Machine Learning Supported Healthcare Management System

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March - 2023

Submitted in partial fulfilment of the Degree of

Bachelor of Technology

In

Computer Science Engineering

DEPARTMENT OF COMPUTER SCIENCE ENGINEERING

JAYPEE INSTITUTE OF INFORMATION TECHNOLOGY, NOIDA

(I)

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1. DECLARATION

We hereby declare that this submission is my/our own work and that, to the best of my knowledge and belief, it contains no material previously published or written by another person nor material which has been accepted for the award of any other degree or diploma of the university or other institute of higher learning, except where due acknowledgment has been made in the text.

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Enrollment No:19103180,19103194,19103211

(V) SUMMARY

The Project Machine Learning Powered Healthcare Management System is a healthcare system, which makes the overall work of the healthcare institute easier and provides better results in mental and women health-related fulfilled problems.

The objectives fulfilling in this system include Reduced Paperwork, simple access to reference records, effectual billing of different services, enhanced hospital administrations, no record duplications, minimized documentation, rapid information across various departments, optimized bed occupancy checks, critical stock information, improve cost control, and more.

This project proposes a management software for the hospital to provide a dashboard of effective operations for different departments such as Hospital Information Management System (HIMS), clients etc. and further implement ML-based algorithms and Security to make the software reliable.

we made it as a user friendly which improved guides the patient, doctor or staff and gives them brief instructions about the benefits of using this as well as makes it easier for them to understand.

The app allows provides the patient to fulfil a survey on mental health and, according to the results, provides them with an appointment for a volunteer or doctor.

We have used an ML dataset for mental health and checked the precision and accuracy of our project. Dataset is used from Kaggle which includes all necessary information of the patient which is then used in the different algorithms and got results accordingly.

We have extended our project and added dataset for heart disease, Diabetes and thyroid prediction. Apart from this, we have extended our work in providing backward connectivity to our app.

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Signature of Student	Signature of Supervisor
Name	Name
Abhijot Singh, Vansh Sachdeva, Deepika Khullar	
Date	Date

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LIST OF SYMBOLS & ACRONYMS

Acronym/Abbreviation/Symbols	**Meaning**
KNN	K Nearest Neighbour
DT	Decision Tree
AUC	Area Under Curve
IEEE	Institute of Electrical & Electronics Engineers
Σ	Summation
	Union
m	Correctly predicted links
L	Total number of links taken into consideration

CHAPTER 1- INTRODUCTION

1.1 General Introduction

ML care is a healthcare system, which makes the overall work of the hospital easier and provides better results in mental and women health-related fulfilled problems. This project proposes a management software for the hospital to provide a dashboard of effective operations for different departments such as Hospital Info Management System (HIMS), clients etc. Dataset is used from Kaggle which includes all necessary information of the patient which is then used in the different algorithms and got results accordingly. The project extension includes dataset to train a model for mental health , heart disease , Diabetes and thyroid prediction and providing backward connectivity to the app.

1.2 Problem Statement

Since The Majority of Small and Mid-sized healthcare infrastructures in our nation mostly use paper and paper-based infrastructure. In this project, we try to provide a platform which changes the paperbased infrastructure into an electronic one along with providing machine learning support in the prediction and diagnosis of some major health issues like Mental health, heart disease, thyroid and women's health issues.

1.3 Significance/Novelty of the problem

Based on the thorough survey of the market's existing product and developing an UX audit sheet the following components were taken and collectively developed for the full stack component.
a. Patient Dashboard: Patient detail view with all records about a particular patient.

b. Growth Chart for paediatrics cases, Diabetic Analysis, Vitals, Medical Histories including allergies.

Doctor Dashboard

a. Dashboard shows snapshot information of current revenue, expense, Lab, and pharmacy data.

b. Lets you set and monitor targets for departments.

c. Provides important analytics information and trends.

Hospital Administration

ADT - ADMISSION, DISCHARGE, TRANSFER Admission, Discharge, and Transfer:

a. Manage the patient's admission, discharge, and transfer process through the inpatient bed management features.

b. Automated bill charge postings based on the patient's period of stay basis configured bed charges for hourly, half-day, full-day charges, duty doctor charges, and nursing charges.

c. Set up multiple discharge states for the patient such as Initial Discharge, Clinical Discharge, and Financial Discharge, and track pending billing and clinical activities in preparation for the patient's clearance for the Physical Discharge.

d. It checks previous patient information, flags the operator about patient preferences, and warns if there are any due payments.

Comprehensive appointments

a. Multi-View Calendar to view appointments for a single doctor, entire hospital and multi-locations

b. Defining working and non-working days and daycare timings:

Doctor's schedule

a. Search for consulting doctors as per department, services and availability -- Online portal for patients to book appointments directly.

b. Overbook appointments with the waitlist feature to manage patient expectations, and waiting time, and maximize resource utilization.

c. First-time contact details capture with minimum details for patient appointments.

d. Track appointments by statuses such as booked, confirmed, no-shows, cancellation, and track noshow history.

e. Book recurring appointments.

OP (Out Patient)

a. Integrated billing: Discount alerts, Automatic Due capture, Option to the bill before and after consultation, day care surgery packages.

b. System generates a UHID (Unique Health Identification) number for each new patient registration, used as the future reference for the patient's medical record.

c. Visit Registration through a single outpatient registration screen which captures patient demography, sponsor, patient photo, visit and order details.

d. Patient Registrations with an external prescription and paying a visit to the pharmacy or the diagnostics department.

PHARMACY Medical Store

a. The nurses place an order to the pharmacy based on the doctor's prescription for patients.

b. The prescription appears in the pharmacy module.

c. Barcode integration.

d. Enabled drug interaction & lifesaving drug alerts to make sure the right medicine is dispensed to the patient with proper advisory.

Track Medicine Status

a. Track every medicine with its status of it. Whether dispensed or undispensed.

b. Also print the Pharmacy card for the patient to pick up the medicines from another store in case of unavailability of drugs.

c. Track Payment mode for dispensed medicines.

1.4 Brief Description of the Solution Approach

With the increasingly electronic and digital presence of the nation having electronic healthcare management that too with comprehensive solutions for medical workers doctors patients by providing them with personalised portals having different own options and features and providing an MLpowered form system for collecting information regarding symptoms and giving a tentative disease which later can be diagnosed by proper tests and other required and prescribed procedures as per the norms and regulations. the application also tries to resolve the requirement and dependence on paperbased infrastructure and make everything digitalised and secure

1.5 Comparison of existing approaches to the problem framed

We researched many research papers and applications related to our topic and then found around 20 major applications in this field that were similar to our idea. We studied how these applications worked and identified their strengths and weaknesses in order to understand how our application could be different and better. So, after performing an UI/UX audit, we got the functionalities and limitations of the apps that we had to incorporate into our own app, and after discussing and researching, we made our project, which fulfilled most of the limitations of other apps, which makes our web app better and more user friendly as it contains everything that lacks in others and thus it can be used in a much better and more efficient way. such as pricing , features , usability, etc

CHAPTER 2- LITERATURE SURVEY

2.1 Summary of Papers Studied

Title of the paper	Interpretable Machine Learning in Healthcare
Authors	Muhammad Aurangzeb Ahmad, Carly Eckert, Ankur Teredesai
Year of Publication	2018
Journal	IEEE
Summary	The terminology, features, challenges and requirements concerning the design of interpretationable and comprehensible machine learning models and systems for healthcare are carefully described in this tutorial. We'll look at a wide range of uses for the use of interpretable machine learning models in healthcare, and discuss how they should be used. Additionally, we explore the landscape of recent advances to address the challenges model interpretability in healthcare and also describe how one would go about choosing the right interpretable machine learning algorithm for a given problem in healthcare.

Title of the paper	Machine Learning Algorithms in Healthcare: A Literature Survey
Authors	Munira Ferdous , Jui Debnath, and Narayan Ranjan Chakraborty
Year of Publication	2020
Journal	IEEE
Summary	This work is aimed at providing all required information on the use of machine learning algorithms in health care. In this process, we have created a table of data about the accuracy of Machine Learning algorithms in terms of different diseases as presented in literature, then progressed through step by step and systematically compiled that study paper. The result of this work is a list of the best Machine Learning algorithms that can predict disease accurately. This information will help researchers and practitioners to understand the contribution of machine learning algorithms to health care and the accuracy of algorithms in a single paper

Title of the paper	A Review on Applications of Machine Learning in Healthcare

Authors	Eteka Sultana Tumpa, Krishno Dey
Year of Publication	2022
Journal	IEEE
Summary	A number of types of machine learning algorithms have been reviewed in this study, as well as certain techniques within the methodology section can be used for developing healthcare applications. The use of machine learning in health care and its characteristics are also discussed in the proposed study. This review paper is mainly considered as an overview of how machine learning is being used to further improve the healthcare sector by making it easier to diagnose and cure diseases too early and also reduce its cost. The research literature has shown that using machine learning techniques can predict a massive shift in the health sector, which will make life more convenient for us.

Title of the paper	Special Disease Prediction System Using Machine Learning
Authors	Rohit Kumar, Prince Thakur, SPS Chauhan
Year of Publication	2022

Journal	IEEE
Summary	The system takes into account the symptoms given by the person and produces the disease as an output. The system is made up of Naive Bayes Classifiers. Our system is concerned with accuracy, which means that the output of disorder prediction will be better when more symptoms are generated by a person as an input.

Title of the paper	Machine Learning in Healthcare: A Review
Authors	K. Shailaja, B. Seetharamulu , M. A. Jabbar
Year of Publication	2018
Journal	IEEE
Summary	In a variety of fields, such as finance, medical sciences and security, it plays an important role. Machine learning, which provides excellent detection and prediction capabilities of diseases, is used to discover patterns from medical data sources. We've reviewed several Machine Learning algorithms for the development of efficient decision support to health applications in this paper. To establish a system of

	intelligent decision support for medical applications, this paper will help reduce the research gap.

Title of the paper	Machine learning algorithm in healthcare system: A Review
Authors	Pradeep Kumar Kushwaha, M. Kumaresan
Year of Publication	2021
Journal	IEEE
Summary	For the purpose of making decisions in health care systems, this research article deals with different areas of machine learning which are used to process complex data. In this paper, brief details on various machine learning approaches are provided and the role of these algorithms in healthcare systems such as diabetic detection, detecting cancer, brain tumor, bioinformatics etc. have been examined.

Title of the paper	Applying Internet of Things and Machine-Learning for Personalized Healthcare: Issues and Challenges
Authors	Farhad Ahamed, Farnaz Farid
Year of Publication	2018
Journal	IEEE
Summary	A new patient-oriented approach to health care, which envisages improvement of the traditional healthcare system, is presented in this research paper "Personalized Health Care". The focus of this new advancement is the patient data collected from patient Electronic health records (EHR), Internet of Things (IoT) sensor devices, wearables and mobile devices, web-based information and social media. PH is applying artificial intelligence technologies to the collected data for improvement of disease progression techniques, disease forecasts, patient self-management and clinical intervention. In this regard, machine learning techniques have been widely applied for the purpose of developing analytical models. The models are integrated into various applications in the field of healthcare delivery systems and Clinical Decision Support Systems.

Title of the paper	AI for Social Good in Healthcare: Moving Towards a Clear Framework and Evaluating Applications

Authors	Michal Monselise, Christopher C. Yang
Year of Publication	2022
Journal	IEEE
Summary	This research paper applies principles of AI4SG to healthcare data that is either user generated or sourced from electronic health records (EHR) and produces meaningful and actionable insights for clinicians and the public in applications such as vaccine misinformation, suicide prevention, and detection of prostate cancer.

Title of the paper	A Pilot-Testing of Social Customer Relationship Management Adoption in Healthcare Context
Authors	Abdullah Nabeel Jalal,Mahadi Bahari,Sultan Rehman Sherief
Year of Publication	2019
Journal	IEEE

Summary	The aim of the study is to confirm the factors which have a significant impact on adopting Social SCRM in Iraq's healthcare organisations. The study also showed that in order to understand how social CRM should be implemented from an organizational strategy point of view, the introduction of a proposed practicable model has been developed. A combination of three theories TOE, DOI and Institutional Theory describes the model developed for this study.

Title of the paper	Decision Making and Support in Healthcare Online Social Networks
Authors	Valeri Sadovykh,David Sundaram
Year of Publication	2015
Journal	IEEE
Summary	The study aims at examining the potential use of Open Social Networks Online to support decision making processes. Health oriented online social networks are an area to be addressed in this research. In order to verify the existence of the DM phases and the sequence in which they are reached, we consider the DM phases in the HOSNs.

2.2 Integrated summary of the literature studied.

So far the research papers we studied for the project were very insightful. We came to know about many Machine Learning Algorithms for detecting diseases in an efficient way. Our major focus was to look at some Algorithm type of approach. So our focus was on searching the research papers which follow the same cause.

We thoroughly studied the research papers on different kinds of algorithms. We studied about Logistic Regression, Fuzzy Neural Network and many more algorithms. We also Learned about supervised learning methods such as Naive Bayes, SVM, Decision tree and Random Forest and many more to Finally find the algorithms the would be suitable for this project.

Then, finally applied Logistic Regression, KNN, Decision Tree Classifier, Random Forest, Bagging, Boosting, and Stacking to get better accuracy in the Mental Health Prediction Model. After that our approach was to study as many research papers on Advancement of Machine Learning Algorithms in Healthcare to get to know about the novelty of the problem.

We studied some classical research papers on Machine Learning in Healthcare to better understand the role and capability of machine learning in the field of healthcare. We came to know about various approaches that we can apply after studying these research papers.

CHAPTER 3- REQUIREMENT ANALYSIS AND SOLUTION APPROACH

3.1 Overall Description of the Project

ML health care is a healthcare system, which makes the overall work of hospitals simpler and provides better results in relation to mental or women's health issues. We have added in patients a ML model to forecast heart disease and thyroid diseases as part of this project.

The objectives of this project includes:

- Reduced Paperwork
- simple access to reference records
- effectual billing of different services
- enhanced hospital administrations
- no record duplication
- minimized documentation
- rapid information across various departments
- optimized bed occupancy checks
- critical stock information
- Improve cost control and more.

This project proposes a system of management software for the hospital to be able to display an effective operational status report in different departments, such as Hospital Information Management System and otherHIMS clients etc., using ML based algorithms and security measures that make it reliable.

We're making it a more user friendly one that introduces patients, doctors or staff to the advantages of using this and provides them with brief information on how they can benefit from its use.

This app enables the patient to answer a questionnaire about his or her state of mind and arranges an appointment with one of the volunteers or doctors, based on results.

Using ML data for mental health, we've verified that the project is accurate and precise. The Kaggle database will contain all the patient's necessary information, which is used in different algorithms to get results accordingly.

Training the ML model is part of the project's extension.

Heart Disease

Dataset Coverage

- According to the CDC, heart disease is one of the leading causes of death for people of most races in the US (African Americans, American Indians and Alaska Natives, and white people). About half of all Americans (47%) have at least 1 of 3 key risk factors for heart disease: high blood pressure, high cholesterol, and smoking. Other key indicator includes diabetic status, obesity (high BMI), not getting enough physical activity or drinking too much alcohol. It is vital in healthcare to identify and prevent factors that are most likely to have an impact on heart disease. In parallel, computational developments have allowed for the use of Machine Learning methods to monitor patterns in data which can predict a patient's condition.

In this dataset, the following machine learning models are used:

1. Decision Tree.

2. K-Nearest Neighbours (KNN).

Explanation of the dataset's variables:

1. heart disease: Respondents who have ever disclosed having myocardial infarction (MI) or coronary heart disease (CHD).

2. Body Mass Index (BMI): Body Mass Index (BMI) is the product of a person's weight in kilogrammes (or pounds) and height in metres (or feet), squared. High body fatness may be indicated by a high BMI. BMI does not make a body fat or health diagnosis for a person, but it does screen for weight categories that may cause health issues. 3. Smoking is the practise of breathing in and exhaling gases from burning plant material.

4. Alcohol consumption: Heavy drinkers (adult men and women who consume more than 14 drinks per week each)

5. Stroke: Also known as a brain attack, a stroke happens when a blood vessel in the brain breaks or when something limits the blood supply to a portion of the brain. The brain either ages or suffers harm in both scenarios.

