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Heart Disease Prediction USING ML and Pandas

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ABSTRACT: Heart disease is one of the learning causes of death around the world . many people do not notice symptoms in the early stages , which makes early detection very important this project focuses on predicting heart disease using machine learning techniques . the system collects important medical details such age, blood presser , cholesterol level, heart rate, and other health factors to analyses person's condition.

Different machine learning algorithms are used to study past patient data and identify patterns related to heart disease. based on these patterns , the model checks the data and tells us if a person may have a heart risk . the main aim to this project is to help doctors and patients detect heart problems at an early stage so that proper treatment and preventive steps can be taken.

By using technology and data analysis , this model provides a faster , cost -effective , and reliable method foe heart disease prediction . this system can support medical professional in making better decisions and improving patient care

The model trained using medical data to improve prediction accuracy. If provides result in a short time, making the process efficient and user friendly. The approach can help in spreading awareness and encourages regular health checkups.

KEYWORDS: Heart disease prediction, machine learning, Healthcare Analytics, Classification Algorithms, Early Detection, Medical DataAnalysis, Risk Management, Predictive Modeling

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I. INTRODUCTION

Heart disease is one of the most serious health problems in the world today. Every year, many people lose their lives because of heart – related conditions . the main reasons for heart disease included unhealthy eating habits, lack of exercise ,stress , smoking ,alcohol consumption ,obesity ,and family history . in many cases heart disease does not show clear symptoms in the early stage which makes it difficult to detect on time

Early prediction of heart disease can help doctors and patients take preventive steps be before the condition becomes server. With the help of modern technologies and machine learning. It is now possible to analyses medical data and predictive whether a person is at risk of heart disease .machine learning models study pattern data such as age , blood pressure , cholesterol level, heart rate and other medical factors to make accurate predictions.

This major project focuses on developing a heart disease prediction system using machine learning techniques . the goal is to create a simple and efficient model that can assist doctors in making better decisions and help patients understand their health condition at an early stage. By using data – drive approaches , we aim to improve early diagnosis and reduce the number of heart disease cases .

1). Heart disease is one of the most common health problem in the world
2). Many people suffer from heart problems due to unhealthy food, lack of exercise ,stress ,smoking and obesity
3). In the early stage ,, heart disease may not shoe clear symptoms
4). Because of this , many people do not know about the problem until it becomes serious
5). Early detection of heart disease can help save lives
6). Machine learning helps in predicting disease using patient data
7). The system uses details like age, blood presser , cholesterol level . and heart rate
8). Based on this data , the model predicts whether a person has high pr low risk of heart disease

Detecting heart disease at an early stage is very important . if the risk is identified early , doctors can give proper treatment and advice to prevent serious completion .with the help of easier to analyse medical data and predictive the chance of heart disease. Machine learning models can study patient information like age , blood pressure, cholesterol level , heart rate and other health details . by finding patterns in this data the system can predictive whether a person is at high or low or risk .

This project is designed to develop a heart disease prediction system using machine learning techniques the aim to build a simple , accurate and user friendly model that can support doctors in making better decision . it can also help patients understand their health condition earlier and take necessary precautions . By using a data -driven approach , this system helps early diagnosis , improving health care support , and reduces the chances of server heart problems in the future

II. STATEMENT

1). Heart disease is increasing day by day
2). Many people do not know they have heart problems in early stage
3). Manual diagnosis can take time and sometimes may not be fully accurate
4). There is a need for system that can predict heart disease early using patient data
5). The system should help doctors in making faster and better decisions

This system helps in identifying heart disease risk at an early stage and supports better medical decisions. It can improve healthcare quality and help save many lives in the future.

III. LITERATURE REVIEW

A lot of work has been done on prediction of heart disease using different data mining and machine learning techniques. Based on increased prediction accuracy, many researchers have developed early diagnosis prediction systems. Some of the important pieces of research work on this topic are reviewed in the next section.
1). Detrano and his team created what came to be known as the Cleveland Heart Disease dataset, which would become one of the most widely used benchmark dataset in research into predicting heart disease. There are 303 records of patients in the dataset, accompanied by 14 medical characteristics, such as age, gender, resting blood pressure,

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cholesterol levels, fasting blood sugar, ECG results, and the highest heart rate. This ensured that classification algorithms could be compared fairly by researchers. However, the dataset is not comprehensive enough, to be reflective of healthcare realities or representative of diverse populations.

