structural imaging data from magnetic resonance imaging (MRI) of the brain to assist in assistive diagnosis of the disease [16]. The Bag of features module was used to classify MRI of the brain with tumors and MRI of the brains of patients with Alzheimer's disease from normal brain MRIs [17]. In this paper, implemented Convolutional Neural Network (CNN) for the earlier diagnosis and classification of AD using MRI images [18, 33]. A deep learning method for distinguishing between Alzheimer's disease patients and healthy patients from 2D anatomical sections obtained by magnetic resonance imaging [19]. In this study, mainly used DCNN and computer algorithms such as transfer learning to evaluate AD classify [21]. This article proposed approach is based on speech processing for efficient feature extraction, followed by a selection of the significant attributes that lead to increase accuracy and minimize computational costs. The selected attributes are then forwarded to machine learning classifiers, in order to obtain pertinent results in different stages of AD classification [22, 23]. Implement a convolutional neural network (CNN) for AD detection and staging in magnetic resonance imaging (MRI). Implementation method begins with basic pre-processing techniques: Image size adjustment, pixel normalization, and extracted features are reconstructed into a one-dimensional vector and sent to the CNN along with the label [24]. This paper 1.predicts future Mini-Mental State Examination (MMSE) scores in

longitudinal studies and 2. Recurrent neural for adopting a multimodal neuroimaging classification process in multiple classes of three different classes. Suggested implementation of networks (RNNs) Known stage diseases of Alzheimer's disease include advanced, cognitive normality (CN), mild cognitive impairment (MCI), and Alzheimer's disease (AD). [26]. Scratch-trained CNN or pre-trained Alex net CNN as a common feature extractor from 2D images. The dimensions are reduced by PCA + TSNE and finally classified by simple machine learning algorithms such as KNN and Navies Bayes Classifier. [27]. This article focuses on the detection of Alzheimer's disease on magnetic resonance imaging (MRI) scans using deep learning techniques. [28]. This paper uses machine learning algorithms to predict the Alzheimer disease using psychological parameters like age, number of visit, MMSE and education [29, 31]. This task examines the generalizability of MRI-based classification of Alzheimer's disease patients and controls (CN) with external datasets and the task of predicting the conversion of people with mild cognitive impairment (MCI) to AD [30]. This study showed that plasma metabolites may be consistent with the AUC of the AD-CSF biomarker established in a relatively small cohort. Further studies in an independent cohort will be conducted to verify whether this particular panel of blood metabolites can isolate AD from controls and how specific it is to AD compared to other neurodegenerative diseases. [32].

Chapter: 3 RESEARCH METHODOLOGY

The main purpose of this paper is to detect whether the patient is Preclinical or Non- Preclinical using MRI technology. By label, the encoder converted the categorical data into numeric data. Dataset entered using the median had many zero values. The median value is not affected by

outliers, so accurate results are obtained. Use MinMaxScaler to balance the data so that it was in the 0-1 range. Feature selection is an important step because it is easy to understand which reasons are more responsible for AD disease. Three main steps have been used to classification the data such as 1. Precision, 2. Recall, 3. F1-Score. Data has been split by the train-test split. The amount of different types of proteins is right or more than necessary which is harmful to the nerves of the brain, the doctor understands through the MRI scanner. MRI initially notes the points of several types of tests. First analyzes several types of test points, patient's gender, age, marital status, educational experience, etc. To detect through the machine learning approach just need to measure these points. Exploratory data analysis is used to visualize the correlation between features. ML has been used to find the score of brain measurement score. This dataset quit imbalance data which is big problem to predict actual result. This is why have to use a few models of machine learning here. At the same time, roc curve classification was used to maintain the accuracy of all models. A roc curve is a tool that probably predicts all binary outcomes. True positive rate is calculated using the ROC curve, which divides the true positive rate by the overall number of correct and false negative. This shows how well the model can predict a positive class if the actual result is positive. Models performed are:

1. Manually selected MRI function,
2. Automatic important features selection.
3. A single model using ensemble learning or hybrid modeling.
4. Using ROC Curve Classification.

In this study dataset has been processed by below steps which are already follow for completely this article.