6. PhysicalHealth: the state of your body, taking into account everything from the lack of illness to your degree of exercise.

7. Mental health is the combination of our psychological, emotional, and social health. It influences our thoughts, emotions, and behaviours.

8. Sex: refers to the socially built traits of girls, boys, women, and men.

9. Fourteen-level age category for age.

10. Race: Imputed value for race and ethnicity.

11. Diabetic: Body either can't utilise insulin properly or doesn't produce enough of it

Adults who reported engaging in physical activity or exercise in the preceding 30 days that wasn't related to their usual job.

GenHealth is a multidisciplinary organisation that offers evidence-based clinical, health promotion, and allied health services to community members who are at risk.

DIABETES PROGNOSIS

When the pancreas can no longer generate insulin or when the body cannot effectively use the insulin it does produce, diabetes develops. We can forecast diabetes by learning about machine learning.

This project's goal is to categorise whether someone has diabetes.

The dataset consists of several independent medical variables and one dependent outcome variable. Pregnancies, glucose, blood pressure, skin thickness, insulin, BMI, diabetes pedigree function, and age are the independent factors in this dataset. The outcome variable's value, which represents whether a person has diabetes (1) or not (0), is either 1 or 0.

Regarding the Dataset

1. Pregnancies: - The total number of pregnancies a woman has had
2. Glucose: - In an oral glucose tolerance test, the plasma glucose concentration was measured after two hours.

3. Blood Pressure: - Diastolic blood pressure in millimetres of mercury (mm hg)
4. Skin Thickness: - Triceps skin fold thickness in millimetres (skin Thickness)
5. Insulin: - Two-hour serum insulin (mu U/ml)
6. BMI: - Body Mass Index is defined as ((weight in kg/height in m)2)
7. Age: - Age in years
8. Diabetes Pedigree Function: - Based on family history, Diabetes Pedigree Function assigns a likelihood score for diabetes.
9. Outcome: - 0 (does not have diabetes) or 1 (does have diabetes).

Pneumonia Dataset

Train, Test, and Val folders are used to organise the dataset. Within the dataset, each image category (Pneumonia/Normal) has a separate subdirectory. There are 5,863 X-Ray images in JPEG format in 2 categories (Pneumonia/Normal).

Chest X-ray images (anterior posterior) were selected from retrospective cohorts of paediatric patients aged one to five at the Guangzhou Women and Children's Medical Centre in Guangzhou. All chest X-ray imaging was performed as a routine component of the clinical care given to patients.

Before being eliminated from the analysis of the chest x-ray images, each chest radiograph was initially examined for quality control. Two skilled doctors evaluated the photographs before the diagnosis could be used to train the AI system. If there were any errors in the grading,

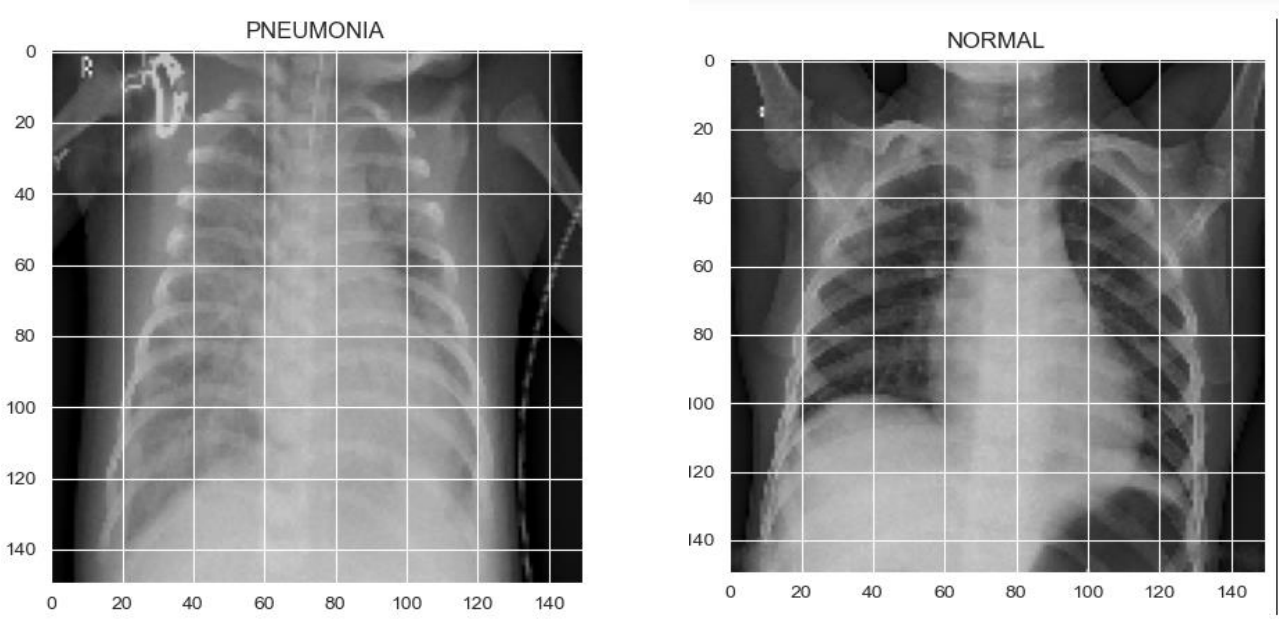


Figure1: Pneumonia

The following models are among them:

a. Tuning hyperparameters using gridsearch CV

b. Best Model Fit

c. Make a prediction based on the test data.

d. Confusion Matrix, F1 Score, Precision Score, and Recall Score are examples of performance metrics.

3.2 Requirement Analysis

Network	Number of Rows	Number of Columns
Survey for ML Model for Mental health	1260	27
Survey for ML Model for Heart Disease	303	14
Survey for ML Model for Breast Cancer	569	32

Table 1: Dataset

Software prerequisites: -

- Operating system: Windows 10 or later.
- Language: MongoDB, JavaScript, and Python
- Libraries: cloudinary, dotenv, helmet, multer, passport.js, express.js, node.js, and sanitize-html, TensorFlow, Eectra
- editing text

  a) Jupyter Notebook programming has been used throughout the entire code execution process. It is used by programmes relying on data science and associated advanced Python projects and which depends on the Anaconda Distribution It is an open-source IDE that is especially designed for the Python programming language.
  Some of its aspects that were applied to our project are:

- Code completion, editing, and syntax highlighting are all done in its editor. editing variables and using a GUI to explore them.

- Its help function, variable explorer, and file explorer were all quite helpful. Linking with numerous libraries facilitates simple code writing.
  b) Vs Code by Microsoft has been utilised for the Web development portion, along with several of its extensions, like Live Share, Github Co-pilot, liveserver, gitbash, etc.
  c) Additionally, the dataset used throughout the entire project has been maintained using Microsoft Excel.

Hardware specifications:

- RAM requirement: 4 GB
- processor running at 2 GHz Intel Core i7 (8th Generation) processor
- 64-bit operating system type

3.3 Solution Method

This study uses machine learning algorithms to predict mental wellness. The many evaluation models include:

Several methods were employed to tune the dataset, including:

Score from Cross Validation By using accuracy as a metric, we have used Cross Validation Score to look for the ideal value of K for KNN.

Cross Validation for Grid Search

GridSearchCV is a method for adjusting hyperparameters to find the best values for a particular model.

a random search Verification Across The set of hyperparameters is randomly passed by RandomizedSearchCV, which then calculates the result and outputs the best set of hyperparameters for the best result.

There are many methods for evaluating models, including:

Rational Regression

One of the most often used Machine Learning algorithms, within the category of Supervised Learning, is logistic regression. Using a predetermined set of independent factors, it is used to predict the categorical dependent variable.

In a categorical dependent variable, the output is predicted via logistic regression. As a result, the result must be a discrete or categorical value. Rather of providing the exact values of 0 and 1, it provides the probabilistic values that fall between 0 and 1. It can be either Yes or No, 0 or 1, true or false, etc.

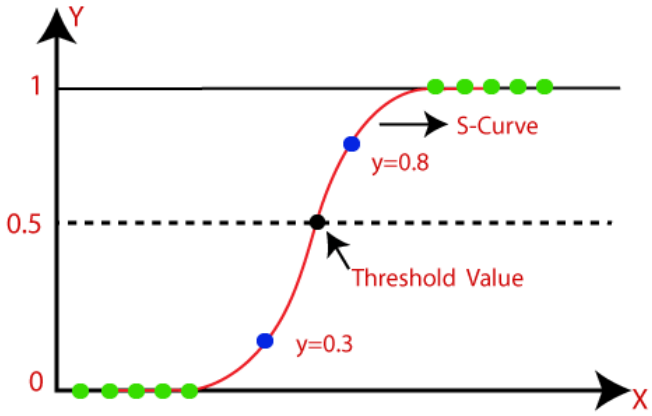


Figure 2: Logistic Regression

Kth Nearest Neighbour

One of the simplest machine learning algorithms, based on the supervised learning method, is K-Nearest Neighbour. The K-NN algorithm makes the assumption that the new case and the existing cases are comparable, and it places the new instance in the category that is most like the existing categories.

A new data point is classified using the K-NN algorithm based on similarity after all the existing data has been stored. This means that utilising the K-NN method, fresh data can be quickly and accurately sorted into a suitable category. Although the KNN technique is most frequently employed for classification problems, it can also be utilised for regression.

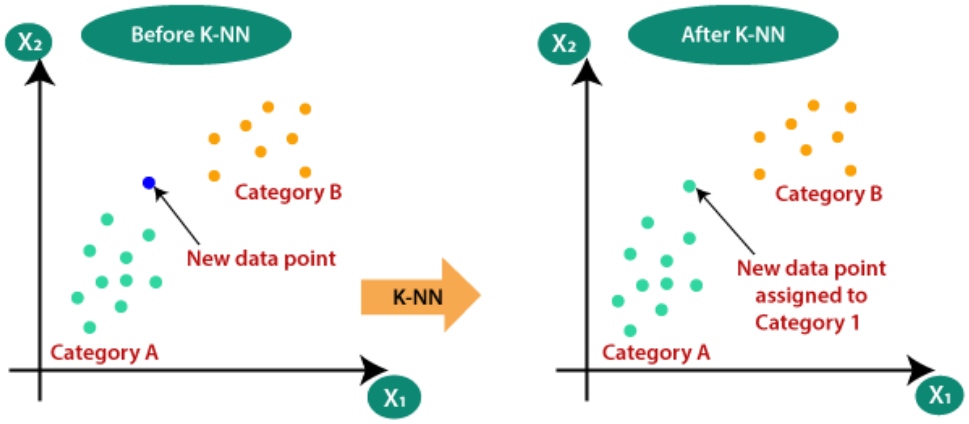


Figure 3 : KNN Classifier

Decision Tree

Decision Tree is a supervised learning technique that can be used for both classification and Regression problems, but mostly it is preferred for solving Classification problems. It is a tree-structured classifier, where internal nodes represent the features of a dataset, branches represent the decision rules and each leaf node represents the outcome. In a Decision tree, there are two nodes, which are the Decision Node and Leaf Node. Decision nodes are used to make any decision and have multiple branches, whereas Leaf nodes are the output of those decisions and do not contain any further branches. The decisions or the test are performed on the basis of features of the given dataset. It is a graphical representation for getting all the possible solutions to a problem/decision based on given conditions.

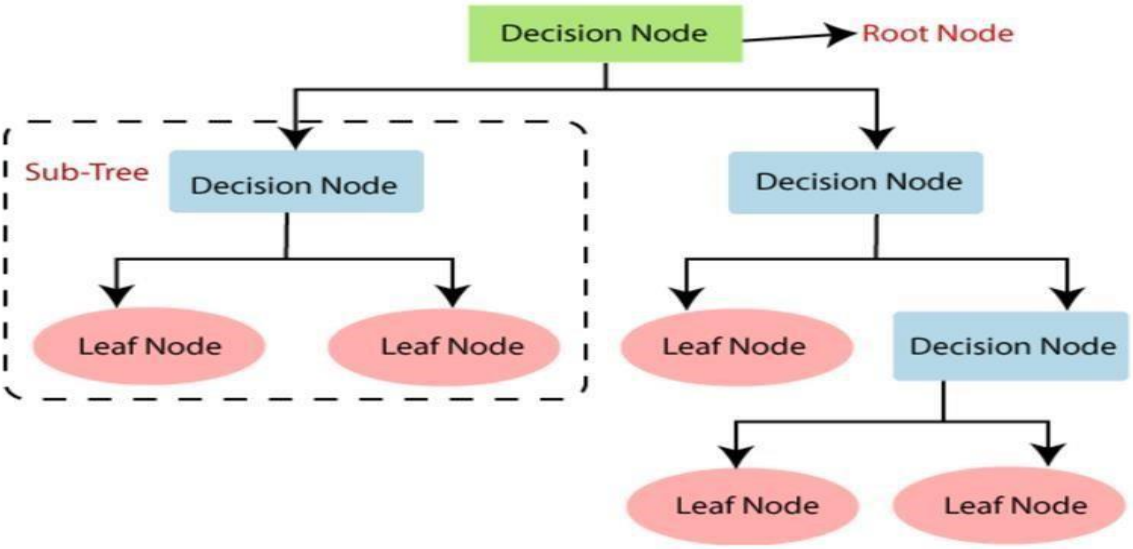


Figure 4: Decision Tree Classifier

Random Forest

Random Forest is a popular machine learning algorithm that belongs to the supervised learning technique. It can be used for both Classification and Regression problems in ML. It is based on the concept of ensemble learning, which is a process of combining multiple classifiers to solve a complex problem and to improve the performance of the model. As the name suggests, "Random Forest is a classifier that contains a number of decision trees on various subsets of the given dataset and takes the average to improve the predictive accuracy of that dataset." Instead of relying on one decision tree, the random forest takes the prediction from each tree and based on the majority votes of predictions, and it predicts the final output. The greater number of trees in the forest leads to higher accuracy and prevents the problem of over fitting.

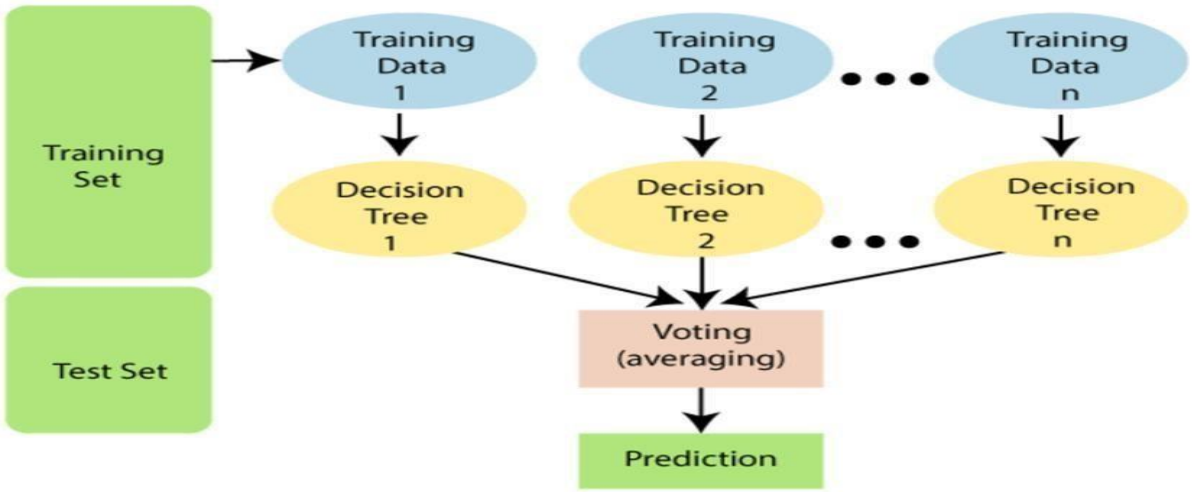


Figure 5 : Random Forest Classifier

Ensemble Learning Models

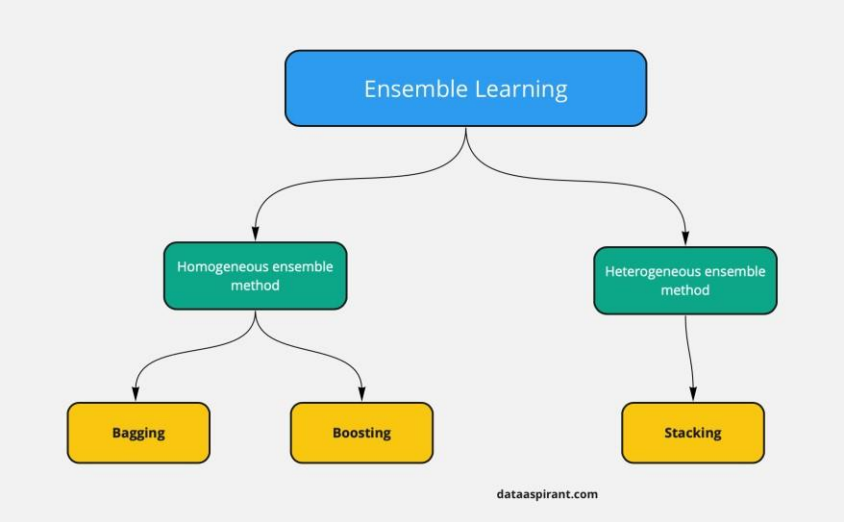


Figure 6 : Ensemble Learning Model

Bagging

Bagging, also known as bootstrap aggregation, is the ensemble learning method that is commonly used to reduce variance within a noisy dataset. In bagging, a random sample of data in a training set is selected with replacement—meaning that the individual data points can be chosen more than once. After several data samples are generated, these weak models are then trained independently, and depending on the type of task—regression or classification, for example—the average or majority of those predictions yield a more accurate estimate.