2). Gudadhe et al developed a Support Vector Machine (SVM) based heart disease predictive model. They compared SVM with other classification methods and observed that SVM gives better accuracy, mainly in medical diagnosis. Their study has also established that using SVM it is possible to distinguish patients with heart disease from those without the disease. SVM is computationally intensive, and its speed reduces when large datasets are involved, thus making the algorithm unsuitable for real-time health-care systems.

3). Amin and his team developed an ensemble learning approach to boost heart disease's predictive performance. The classifiers are Logistic Regression, Decision Tree, and Random Forest. Their findings show that ensemble techniques reduce overfitting and provide better predictions than a single classification technique. On the downside, ensemble models escalate complexity and necessitate more time to train and tune hyperparameters.

4). Jabbar et al. have developed a heart disease prediction model relying on a Decision Tree after cleaning and preparing the data. The authors work concerned missing values, noise removal, and feature selection to improve accuracy. Selection of the most appropriate attributes and noise elimination resulted in more accurate results. Decision Tree overfits data when it works with bigger data samples.

5). Tomov and his team assessed the predictive performance of machine learning algorithms, such as Logistic Regression and Random Forest, on cardiovascular disease. Their study proved that the random forest has more accuracy because it is an ensemble learning technique that combines many models to reduce the margin of error in predictions. Besides this, they also highlight the importance of feature selection in the prediction model to improve its performance. The amount of data that is required is large, and the training takes longer before the results are stable.

6). Haq et al. developed a hybrid model in which genetic algorithms were combined with classifiers KNN, SVM and Random forest, with the genetic algorithms being used to identify relevant features. They are able to optimize prediction accuracy and minimize the computational power requirements based on the output.

The study performed by Haq and the others demonstrates the impact of feature optimization in enhancing model accuracy. System design becomes complex with genetic algorithms, and so is the processing time.

7). Khan et al. suggested Logistic Regression combined with K-Nearest Neighbors (KNN) for a heart disease prediction system. The k-nearest neighbors helped sort the patients against their neighbors. The hybrid was supposed to increase predictive accuracy and reduce classification errors. KNN is very slow for large datasets because all training samples have to be rechecked for every new sample.

IV. RESEARCHMETHODOLOGY

In this project , we are trying to build a system that can predict heart disease at early stage using machine learning . heart disease is serious health problem , and many people may not realize they have it until becomes severe . so , early prediction is very important because it can help doctors give treatment at the right time and reduce health risks.

4.1 PROBLEM IDENTIFICATION

1). Heart disease is one the leading causes of death worldwide
2). Many people do not show early symptoms
3). Early prediction can help doctors take preventive action
4). The goal of this project is to build a machine learning model that predicts whether a person has disease or not

4.2 DATA COLLECTION

The dataset was collected from a trusted medical dataset such as the UCI Heart Disease Dataset
It contains patient health details like:

- Age
- Gender
- Blood Pressure
- Cholesterol level
- Chest pain type
- Maximum heart rate
- Blood sugar

These features help in predicting heart disease

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4.3 DATA PREPROCESSING

1) Removed missing or incorrect values
2) Convert categorial values (like chest pain type) into numerical format
3) Normalized the data to bring all values to same scale
4) Split the dataset into
5) Training data(used to train the model)
6) Testing data (used to test the model performance)

4.4 EXPLORATORY DATA ANALYSIS (EDA)

1. Analyse to dataset using graphs and charts
2. Checked correlation between features and heart disease
3. Identified which features influence heart disease the most
4. Visualized data using bat charts , histograms , and , heatmaps

4.5 MODEL SELECTION

Different machine learning algorithms were used, such as

- Random forest
- K-Nearest Neighbors (KNN) Support Vector Machine (SVM)

This models were selected to compare performance and accuracy

4.6 MODEL TESTING & EVALUTION

The model was tested using unseen testing data
Performance metrics used :