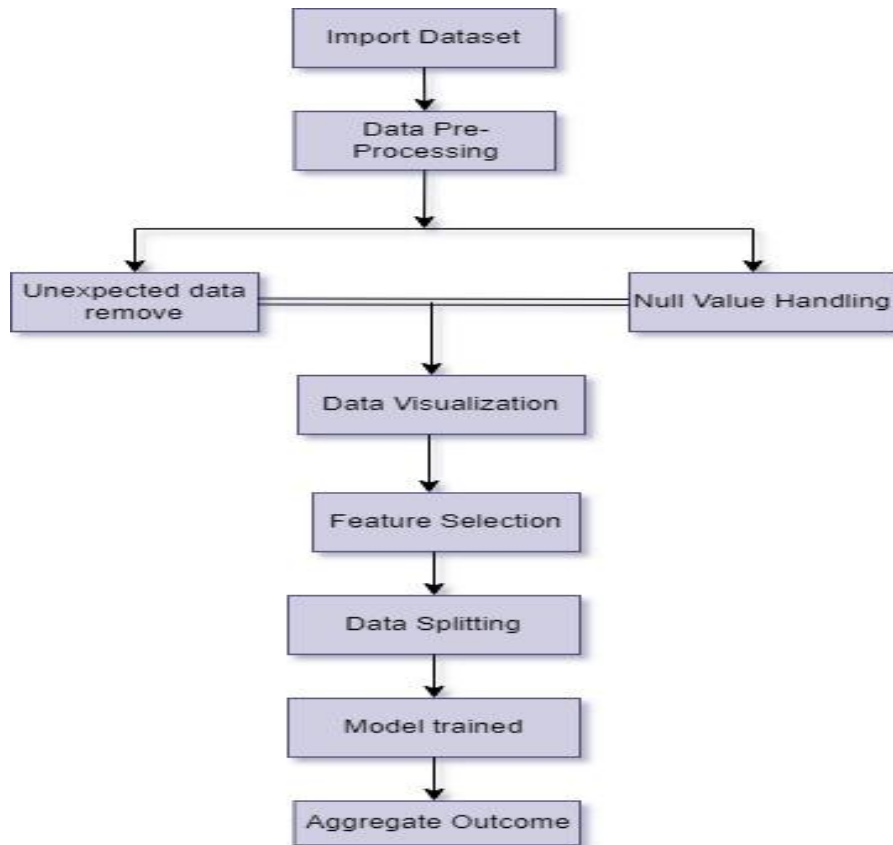


Figure No: 1- Processing Task

Fig. 1 is showing the steps are following to complete the article which are very helpful for other the next time implement this related paper.

3.1. Feature Selection: By using the Selectkbest function, the top 10 data that are the primary causes of a person being Preclinical or Non-Preclinical is chosen once the features are picked. For feature selection use to Selectkbest function which is more effective function in our dataset because this dataset is so much imbalance data. Selected attribute and details included in Table-

1

ATTRIBUTES

DETAILS

ABETA1700	A1-42 can cause the pro-inflammatory cytokine interleukin-1 (IL-1) to be produced by immune cells both inside and outside the nervous system.
ABETA12	It's made whenever a large type of protein amyloidogenic peptide begins to break down. One type, beta-amyloid 42, is thought to be particularly harmful.
APOE4	Lipoprotein Apo (Apo lipoprotein) A piece of DNA is found in 25% of people, so it allows fat to develop in brain cells.
APOE4B	Apo lipoprotein (APOE) is a protein associated with lipid particles that is essential in the transfer of lipoprotein-mediated lipids among tissues, blood, and interstitial fluid.
AV45	APOA5 is a newly discovered Apo lipoprotein that has been originally related to a triglyceride (TG) metabolic problem.
FDG	Fluorodeoxyglucose. FDG is a glucose analog that is actively transported across the whole blood-brain.
VENTRICLES	Ventricles are hollow communication networks that are filled with fluid (CSF) and are located within the brain parenchyma.
HIPPOCAMPUS	Here, short-term memory is also converted to long-term memory. These are then stored in the brain.
ENTORHINAL	Entorhinal cortex (EC) is a region of the allocortex of the brain located in the medial temporal lobe, whose functions include extensive network nodes for memory, navigation, and time perception.