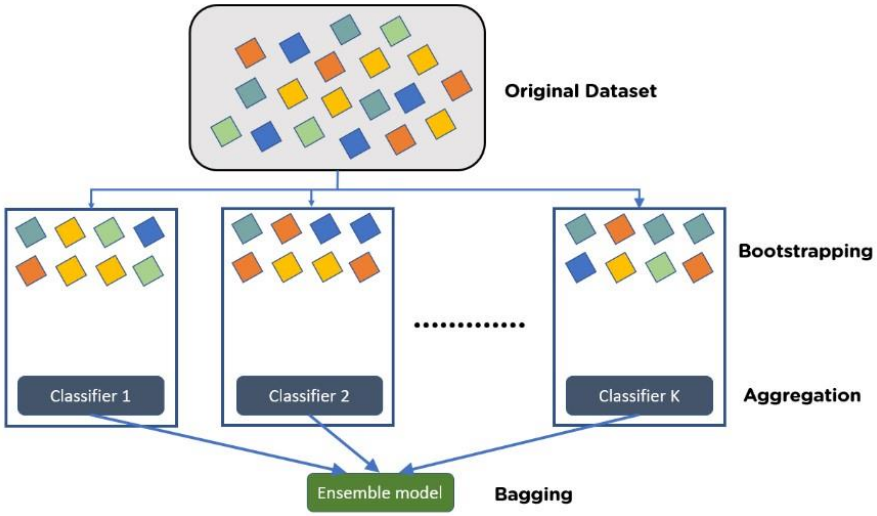


Figure 7: Bagging

By combining several weak classifiers, the ensemble modelling technique known as "boosting" aims to create a powerful classifier. It is accomplished by using weak models in series to develop a model. First, a model is created using the training set of data. The second model is then created in an effort to fix the previous model's flaws. Models are added in this manner until either the full training data set is properly predicted or the maximum number of models have been added.

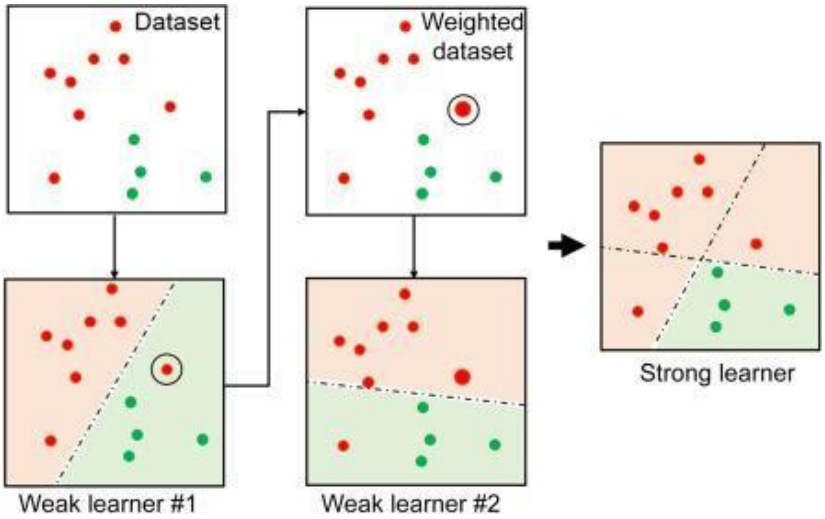


Figure 8: Boosting

Stacking

This ensemble technique applies input from aggregated predictions from several weak learners and meta learners to produce a superior output prediction model.

In stacking, an algorithm learns how to optimally combine the input predictions to get a better output prediction by using the outputs of sub-models as input.

Stacking is also known as **a stacked generalization** and is an extended form of the Model Averaging Ensemble technique in which all sub-models equally participate as per their performance weights and build a new model with better predictions. This new model is stacked up on top of the others; this is the reason why it is named stacking.

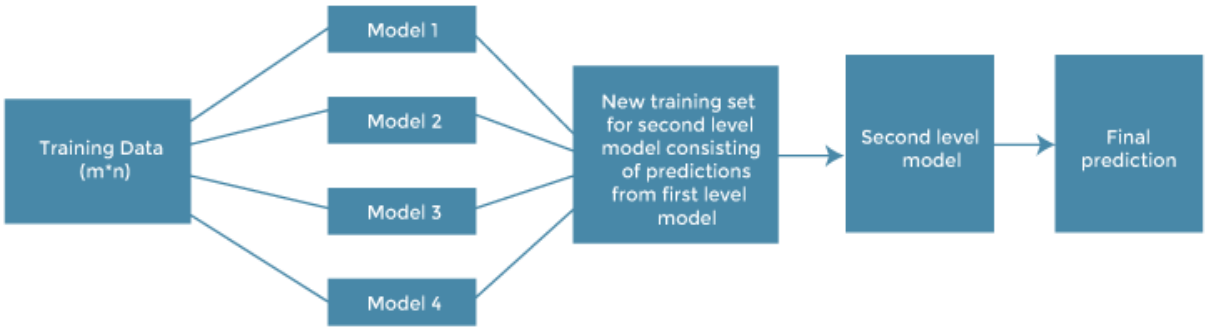


Figure 9: Stacking

Comparison Metrics Used:

The approaches which are discussed above were compared on the following metrics:

AUC

AUC also known as Area Under Curve measures how accurate the Link Prediction [3,10,16] results are. If the rank of all non possible links is provided then the AUC score can be interpreted as the probability that a randomly chosen non-existing link is given higher priority than the existing link.

To calculate the AUC score, we each time randomly select a missing link and a non existing link to compare the scores. If among the n independent comparisons, n' times there are missing link have a higher score as compared to non existing link and n'' times have the same score as compared to non existing link then the AUC score is given by the following formula:

$$AUC = \frac{n' + 0.5n''}{n}$$

Figure 10: AUC Score Formula

If all the AUC scores are obtained from an unconstrained and similar distribution, the AUC score should be approximately equals to 0.5.

Hence, the degree to which value crosses the bar of 0.5 tells how well it performs.

Precision

If we have the ranking of the predicted links then the precision can be defined as the ratio of links which are predicted correctly to the total number of predicted links selected.

For example, if we take top L links as the predicted links among which m links are correctly predicted then the precision is given by the following formula:

$$precision = \frac{m}{L}$$

Figure 11 : Precision Formula

Hence, it is clear from the formula that higher value of precision means higher prediction accuracy and hence better is the solution.

CHAPTER 4- MODELLING AND IMPLEMENTATION DETAILS

4.1 Design Diagrams

4.1.1 Use Case Diagrams

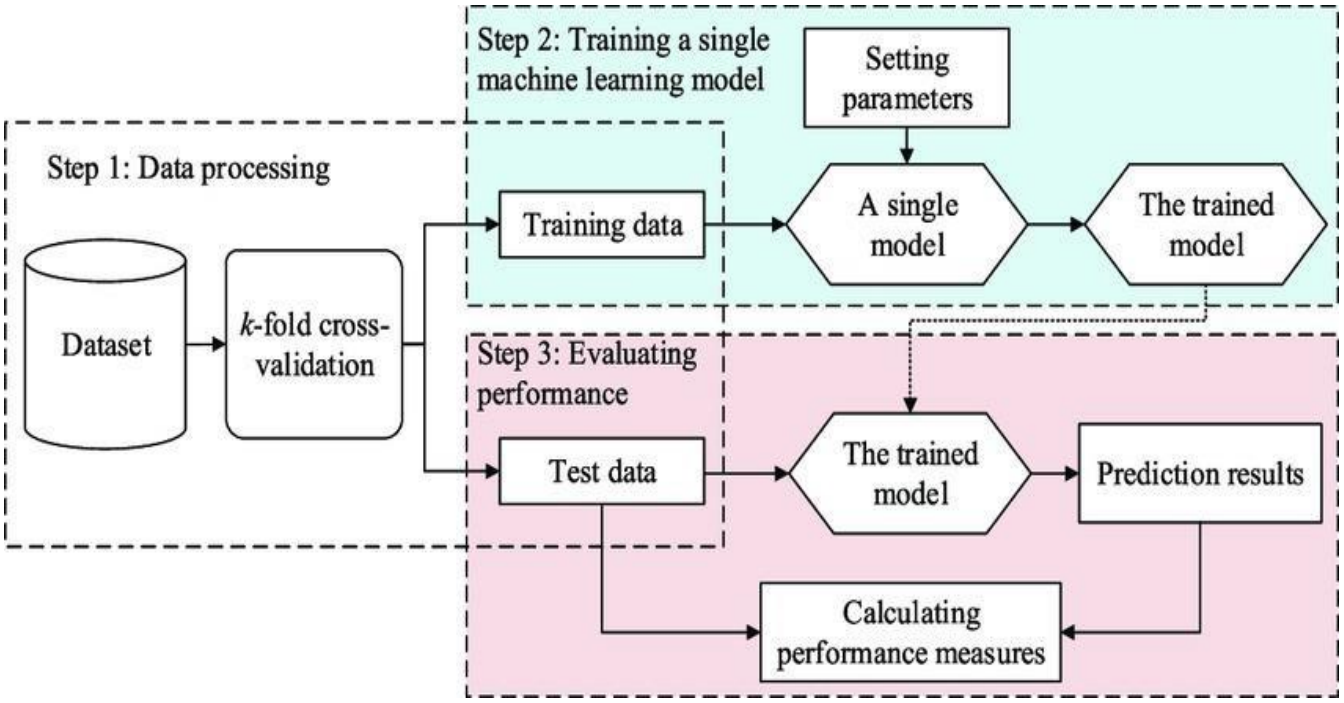


Figure 12:Use Case Diagram

4.1.2 Control Flow Diagram

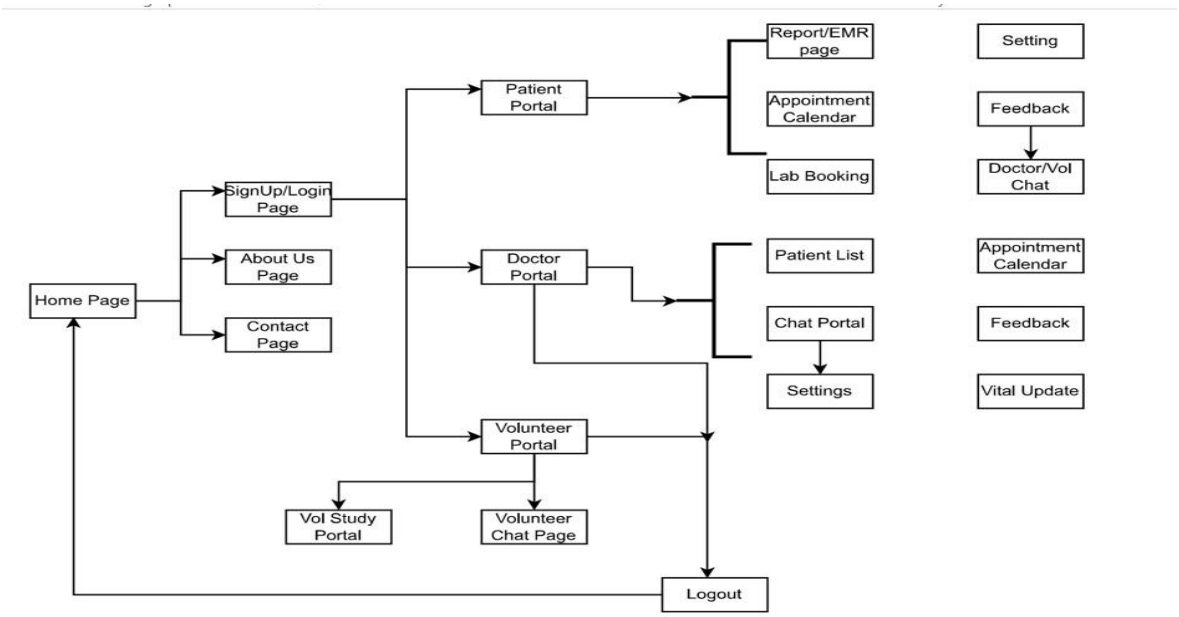


Figure 13: Control Flow Diagram

4.2 Implementation details

Data Cleaning

At first we took a dataset and applied Data Cleaning process to drop any missing values.

Data Pre-processing

Then we applied Cleaning that involves removing NaN values, made groups based on gender, removed few irrelevant columns like country etc. and finally the columns used are Age, Gender, Self Employed, Work Interfere, Family History, Care Options, Benefits.

	Total	Percent
Age	0	0.0
Gender	0	0.0
obs_consequence	0	0.0
mental_vs_physical	0	0.0
phys_health_interview	0	0.0
mental_health_interview	0	0.0
supervisor	0	0.0
coworkers	0	0.0
phys_health_consequence	0	0.0
mental_health_consequence	0	0.0
leave	0	0.0
anonymity	0	0.0
seek_help	0	0.0
wellness_program	0	0.0
care_options	0	0.0
benefits	0	0.0
tech_company	0	0.0
remote_work	0	0.0
no_employees	0	0.0
work_interfere	0	0.0
treatment	0	0.0
family_history	0	0.0
self_employed	0	0.0
age_range	0	0.0

Figure 14: Pre-processed Data

Feature Scaling

We have further applied feature scaling to scale age.