- Accuracy
- Precision
- Recall
- F1- Score
- Confusion matrix

The best model was selected based on highest accuracy and balanced performance

4.7 Performance Metrics Comparision:

Model	Accuracy	Precision	recall	F1- Score
K – Nearest Neighbors (KNN)	0.8587	0.8621	0.8587	0.8589
Support Vector Machine (SVM)	0.8696	0.8712	0.8696	0.8698
Random Forest	0.8804	0.8819	0.8804	0.8806

4.8 Comparative Performance Analysis:

Model	Accuracy	Precision	Recall	F1-Score	Average
Random Forest	0.8804	0.8819	0.8804	0.8804	0.8808
Support Vector Machine (SVM)	0.8696	0.8712	0.8696	0.8696	0.8701
K-Nearest Neighbors (KNN)	0.8587	0.8621	0.8587	0.8587	0.8596

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4.9 Backend Development

We built and tested the login module as the main security gate for the Heart Scan Dashboard. It's the first thing standing between sensitive health data and anyone trying to sneak in. When users want access, they hit the login page and punch in their username and password.

While testing, the system checked those details against what's in the database. If the info matched, users got in. Type in the wrong credentials? The system threw up an error and blocked access. Simple, but it did the job—no one's getting to private health info without the right login. Once inside, users landed on the main dashboard with all the good stuff—Diagnosis, Chatbot, Doctors, Appointments. The whole login flow was designed to be quick and painless, so people could get where they needed to go without getting stuck.

We checked the logout feature too. No issues there. When someone clicked logout, the system wiped their session and sent them back to the login page to keep things tight.

In the end, the login module locked down the system, kept user data safe, and made sure only registered folks could use the heart disease prediction platform.

4.10 Frontend Development

In our project , format is the part that users can see and interact with . we designed it in simple and clear way so that anyone it easily without confusion

We used HTML to create the basic structure of web pages CSS to make the design look neat and attractive , and java script to add some interactive features . the main aim was to keep the design clean and user -friendly

The system has login page and a register page for new users . after logging in, users can enter their health details like age , blood pressure , cholesterol level , and other medical information .once they submit details, the prediction result on the screen

Overall the frontend makes the system easy to use and helps users quickly get their heart disease predicte

4.11 Integration of Frontend and Backend

Integration is the point where the frontend and backend actually begin to communicate. When someone fills out the form and hits submit, the frontend sends that data to the backend as a JSON request. The backend pulls the data, runs it through the trained machine learning model, and then sends the prediction back. This setup lets users get predictions right away, with no waiting needed. The app is a web-based healthcare tool that lets people quickly check heart disease risk by entering patient details.

V. RESULT ANALYSIS

Experimental Setup

To see how well the Heart Disease Prediction system works, the full model was built and tested on a local setup. For this project, I got the dataset from the UCI Heart Disease repository and brought it into Python to work with.

We handled data preprocessing with the Pandas library. At this point, we took care of missing values, got rid of duplicate records, and changed the categorical features into numbers. These steps made the dataset better and helped the model work more accurately.

After cleaning up the data, we split it into training and testing sets. The machine learning models were trained using the training data, and the testing data was used to check how well they performed. I used the Scikit-learn library to run algorithms like Logistic Regression, Decision Tree, and Random Forest.

Out of all the models, Random Forest gave the best accuracy and performed better overall. It was chosen as the final prediction model because it can cut down on overfitting and handle tricky data patterns well.

The trained model was saved with Pickle or Joblib and then linked to a Flask backend. This made it possible for the system to provide real-time predictions right through the web interface