FUSIFORM	Fusiform gyrus is a large region in the inferior temporal cortex that plays important roles in object and face recognition, and recognition of facial expressions is located in the fusiform face area (FFA)
TAU80	Tau protein serves as an internal support for neurons and exchanges for other important materials.
PTAU8	Amyloid beta protein. This is a large membrane protein which is normally plays an essential role in the growth and repair of nerve cells.
CDR	Stage of dementia Instrument Alzheimer disease and related dementias: Memory, Orientation, Judgment & Problem Solving, and Community Affairs.
GENDER01	In this dataset by 0, 1 mean that 0=male and 1=female.

Table-1: Selected Feature with details

3.2. Data Visualization: Evaluate the correlation between the selected characteristics following feature selection.

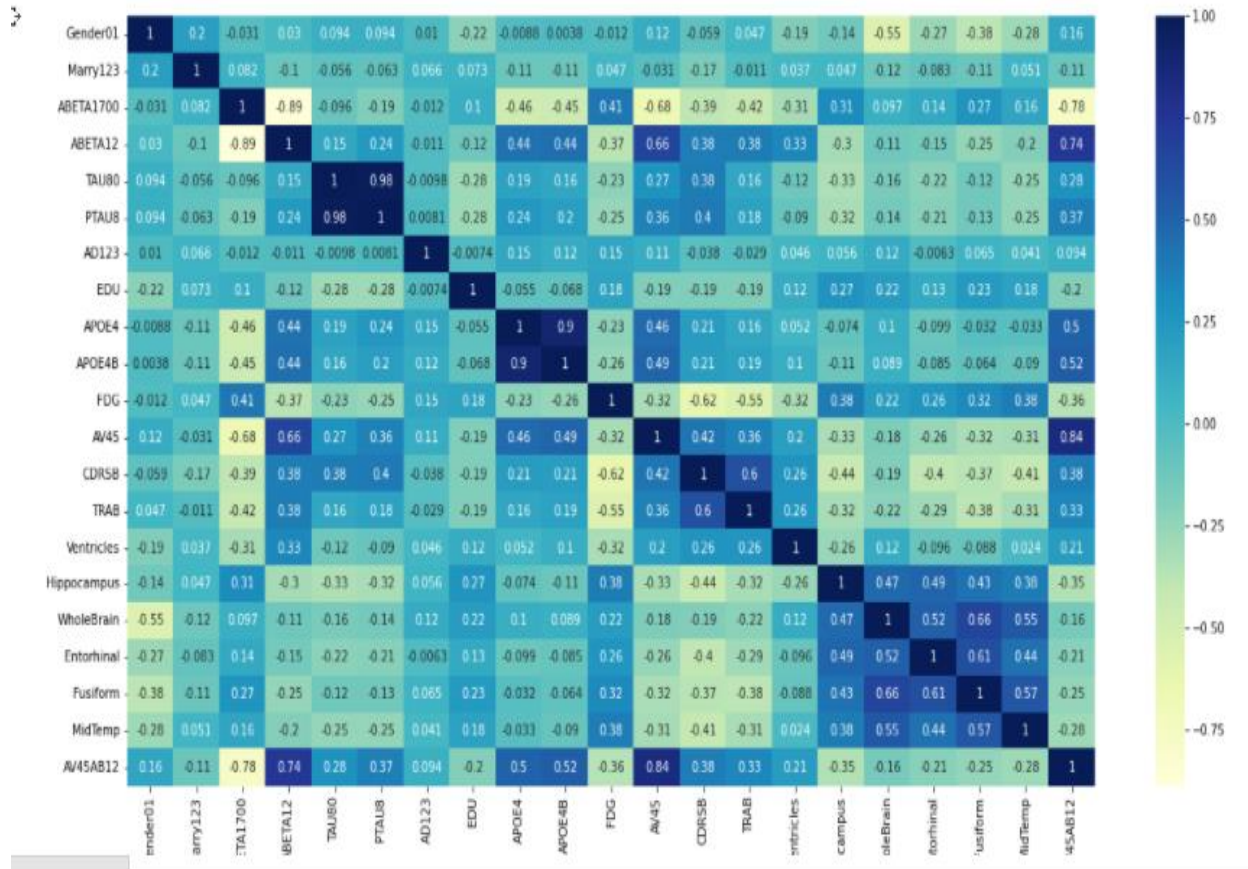


Figure No: 2- Relation in Feature Selection Data

3.3. Model Classification: Incorporate the following There are some features mentioned here are extremely important in understanding these confirmed the effectiveness.