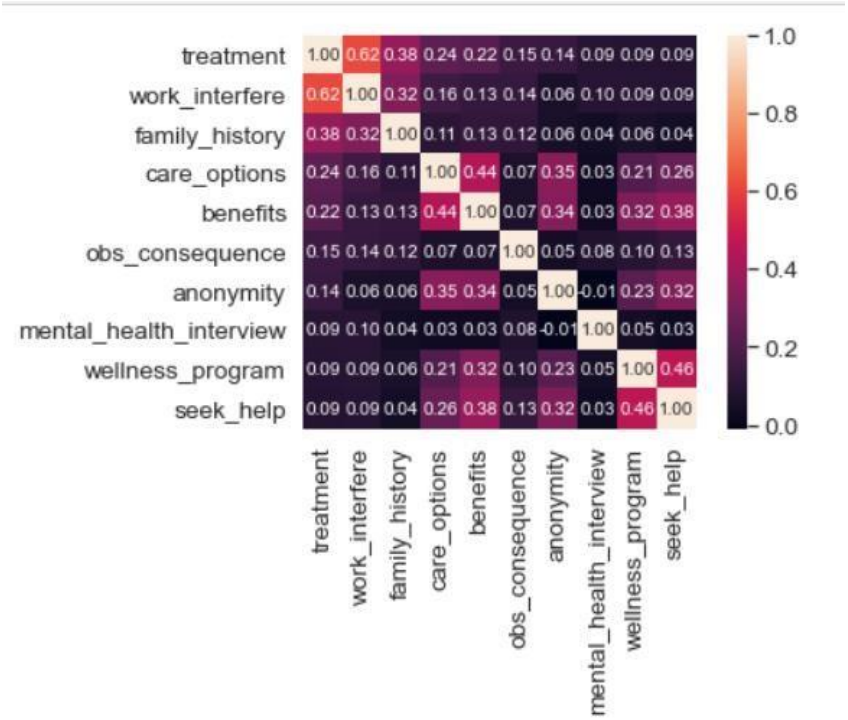


Figure 15: Confusion Matrix

Data Relationship

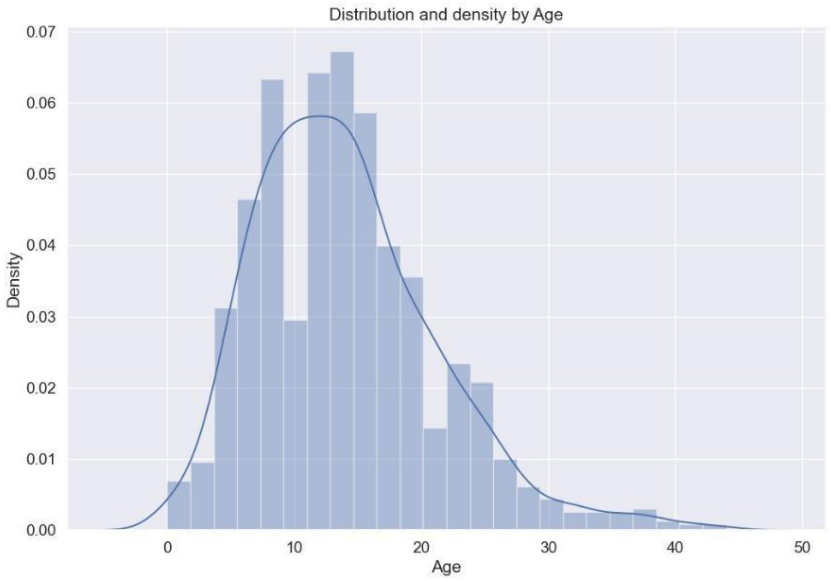


Figure 16: Variation by Age

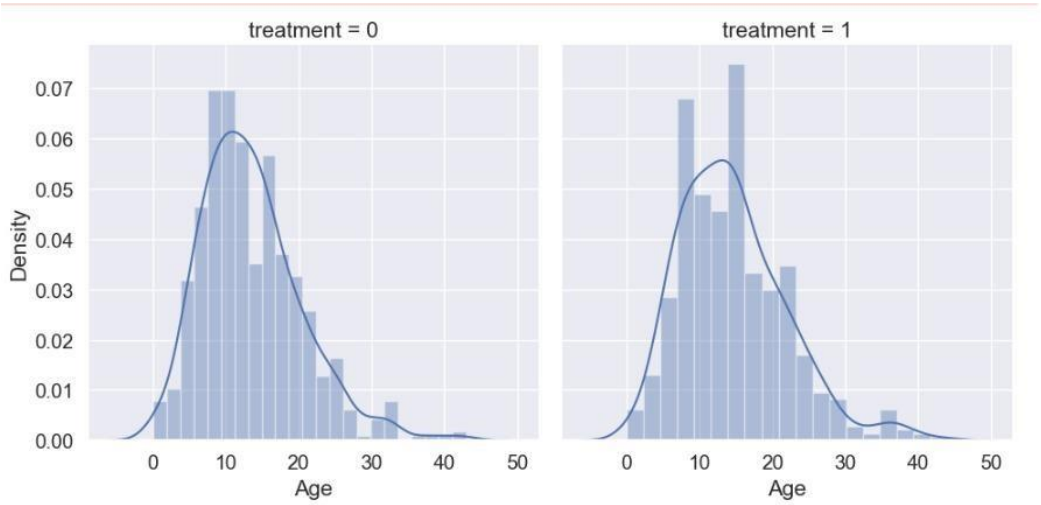


Figure 17 : Treatment Graph

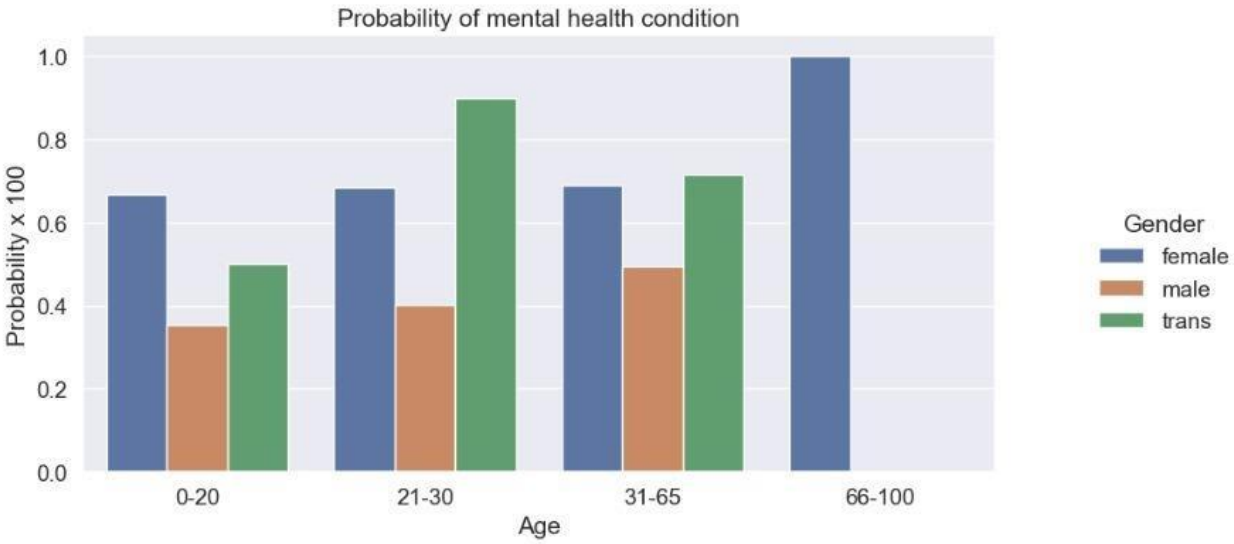


Figure 18 : Mental Health grouped by gender

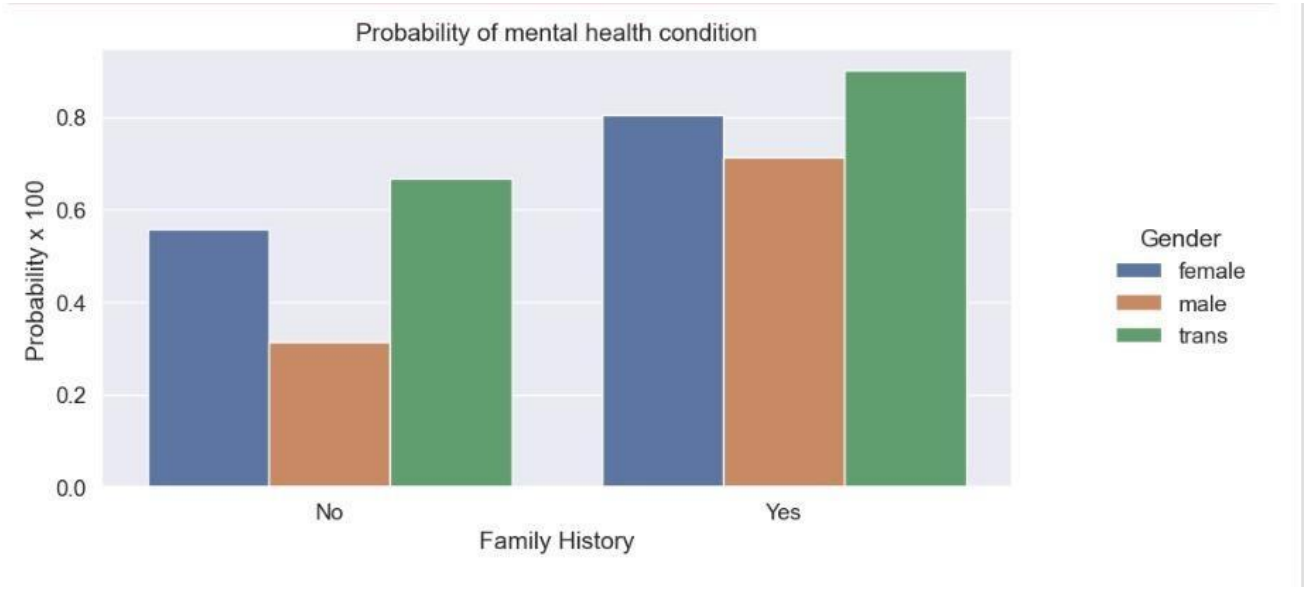


Figure 19: Family history

Tuning

Tuning using Cross Validation

Tuning is the process of maximizing a model's performance without overfitting or creating too high of a variance.

Cross validation is a technique for assessing how the statistical analysis generalises to an independent data set. It is a technique for evaluating machine learning models by training several models on subsets of the available input data and evaluating them on the complementary subset of the data. Using cross-validation, there are high chances that we can detect over-fitting with ease.

The following are the approaches that we applied in our model.

Evaluating Models

The following are the approaches that we used to evaluate our model

Logistic Regression

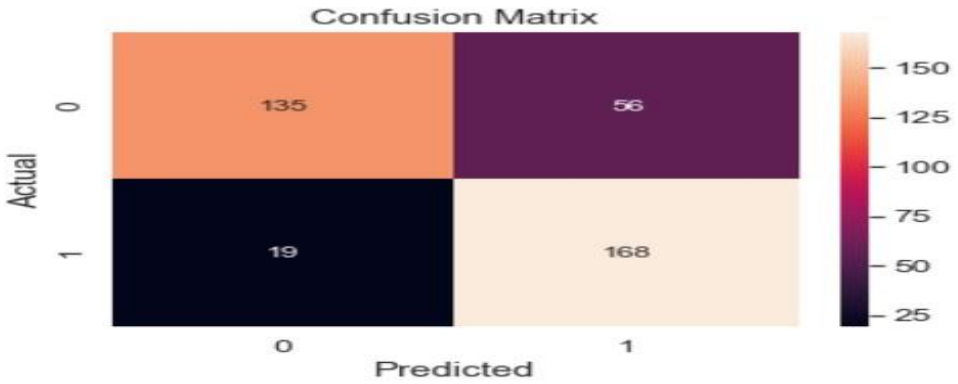
```
Accuracy: 0.7962962962962963
Null accuracy:
 0    191
1     187
Name: treatment, dtype: int64
Percentage of ones: 0.4947089947089947
Percentage of zeros: 0.5052910052910053
True: [0 0 0 0 0 0 0 0 0 1 1 0 1 1 0 1 1 0 1 0 0 0 1 1 0 0]
Pred: [1 0 0 0 1 1 0 1 0 1 0 1 1 0 1 1 1 1 0 0 0 0 1 0 0]
```


```
Classification Accuracy: 0.7962962962962963
Classification Error: 0.20370370370370372
False Positive Rate: 0.256544502617801O4
Precision: 0.7644230769230769
AUC Score: 0.7968614385306716
Cross-validated AUC: 0.8753623882722146
First 10 predicted responses:
 [1 0 0 0 1 1 0 1 0 1]
```

Figure 20: Analysis of Logistic Regression

K Neighbour Classifier

```
Accuracy: 0.8015873015873016
Null accuracy:
 0    191
1     187
Name: treatment, dtype: int64
Percentage of ones: 0.4947089947089947
Percentage of zeros: 0.5052910052910053
True: [0 0 0 0 0 0 0 0 0 1 1 0 1 1 0 1 1 0 1 0 0 0 1 1 0 0]
Pred: [1 0 0 0 1 1 0 1 1 1 0 1 1 0 1 1 1 1 0 0 0 0 1 0 0]
```




```
Classification Accuracy: 0.8015873015873016
Classification Error: 0.19841269841269837
False Positive Rate: 0.2931937172774869
Precision: 0.75
AUC Score: 0.8026010023238234
Cross-validated AUC: 0.878889648937532
First 10 predicted responses:
 [1 0 0 0 1 1 0 1 1 1]
```

Figure 21: Analysis of KNN

Decision Tree Classifier

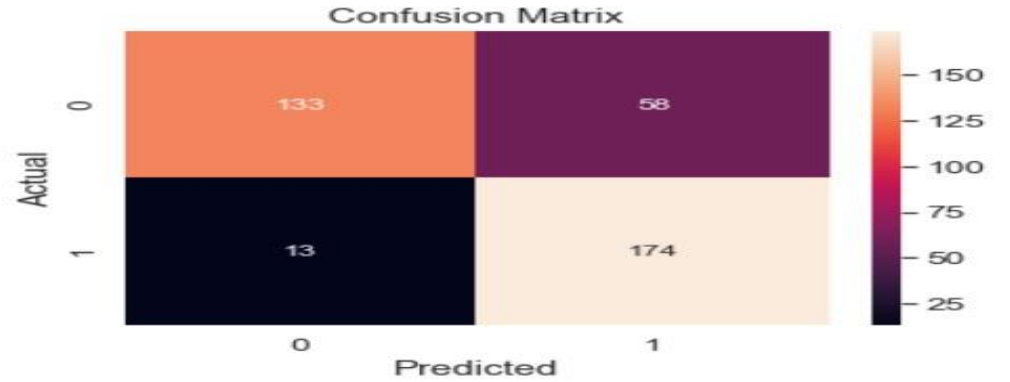
```
Accuracy: 0.8068783068783069
Null accuracy:
 0    191
1    187
Name: treatment, dtype: int64
Percentage of ones: 0.4947089947089947
Percentage of zeros: 0.5052910052910053
True: [0 0 0 0 0 0 0 0 0 1 1 0 1 1 0 1 1 0 1 0 0 0 1 1 0 0]
Pred: [1 0 0 0 1 1 0 1 1 1 0 1 1 0 1 1 1 1 0 0 0 0 1 0 0]
```


```
Classification Accuracy: 0.8068783068783069
Classification Error: 0.19312169312169314
False Positive Rate: 0.3193717277486911
Precision: 0.7415254237288136
AUC Score: 0.8082285746283282
Cross-validated AUC: 0.8893137668747307
First 10 predicted responses:
 [1 0 0 0 1 1 0 1 1 1]
```

Figure 22: Analysis of DT

Random Forest

```
Accuracy: 0.8121693121693122
Null accuracy:
 0    191
1    187
Name: treatment, dtype: int64
Percentage of ones: 0.4947089947089947
Percentage of zeros: 0.5052910052910053
True: [0 0 0 0 0 0 0 0 0 1 1 0 1 1 0 1 1 0 1 0 0 0 1 1 0 0]
Pred: [1 0 0 0 1 1 0 1 1 1 0 1 1 0 1 1 1 1 0 0 0 0 1 0 0]
```



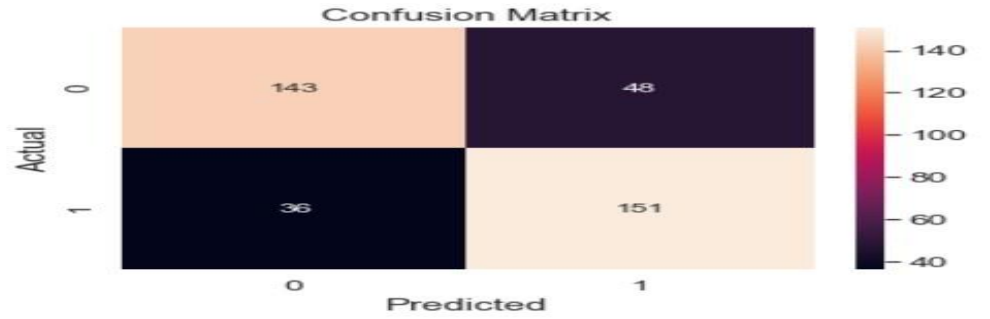

```
Classification Accuracy: 0.8121693121693122
Classification Error: 0.1878306878306878
False Positive Rate: 0.3036649214659686
Precision: 0.75
AUC Score: 0.8134081809782457
Cross-validated AUC: 0.8934280651104528
First 10 predicted responses:
 [1 0 0 0 1 1 0 1 1 1]
```