3.3.1. Logistic Regression: The most typical application of logistic regression is to solve classification problems. Binary and polynomial classes are the two different forms of logistic regression classes. The binary class was used for this data set because of output column has two prediction classes. For linearly separated data, logistic regression is appropriate. In logistic regression, the risk of over fitting is low.

3.3.2. Support Vector Classification: Both classification and regression issues are solved using the SVM technique. SVM is more prevalent in data sets that are small to medium in size. SVM has the advantage of being able to distinguish between linear and non-linear objects. SVM is a memory-efficient method for dealing with high-dimensional spaces.

3.3.3. K-Neighbors Classifier: This concept is most commonly found in classification algorithms. This article's dataset is essentially a classification dataset. The kNN algorithm is simple to implement. Because it learns data at data prediction time rather than during data train, the KNN method is one kind of lazy algorithm.

3.3.4. Gaussian Naïve Bayes: It's simple and classification algorithm to use and gets it done quickly. Working with little datasets is a simplicity. The accuracy of this algorithm is slightly lower than that of other techniques. In the Navigator, all attributes are regarded totally independent. Naive Bayes Classifiers are easy to develop and execute.

Chapter 4: RESULTS & DISCUSSION

The goal of this study was to employ four supervised models to assess AD based on MRI findings. Models such as Logistic Regression, Support Vector Machine Learning, K-Nearest Neighbor, and Gaussian Nave Bayes must be recognized. The accuracy of the model was assessed using Receiver Operating Characteristic (ROC) Curve scores and ROC works with true positive rate and false positive rate. We created four separate experiments in which we tested the model and evaluated its performance using distinct MRI features. In this dataset, supervised algorithms predict varying levels of accuracy. Interfering with noise, error, and geographical values in the dataset to predict actual values. This is why the exploratory data,

null value handling, data sampling, label encoder, minmaxscaler, and undesired data are being handled in the first place. There was also a score classification based on the use of a name of the table is Table-2:

Machine Learning Classifier	Predicted Output	Accuracy	Precision	Recall	F1-score
Logistic Regression	0: Non Predicted	0.98	0.95	1.00	0.98
	1: Predicted		1.00	0.97	0.98
Support Vector Machine	0: Non Predicted	0.92	0.84	1.00	0.91
	1: Predicted		1.00	0.87	0.93
K-Nearest Neighbors	0: Non Predicted	0.88	0.78	1.00	0.88
	1: Predicted		1.00	0.80	0.89
Gaussian Naïve Bayes	0: Non Predicted	0.96	0.91	1.00	0.95
	1: Predicted		1.00	0.93	0.97

Table-2: Model Comparison

This table represented various types of model comparisons with accuracy, precision, recall, and f1-score. Which the best performance in this dataset. True positive, true negative, false positive, and false negative are denoted by the letters TP, TN, FP, and FN, respectively. The following are the performance measures:

$$\text{Accuracy} = (TP + TN) / (TP + FP + FN + TN)$$

$$\text{Precision} = TP / (TP + FP)$$

$$\text{Recall} = TP / (TP + FN)$$

$$f1\text{-score} = 2 * \text{Precision} * \text{Recall} / (\text{Precision} + \text{Recall})$$

By this classification model easily find out that a person Preclinical or Non-Preclinical. A confusion matrix is a summary of categorization problem prediction outcomes. The number of accurate and incorrect predictions is totaled and decomposed by category using counting metrics. Visualize Confusion Matrix by 4 models which are: 1. Gaussian Naïve Bayes, 2. K-Nearest Neighbor, 3. Support Vector Machine, 4. Logistic Regression.