Figure 23: Analysis of Random Forest

Ensemble Learning Models

Bagging

```
Accuracy: 0.7777777777777778
Null accuracy:
 0     191
1     187
Name: treatment, dtype: int64
Percentage of ones: 0.4947089947089947
Percentage of zeros: 0.5052910052910053
True: [0 0 0 0 0 0 0 0 0 1 1 0 1 1 0 1 1 0 1 0 0 0 1 1 0 0]
Pred: [1 0 0 0 0 0 1 0 0 1 1 0 1 1 1 1 1 0 0 1 0 0 0 0 0 1 0 0]
```

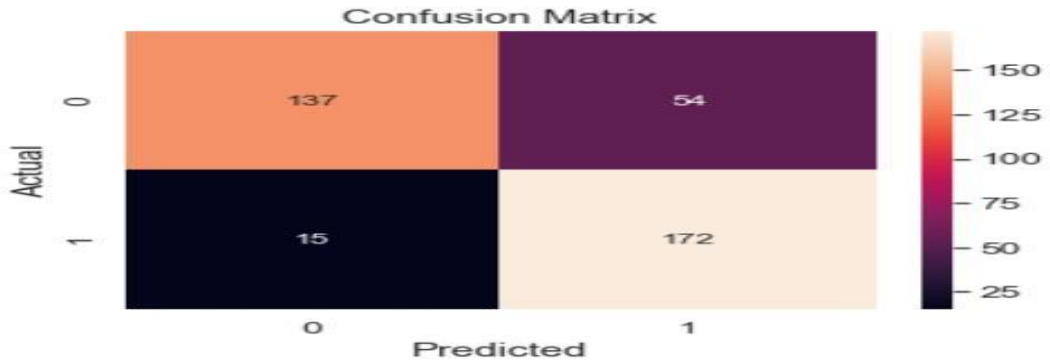



```
Classification Accuracy: 0.7777777777777778
Classification Error: 0.2222222222222222
False Positive Rate: 0.2513089005235602
Precision: 0.7587939698492462
AUC Score: 0.7780888652462413
Cross-validated AUC: 0.8465283555925358
First 10 predicted responses:
 [1 0 0 0 0 1 0 0 1 1]
```

Figure 24: Analysis of Bagging

Boosting

```
Accuracy: 0.8174603174603174
Null accuracy:
 0     191
1     187
Name: treatment, dtype: int64
Percentage of ones: 0.4947089947089947
Percentage of zeros: 0.5052910052910053
True: [0 0 0 0 0 0 0 0 0 1 1 0 1 1 0 1 1 0 1 0 0 0 1 1 0 0]
Pred: [1 0 0 0 0 1 0 1 1 1 0 1 1 0 1 1 1 1 0 0 0 0 1 0 0]
```

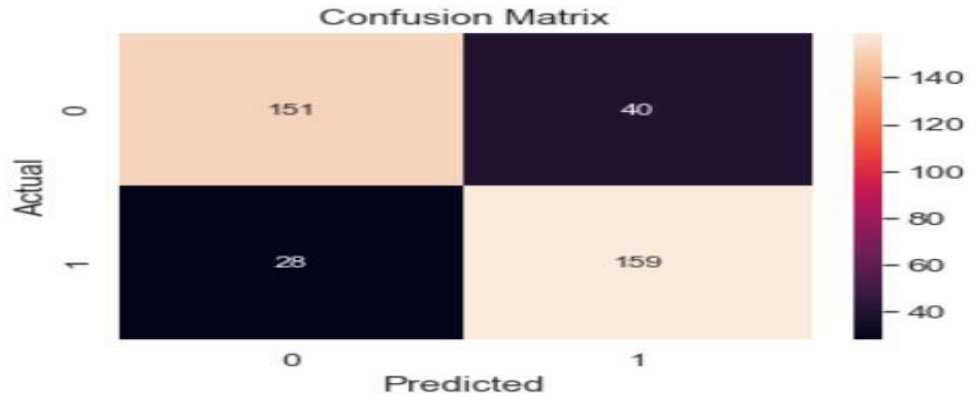



```
Classification Accuracy: 0.8174603174603174
Classification Error: 0.18253968253968256
False Positive Rate: 0.2827225130890052
Precision: 0.7610619469026548
AUC Score: 0.8185317915838397
Cross-validated AUC: 0.8746279095195426
First 10 predicted responses:
 [1 0 0 0 0 1 0 1 1 1]
```

Figure 25: Analysis of Boosting

Stacking

```
Accuracy: 0.8201058201058201
Null accuracy:
 0    191
1    187
Name: treatment, dtype: int64
Percentage of ones: 0.4947089947089947
Percentage of zeros: 0.5052910052910053
True: [0 0 0 0 0 0 0 0 1 1 0 1 1 0 1 1 0 1 0 0 0 1 1 0 0]
Pred: [1 0 0 0 0 1 0 0 1 1 0 1 1 1 1 1 0 1 0 0 0 0 1 0 0]
```




```
Classification Accuracy: 0.8201058201058201
Classification Error: 0.17989417989417988
False Positive Rate: 0.2094240837696335
Precision: 0.7989949748743719
AUC Score: 0.8204216479547554
Cross-validated AUC: 0.8431980281658662
First 10 predicted responses:
 [1 0 0 0 0 1 0 0 1 1]
```

Figure 26: Analysis of Stacking

Evaluation Model	Accuracy Achieved (in Percentage)
Logistic Regression	79.6
KNN Classifier	80.16
Decision Tree Classifier	80.68
Random Forest	81.21
Bagging	77.78
Boosting	81.75
Stacking	82.01

Table 2: Analysis of Models For Mental Health

Evaluation Of Diabetes Datasets

Logistic Regression

```
Accuracy: 0.7922077922077922
Precision: 0.6923076923076923
Recall: 0.574468085106383
F1 Score: 0.627906976744186
Cohens Kappa Score: 0.48548757569429946
Area Under Curve: 0.8558361503280971
Confusion Matrix:
 [[95 12]
 [20 27]]
```

Figure27: Analysis Of Logistic Regression

Decision Tree

```
Accuracy: 0.7272727272727273
Precision: 0.5454545454545454
Recall: 0.6382978723404256
F1 Score: 0.5882352941176471
Cohens Kappa Score: 0.3862212943632568
Area Under Curve: 0.7023265062636707
Confusion Matrix:
 [[82 25]
 [17 30]]
```

Figure28: Analysis of Of Decision Tree

Kth Nearest Neighbour

```
Accuracy: 0.7792207792207793
Precision: 0.6511627906976745
Recall: 0.5957446808510638
F1 Score: 0.6222222222222222
Cohens Kappa Score: 0.4666938276634752
Area Under Curve: 0.8304831974547624
Confusion Matrix:
 [[92 15]
 [19 28]]
```

Figure29: Analysis of Kth Nearest Neighbour

Ensemble Learning

Boosting

```
Accuracy: 0.7662337662337663
Precision: 0.6222222222222222
Recall: 0.5957446808510638
F1 Score: 0.608695652173913
Cohens Kappa Score: 0.442141275910646
Area Under Curve: 0.8027440843109962
Confusion Matrix:
 [[90 17]
 [19 28]]
```

Figure30: Analysis of Of Boosting Method

Bagging Method

```
Accuracy: 0.7727272727272727
Precision: 0.6304347826086957
Recall: 0.6170212765957447
F1 Score: 0.6236559139784946
Cohens Kappa Score: 0.4608921784356871
Area Under Curve: 0.8337641678266057
Confusion Matrix:
 [[90 17]
 [18 29]]
```

Figure31: Analysis of Bagging Method

Naïve Bayes

```
Classification Report is:
               precision    recall  f1-score   support

         0.0       0.81      0.87      0.84       107
         1.0       0.64      0.53      0.58        47

    accuracy                           0.77       154
   macro avg       0.72      0.70      0.71       154
weighted avg       0.76      0.77      0.76       154


 F1:
 0.5813953488372093

 Precision score is:
 0.6410256410256411

 Recall score is:
 0.5319148936170213
```

Figure32: Analysis Of Naïve Bayes

4.3 Risk Analysis and Mitigation

Risk

Risk Statement 1: Members were not proficient in dealing with the project problem.

Risk Statement 2: Discussion of how to make project problem more accurate and efficient.

Risk Statement 3: Issues related hardware like charger and laptop overheating because of low GPU and memory card.

Risk Statement 4: It was taking time to see the results as the process was taking time to load the results.

Risk Statement 5: Failing to follow the deadlines or timetable at some point because of personal activities, implementation issues,placements and exams preparations.

Risk ID	Risk Statement	Risk Area	Priority
1	Design(Hardware Constraints)	Testing Environment	5
2	Work Environment(Communication)	Personal Related	5
3	Management Process (Planning)	Project Scope	2

Table 3: Mapping of Risk statements according to SEI Risk Taxonomy

In the above table, risk statements are according to the SEI Risk Taxonomy. The risk areas are provided by the members according to the experiences and priorities have been assigned accordingly.

Mitigation

1. **Response:** Finding common time schedule for conducting meetings for planning and further implementation of project.

Effectiveness: Timely completion of project and understanding the problem encountered by each member of the team.

2. **Response:** Running the algorithm on Jupyter Notebook in different time intervals to get rid of heavy traffic and slow time response.

Effectiveness: Sometimes were able to get a fast timely response.

Risk	**Mitigation**
If too many users come simultaneously to the site, then they might suffer delay in adding doubts.	To avoid delay, we have used asynchronous functions in the models, so that the tasks which consume time, get executed in the backend.
Fetching and uploading media might take a long time.	To avoid delay in fetching and uploading media we have used a cloud service AWS, S3 bucket.
Unauthorized users try to access functions which are only for authorized users using url manipulation.	To avoid unauthorized access of data we have created private routes which will check if the user is authorized on every webpage.
If the user tries to bypass the frontend through any tool.	We have added authentication to the backend too, so that if user bypasses
If an unauthenticated user tries to use a functionality out of their scope.	We have added validation so that only authenticated users will be able to access the different functionalities.

Table 4: Risk and Mitigation

CHAPTER – 5 TESTING

5.1 Testing Plan

Type of Test	Will Test be Applicable?	Comments/Explanation	Software Component
Requirements Testing	Yes ☑ No ☐	Precision score and AUC score was calculated for each dataset.	Jupyter Notebook / Sublime Text Editor / VS Code / Google Colaboratory
Unit	Yes ☐ No ☑	Not required as per the project	N/A
Integration	Yes ☐ No ☑	Not required as per the project	N/A
Performance	Yes ☐ No ☑	Not required as per the project	N/A
Stress	Yes ☐ No ☑	Not required as per the project	N/A
Compliance	Yes ☐ No ☑	Not required as per the project	N/A
Security	Yes ☐ No ☑	Not required as per the project	N/A
Load	Yes ☐ No ☑	Not required as per the project	N/A

Table 5: Testing Plan

TEST ENVIRONMENT_PROVIDE A DESCRIPTION OF THE TESTING PLATFORMS
SOFTWARE ITEMS
Windows 10, 64 GB RAM, Intel i3 7th Gen
HARDWARE ITEMS
Computer

Table 6: Test Environment

5.2 Component Decomposition and Type of testing required.

5.3 List of all tests in prescribed format

Unit Testing

We tested the functionality of methods used to develop our websites and train out ML model.

Integration

To test the compatibility amongst the system components, we used these test

System

Software testing is a process to evaluate the functionality of a software application with an intent to find whether the developed software meets the specified requirements or not and to identify the defects to ensure that the product is defect-free in order to produce a quality product. It is a very important phase of the software development life cycle as it verifies and validates the system under test. With respect to a recommendation system, testing is highly important to ensure the system quality and functionality before delivery. In order to assess the system output, appropriate quality assessment techniques must be adopted to determine the system performance with respect to the benchmark level or similar products.

5.4 Error and Exception Handling

Types of debugging techniques

1. Print (or tracing) debugging

For designing our Machine Learning Model, to understand the working of model, we often tried logging the statements to judge the error in output, to improve the functionality.

2. Backtracking

Training the machine learning model, often requires the knowledge of having an aim to achieve, Once we clarity on this we backtrack to understand which algorithm can be used on our dataset to achieve the desired results.

3. Post-mortem debugging

We inspected the state of our application whether it has crashed or failed in some way, in order to determine the conditions that lead to the failure of our website.

5.2 Limitations of the solution

As with every approach, this also has some limitations. Since the models are being trained on publicly available datasets which might be filled with unsolicited and fake data they might turn out to be problematic when being used to diagnose and predict the conditions though this has been tried to reduce by sourcing the datasets from reliable healthcare services and by using multiple sources lead to reduced chances of fake data. In the full-stack component, the work has been reduced to the development of a full-stack website which doesn't give a proper all-device access for the product and solution being designed

CHAPTER 6- FINDINGS, CONCLUSIONS, AND FUTURE WORKS

6.1 Findings

The Aim of this project is to the create a digital infrastructure for healthcare management institutes with comprehensive solutions for healthcare human resources, patients and volunteers along with providing a machine learning powered platform to diagnoses. In phase one of the development, we developed the portals for doctors, patients and volunteers along with the machine learning models for mental health diagnoses