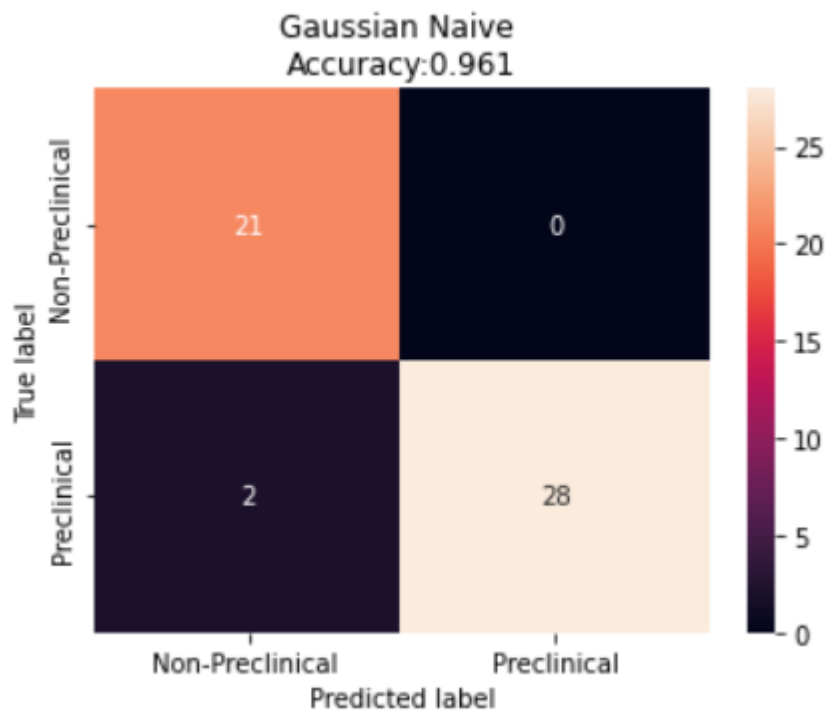


Fig No: 3- Gaussian Naïve

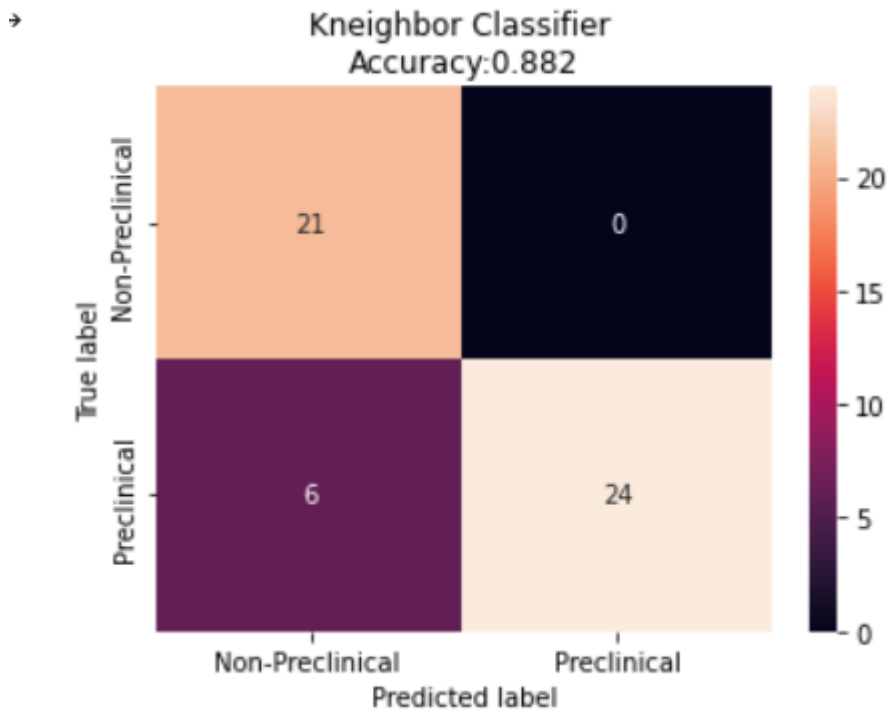


Fig No: 4- K-Nearest Neighbor

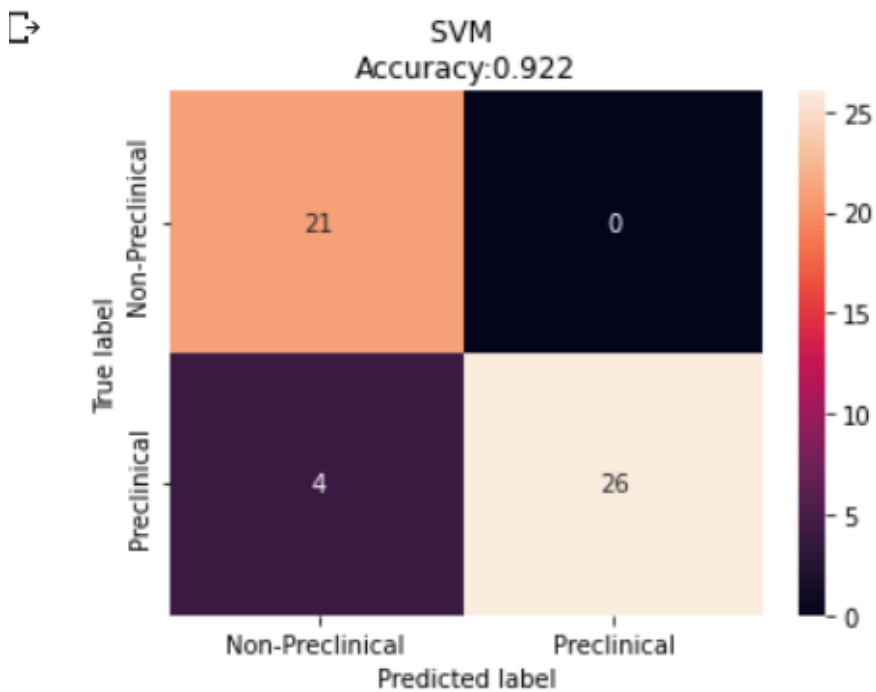


Fig No: 5- Support Vector Machine

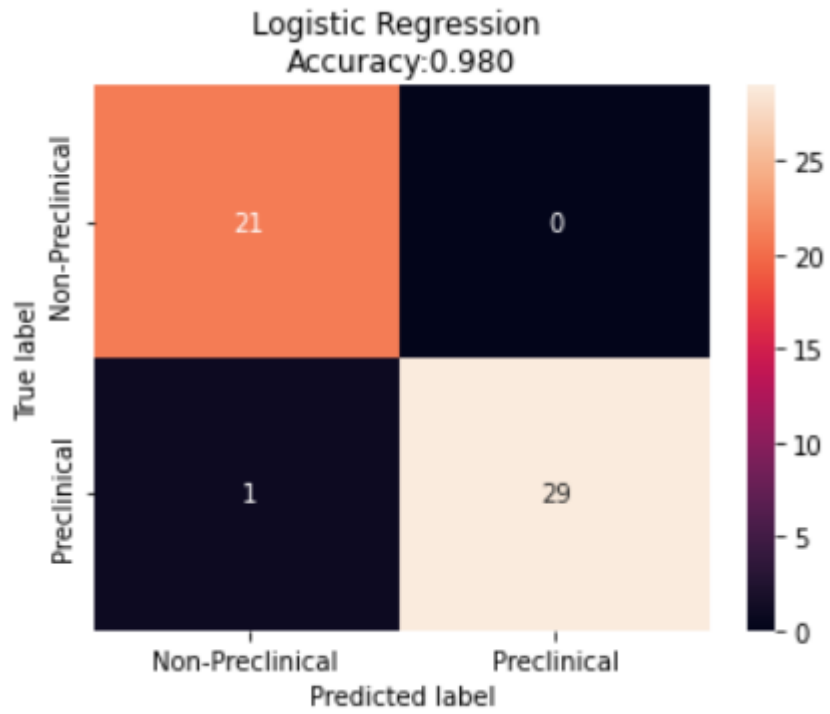


Fig No: 6- Logistic Regression

Also in there is a Receiver operating characteristic (roc assessment picture (figure no. 7)