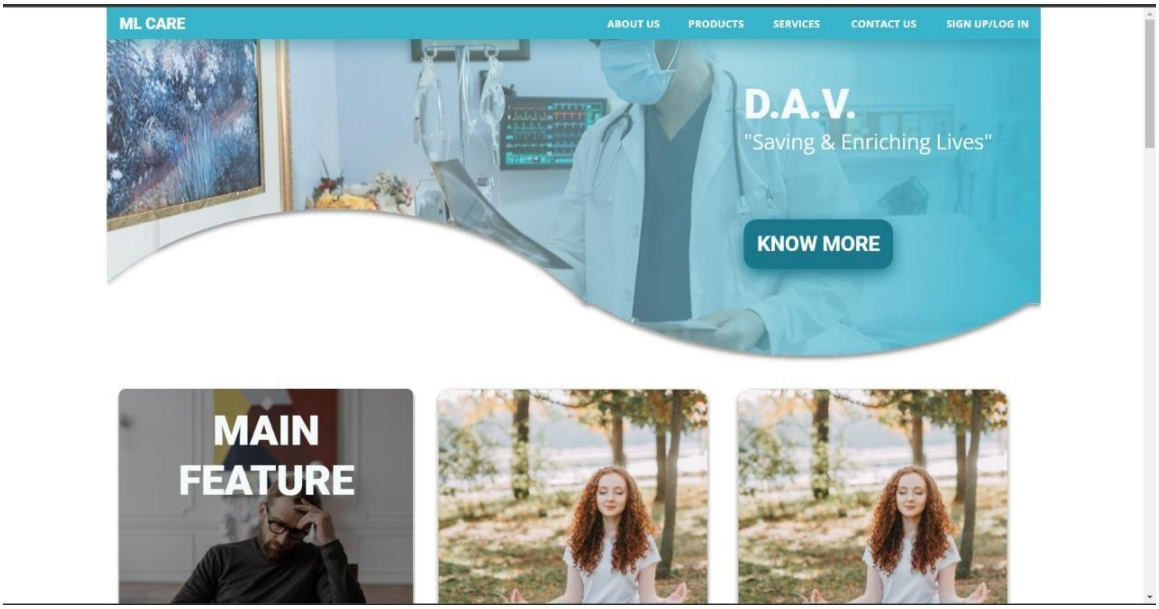


Figure 33: Website Home Page

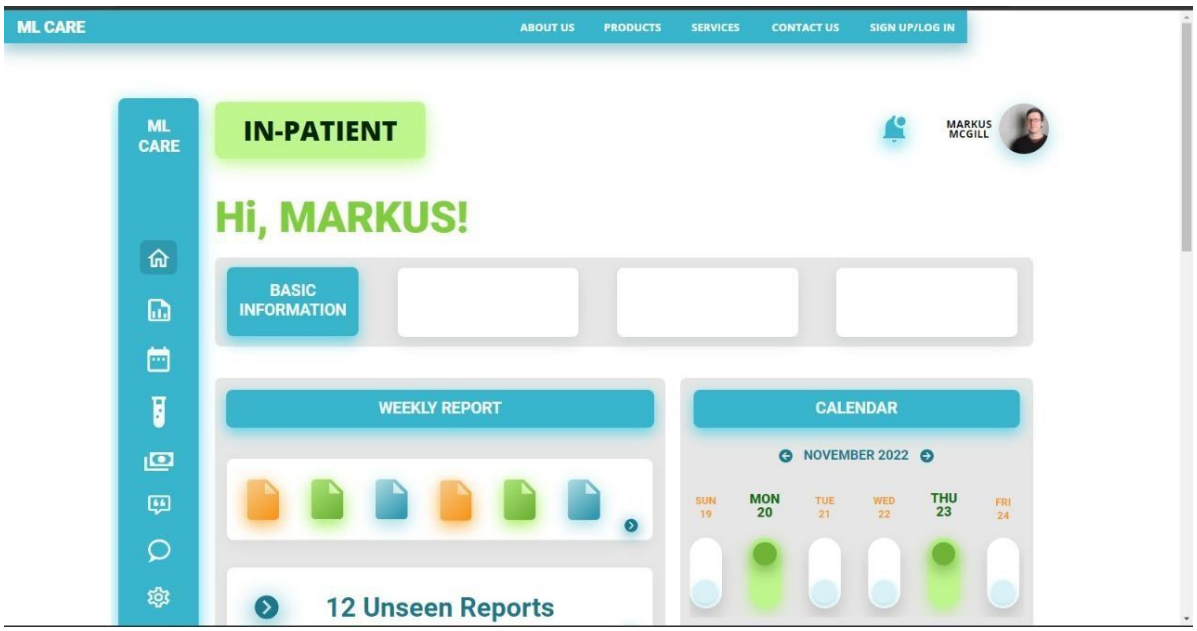


Figure 34: Patient Portal Page

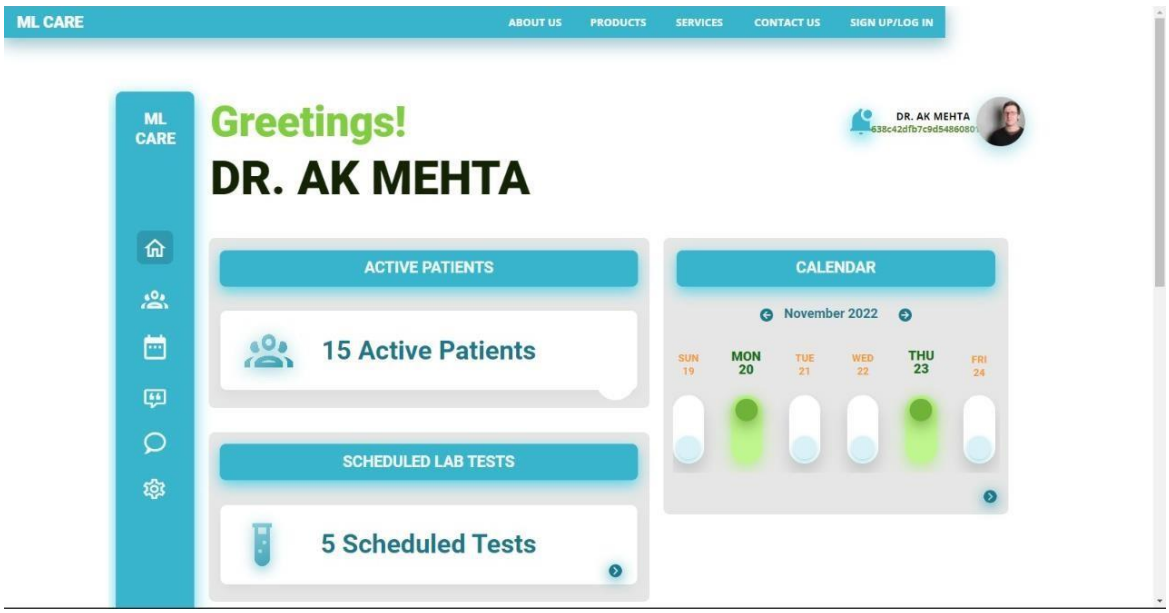


Figure 35: Doctor Portal Page

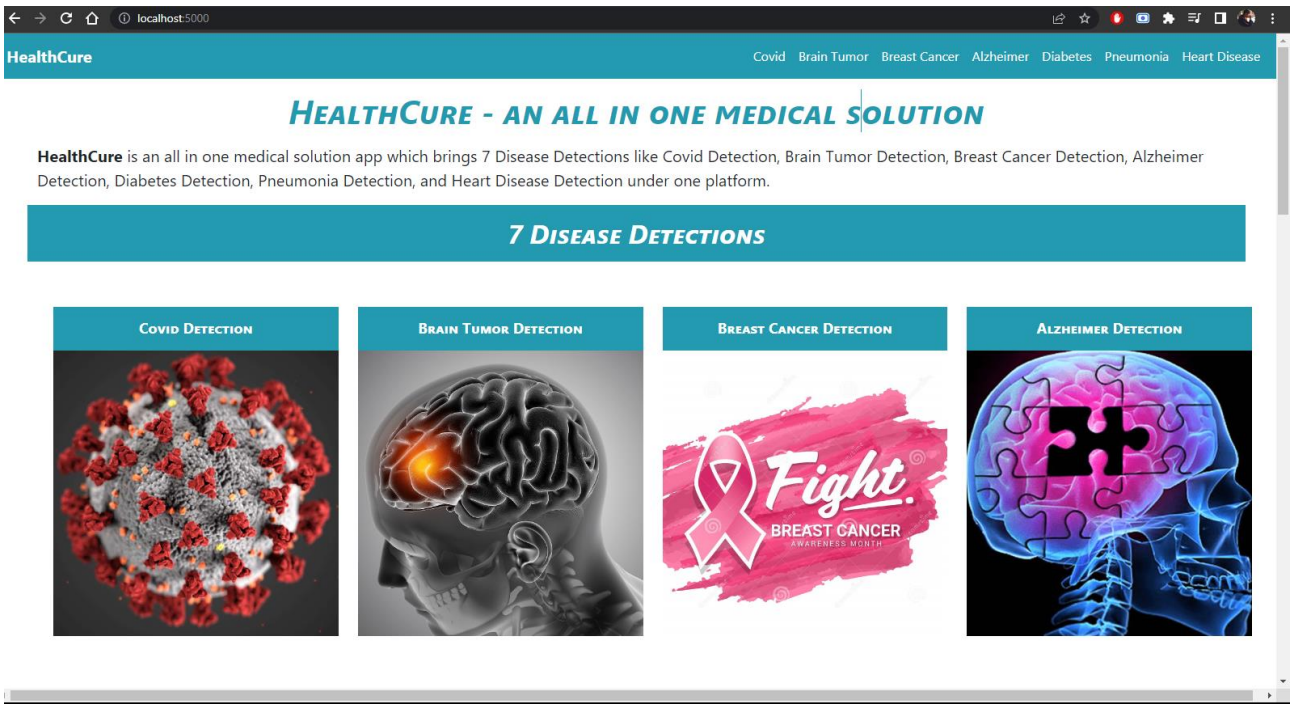


Figure 36: Homepage For ML-UI

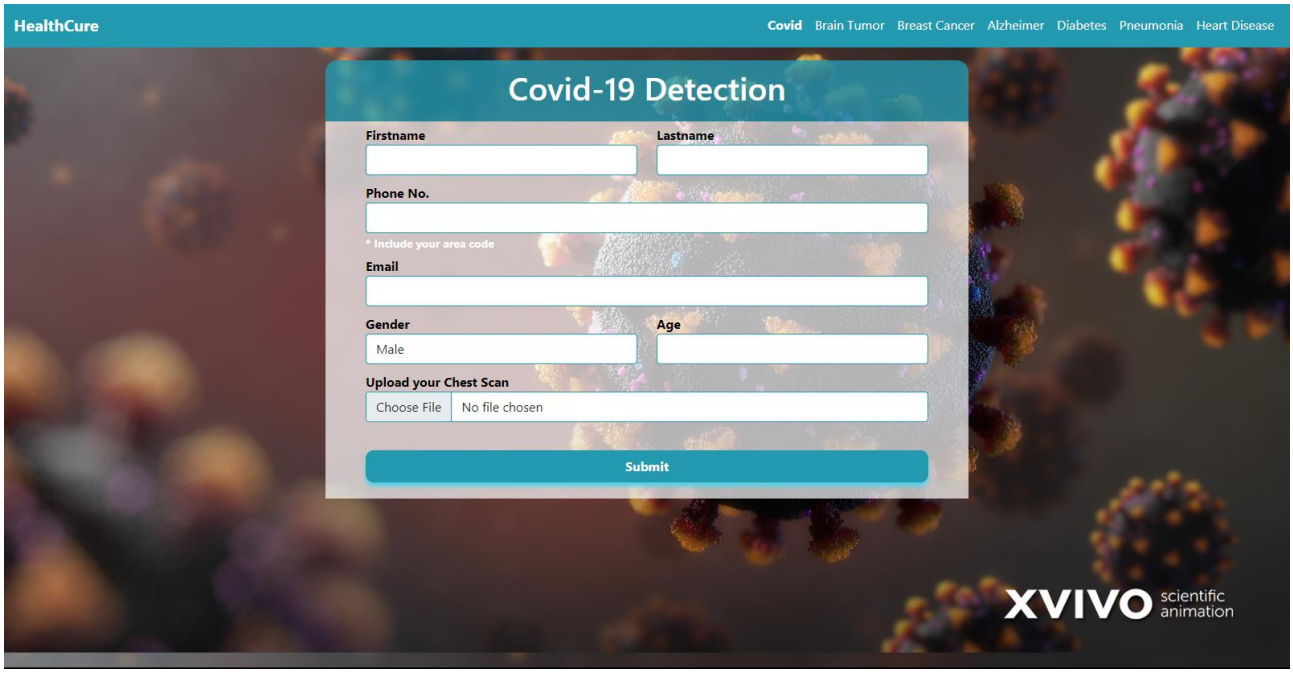


Figure37: Covid-19 Test Form

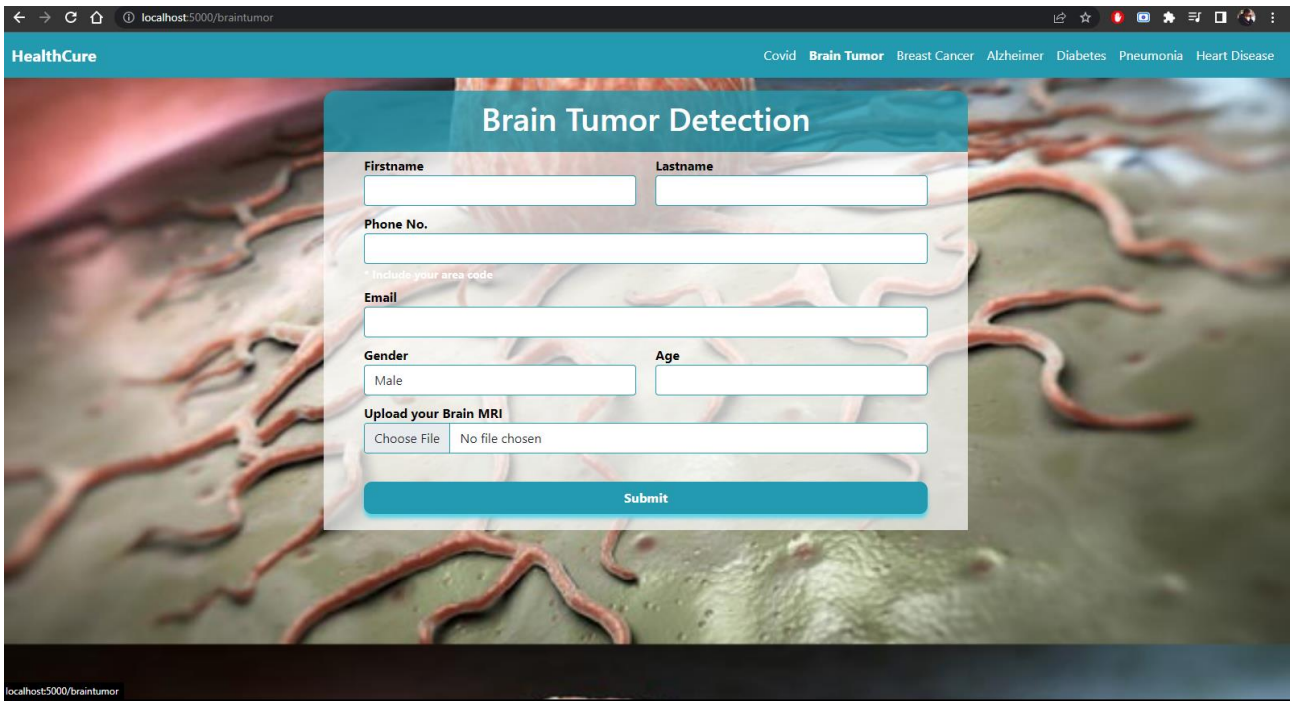


Figure 38: Brain Tumour Detection Form

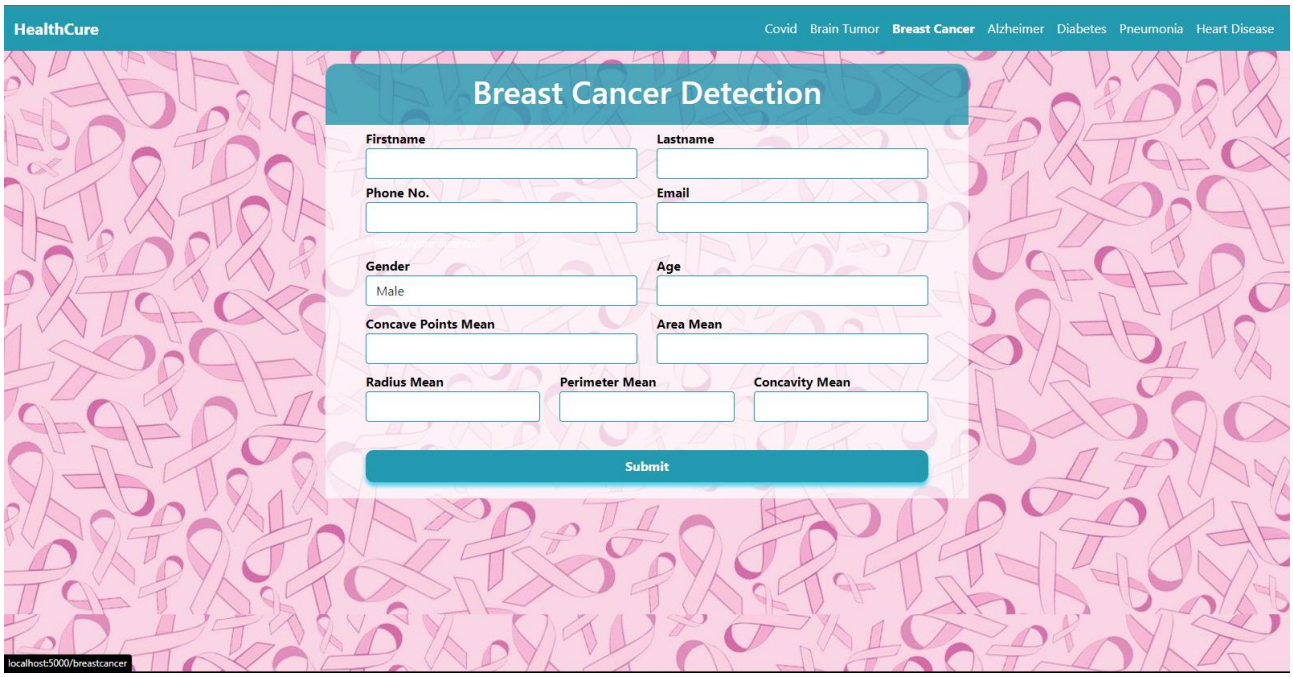


Figure 39: Breast Cancer Detection Form

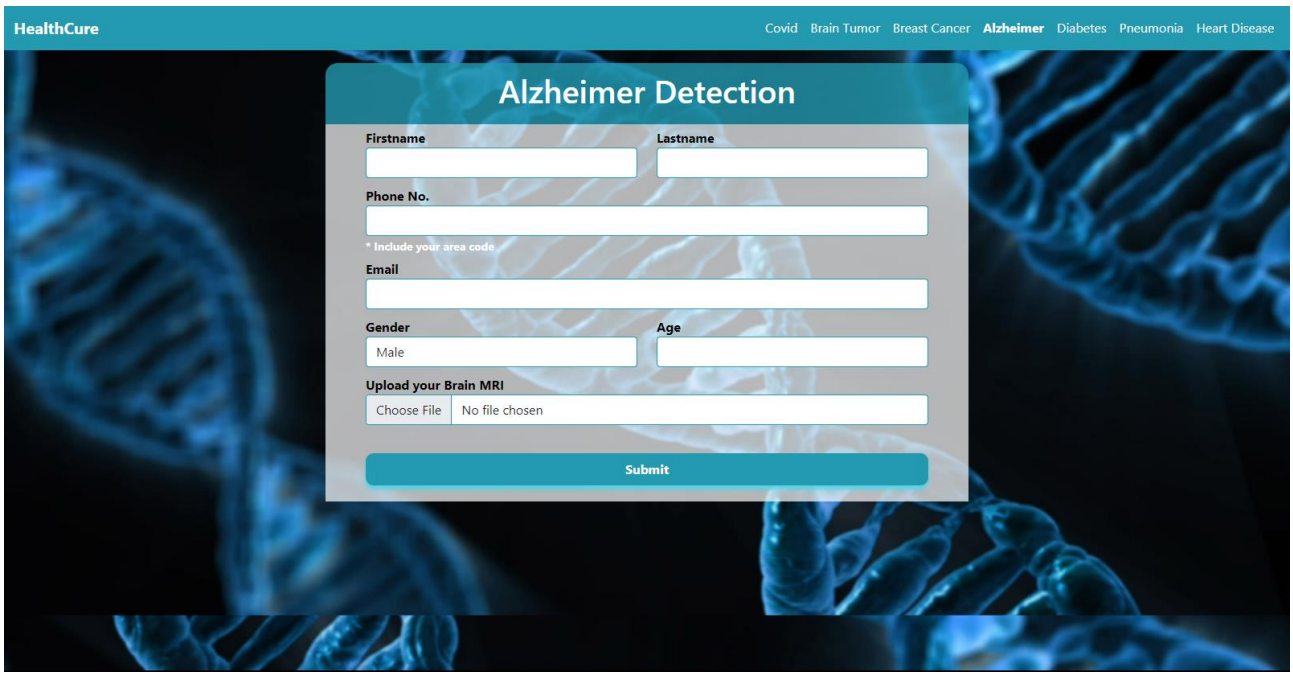