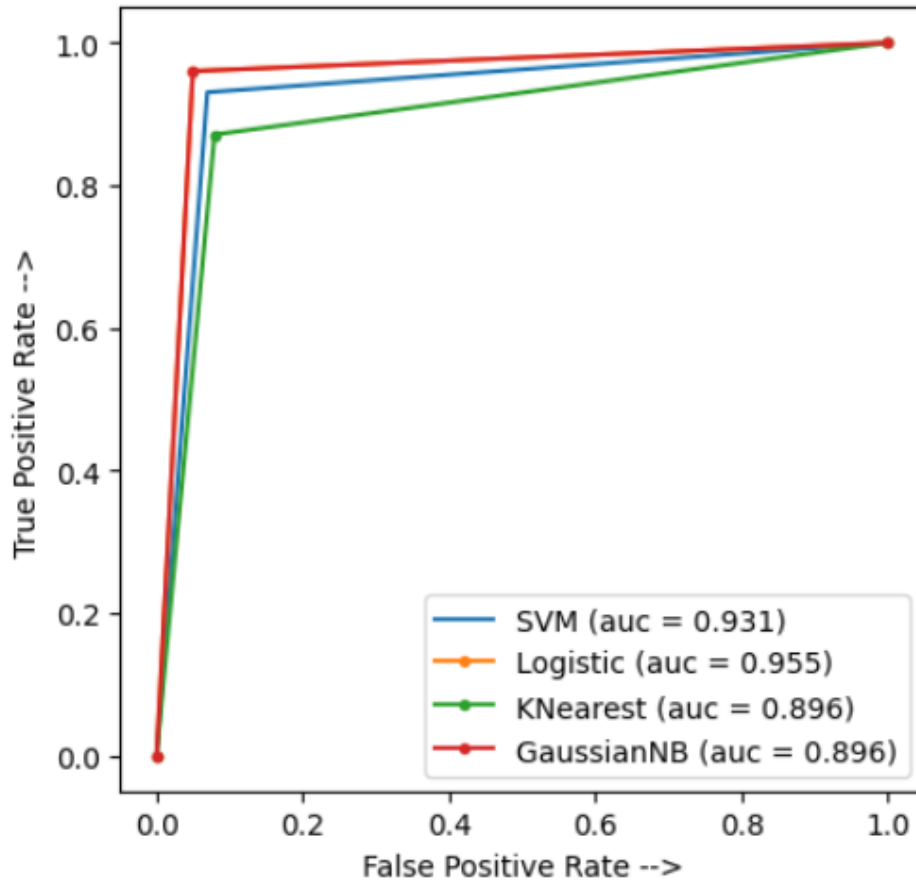


Figure No: 7- ROC Curve Graph

Figure: 7 depending on their respective accuracy, displays a graphical comparison of four model training classifiers. Check out how accurate all of the models are here. The classification accuracy of K- Nearest Neighbor is 0.88. The classification accuracy of the Logistic Regression model is 0.98 and Gaussian model is 0.96. Another model, the Support vector model, has a classification accuracy of 0.92, which all model good performance for this Alzheimer's disease dataset but Logistic Regression predict the best accuracy. Overall, classification algorithms function well in identifying patient is Preclinical on Non- Preclinical. A receiver operating characteristic curve (ROC) out of complete accuracy reflected 88–98 percent accuracy among the true positive rate and false positive rate anticipated by this data.

Chapter: 5 CONCLUSIONS AND RECOMMENDATION

Implemented some machine learning model which are already proposed in this paper. Created a test to validate the efficacy of the suggested AD detection and classification model. Validation of the suggested AD detection and classification model's efficacy. This article presents a classification of the basic concepts and forms of machine learning. After MRI, we have created an efficient approach with the help of Machine learning of brain data, so that it is possible to predict the early stage of AD patients. The multiclass classification was performed using the Alzheimer's disease dataset. About classification of various classifiers such as the multiclass Alzheimer's disease dataset was trained and analyzed. All mentioned Classifiers are individually trained and tested with level-based train-test split data scores. AD detection is normal, very mild, mild, and moderate. Once the disease is detected in the patient's preclinical condition or early stage, doctors can pre-plan the treatment of the patient. The amount of data on paper is too small. These results open up new perspectives about the use of transfer learning in combination with neuro-images for automatic early detection. As a result, the accuracy of the classification sample has increased to almost 95% due to the reduction of the training sample.

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