Figure 40: Alzheimer's Detection Form

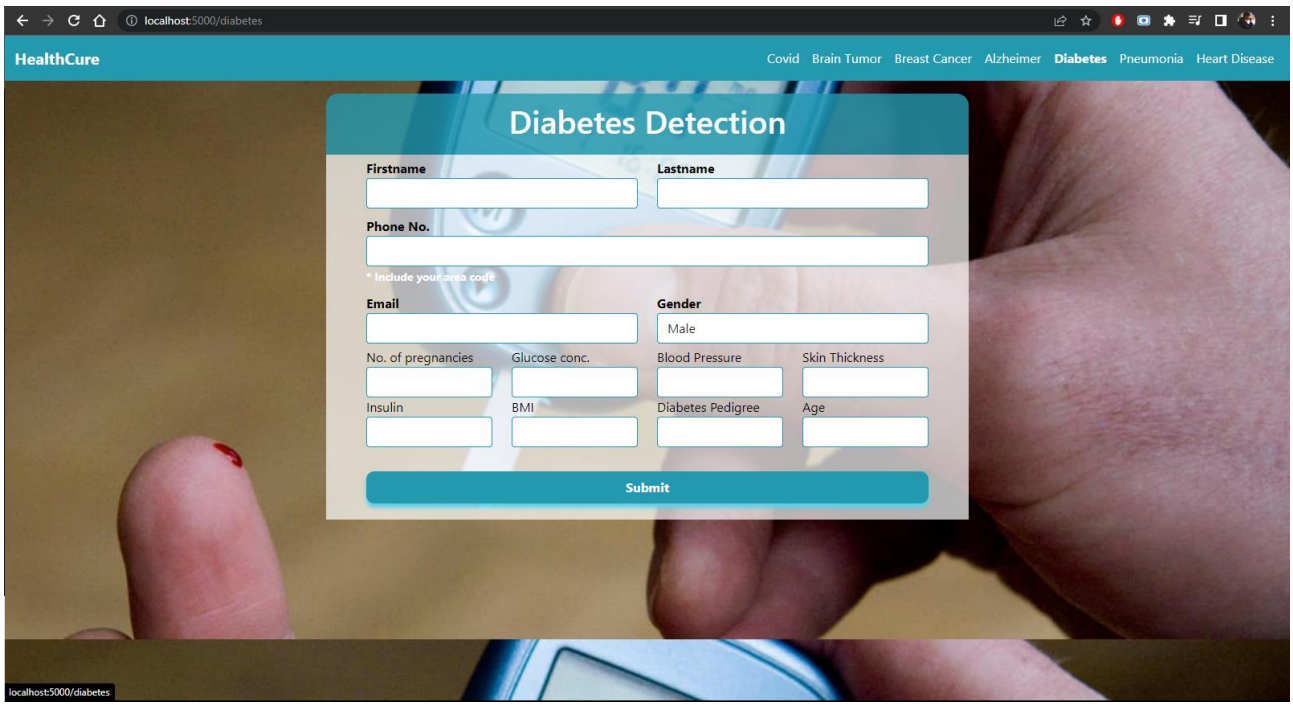


Figure 41: Diabetes Detection Form

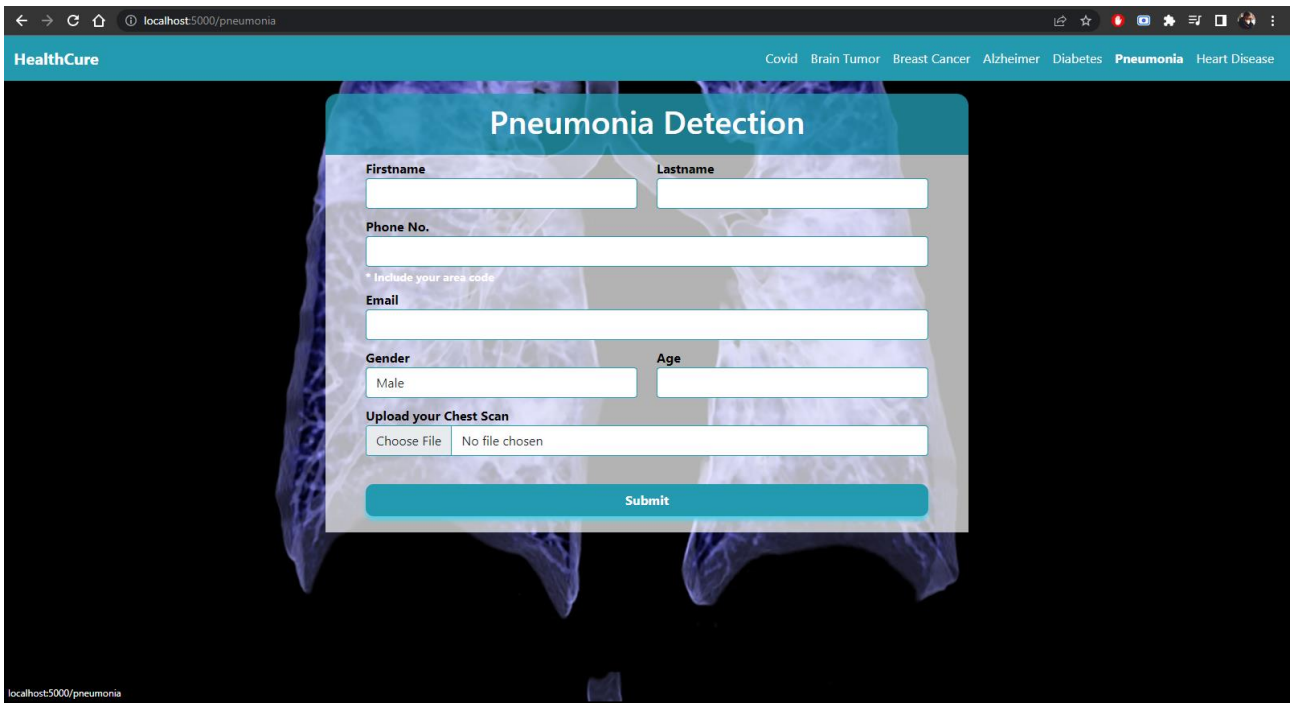


Figure 42:Pneumonia Detection Form

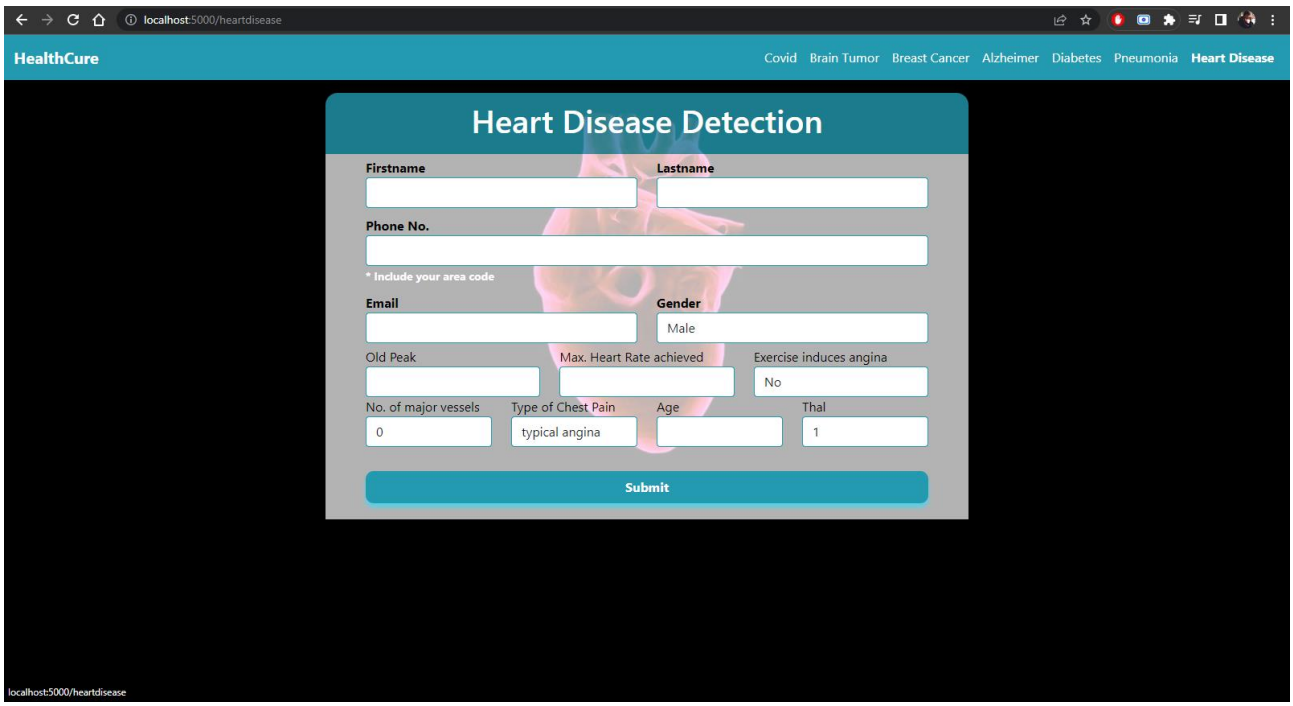


Figure 43: Heart Disease Detection Form

In Developing of the Mental Health Model we analysed the processed dataset over a number of conventional and hybrid algorithms and checked their accuracies, precisions and auc scores and opted for the best fitted and most accurate model in integration with the user platform.

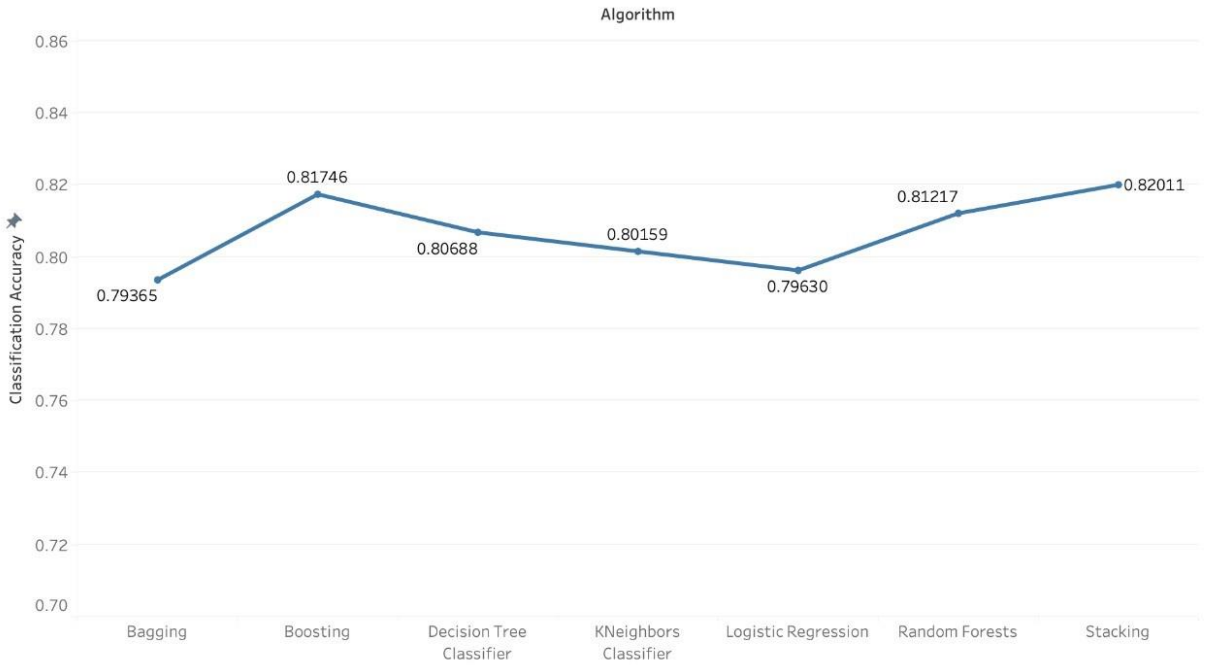


Figure 43: Classification Accuracy Of The Models Being trained

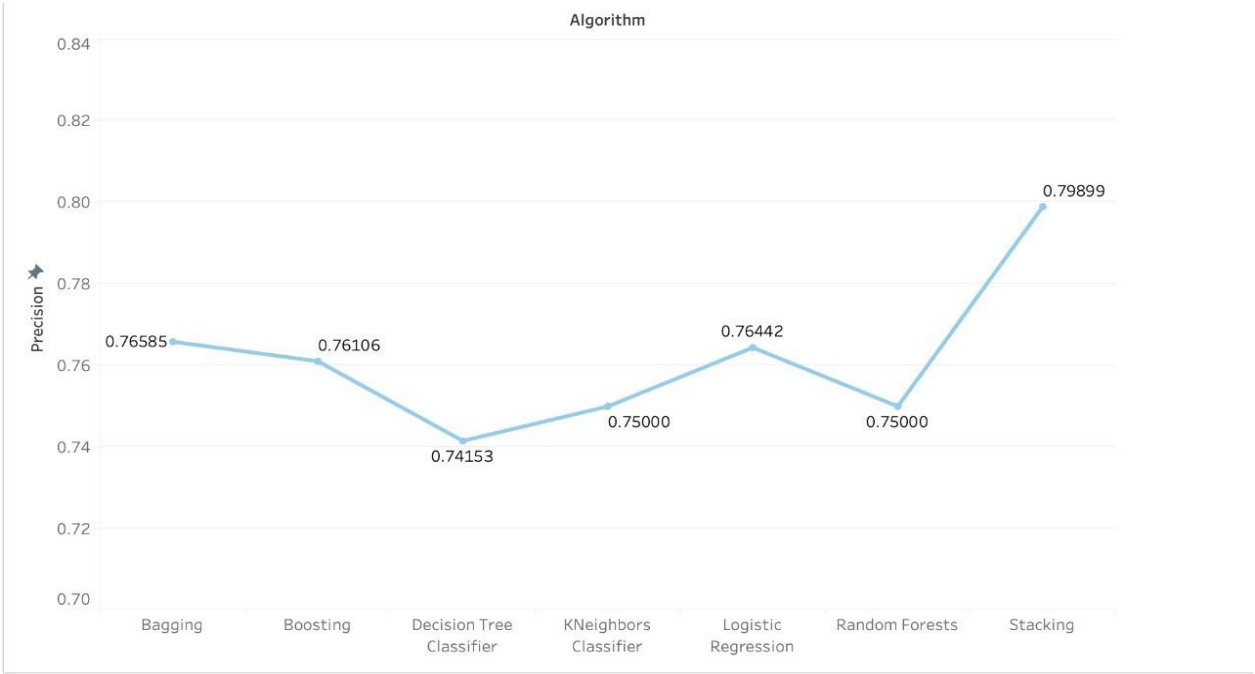


Figure 43: Classification Precision Of The Models

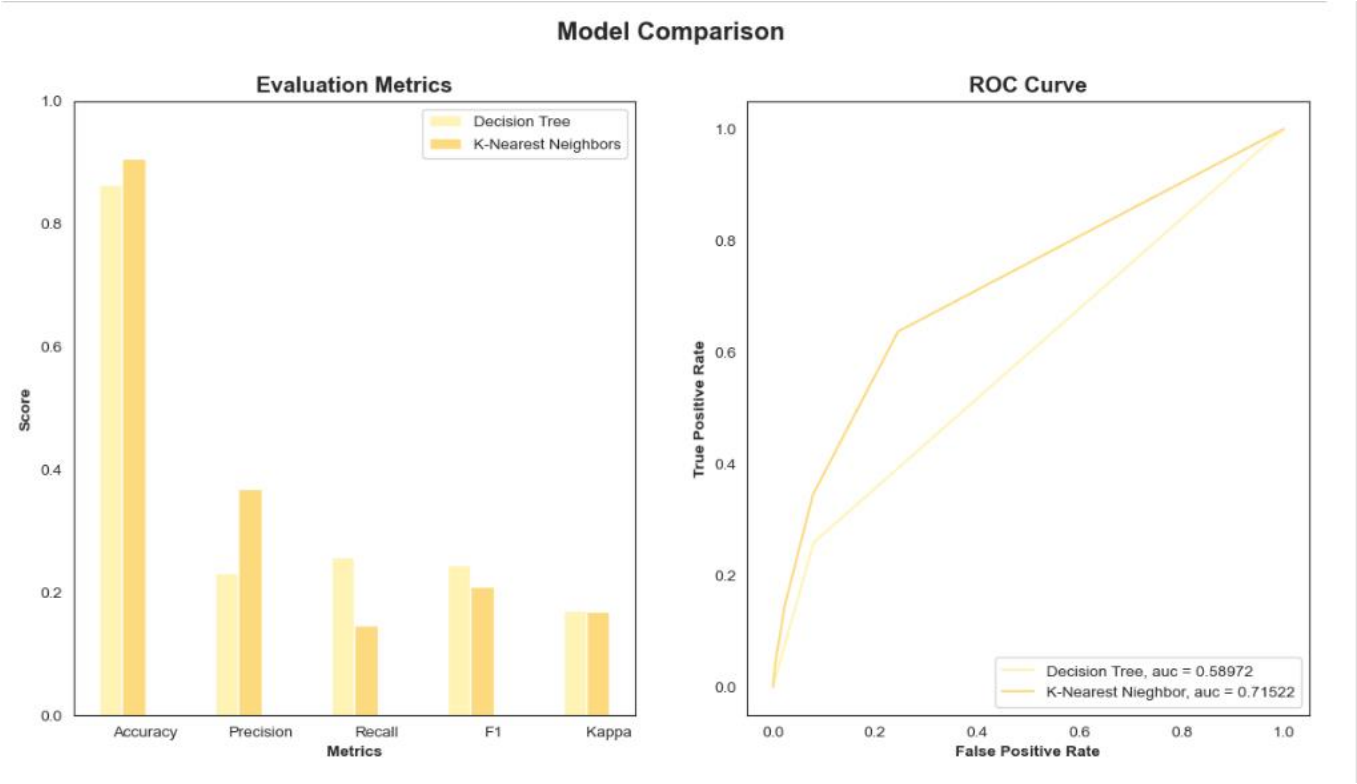


Figure 45: Heart Disease Prediction Comparison

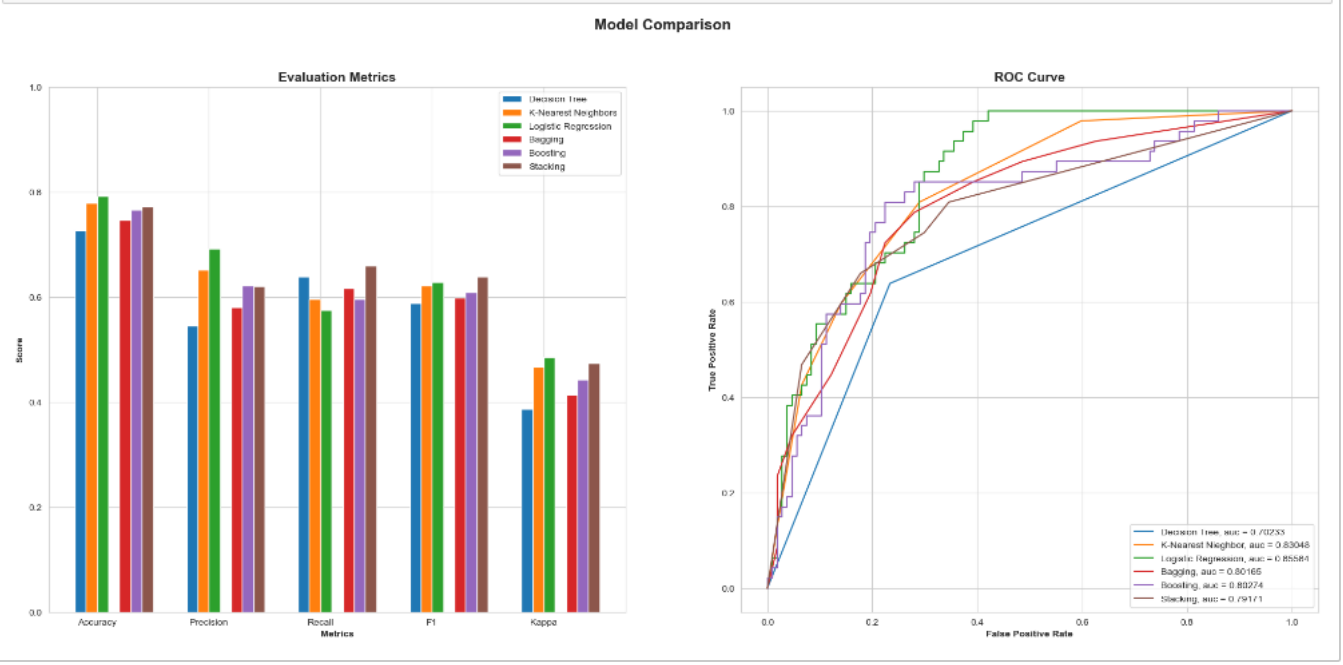


Figure46: Model Comparison For Diabetes Dataset

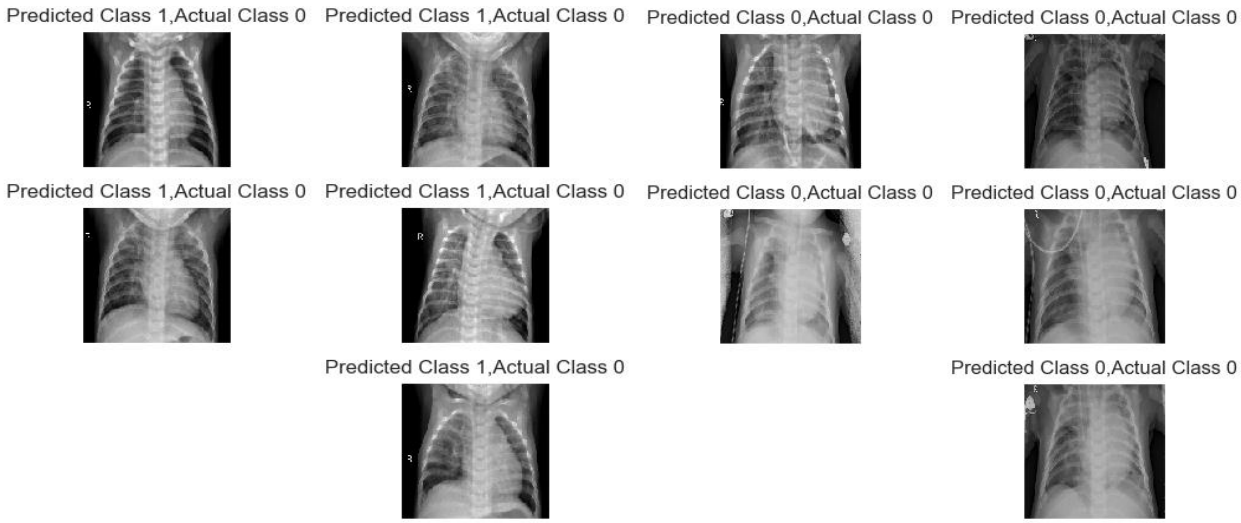


Figure 47: True/False Prediction Of Pneumonia

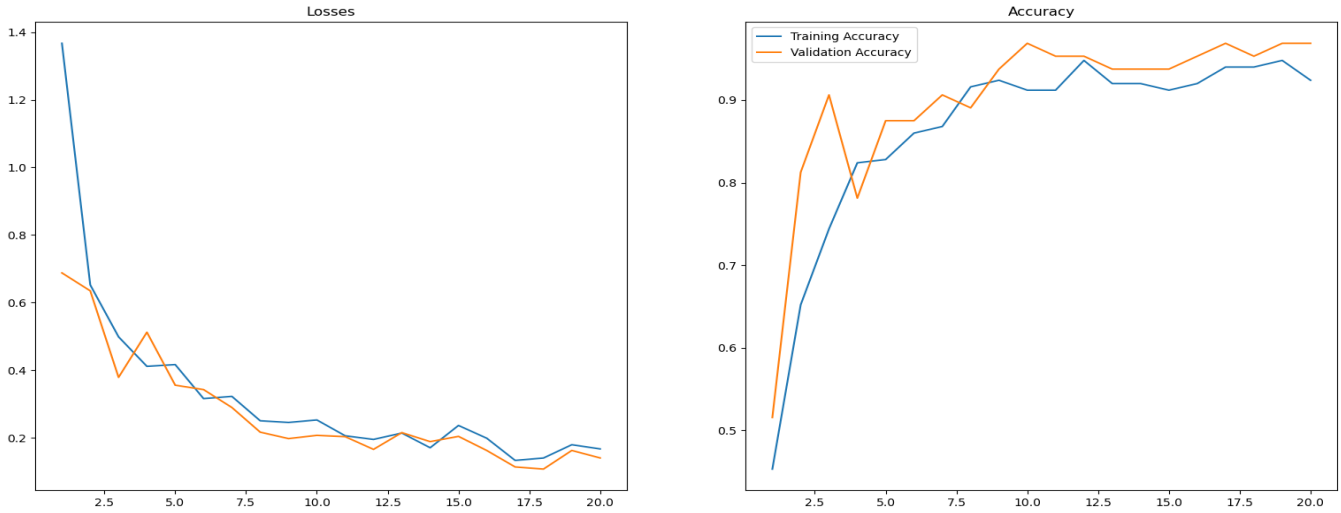


Figure48 : Analysis Of Covid Model

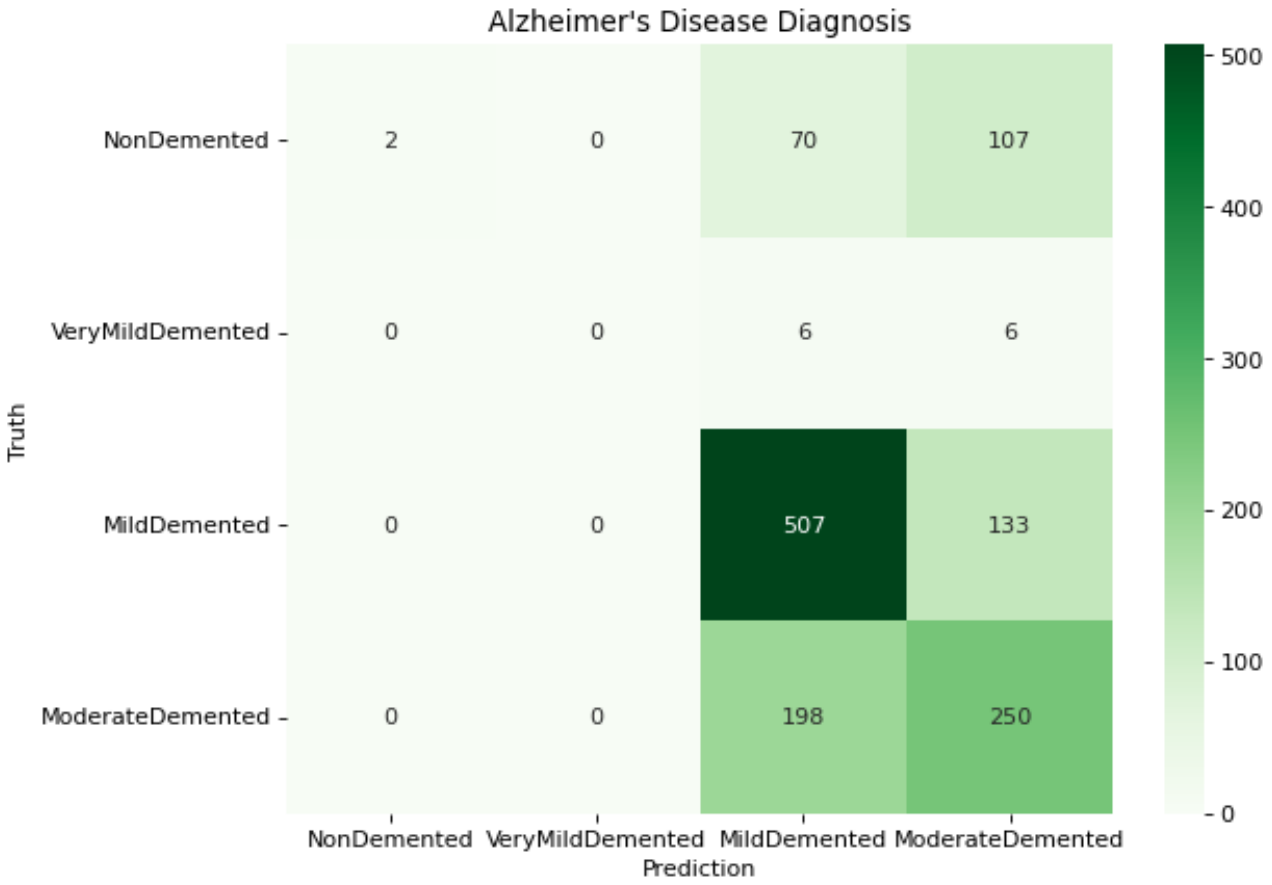


Figure 49 : Confusion Matrox Of Alzheimer’s

6.2 Conclusions

With the increasingly electronic and digital presence of the nation having electronic healthcare management that too with comprehensive solutions for medical workers doctors patients by providing them with personalised portals having different own options and features and providing an MLpowered form system for collecting information regarding symptoms and giving a tentative disease which later can be diagnosed by proper tests and other required and prescribed procedures as per the norms and regulations.

The application also tries to resolve the requirement and dependence on paper-based infrastructure and make everything digitalised and secure

6.3 Future Works

To improve the algorithms being used to train the machine-learning models to get better precision and accuracy. Along with optimizing the time complexities of the algorithms work to reduce the load and requirement of the processing power required to sustain the infrastructure being developed

Furthermore, there will be an addiction to other models and datasets of different health-related problems which will allow us to work and make our system more usable for people. lastly, the system are to be made more patient-friendly and easy to use with appropriate instructions and will provide data encryption in client details as well as the records in the hospital the system being used

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