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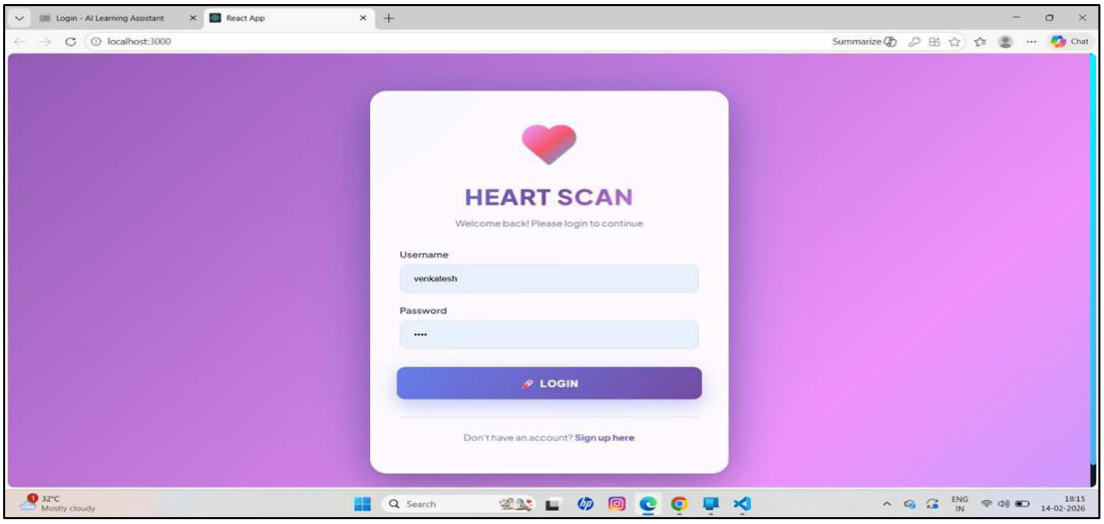

We built and tested the login module as the main security gate for the Heart Scan Dashboard. It's the first thing standing between sensitive health data and anyone trying to sneak in. When users want access, they hit the login page and punch in their username and password.

While testing, the system checked those details against what's in the database. If the info matched, users got in. Type in the wrong credentials? The system threw up an error and blocked access. Simple, but it did the job—no one's getting to private health info without the right login.

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In the end, the login module locked down the system, kept user data safe, and made sure only registered folks could use the heart disease prediction plan

5.1 System Dashboard Interface

We set up and tested the Heart Scan Dashboard, and honestly, everything just worked. This is the main page — the one everyone lands on after logging in. Right up top, you get all the important features: Diagnosis, Chatbot, Doctors, Appointments. Testing went smoothly. The dashboard loaded fast, and switching between sections felt seamless. No weird lags or broken links. Using it feels straightforward.

In the Patient Diagnosis section, things are pretty clear. Users fill in details like age, gender, resting blood pressure, cholesterol, max heart rate, oldpeak, chest pain type, and slope. Once they've got everything in, they just hit "Generate AI Report." The system grabs the info, runs it through the trained machine learning model, and instantly gives a prediction

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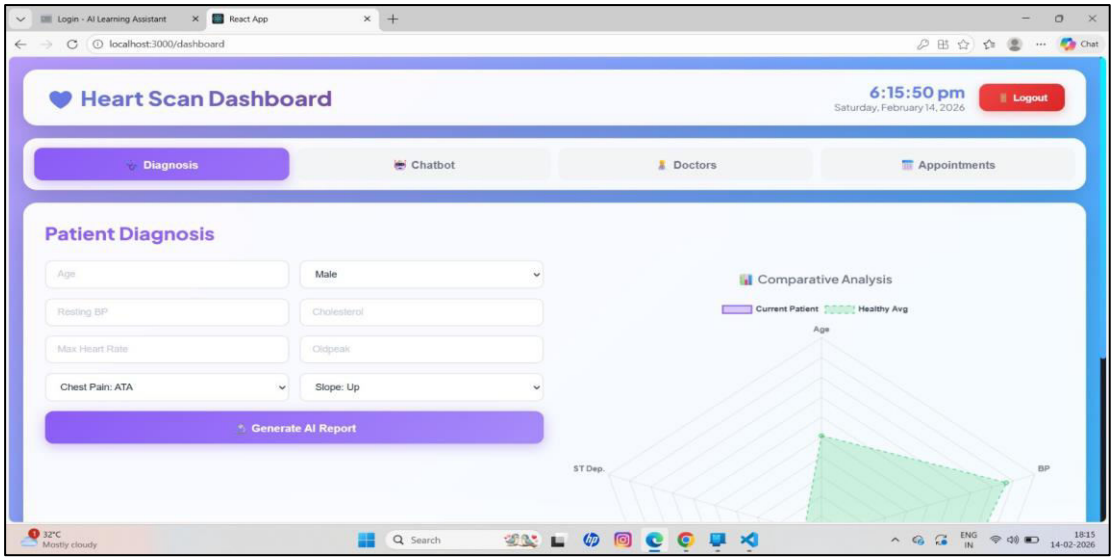
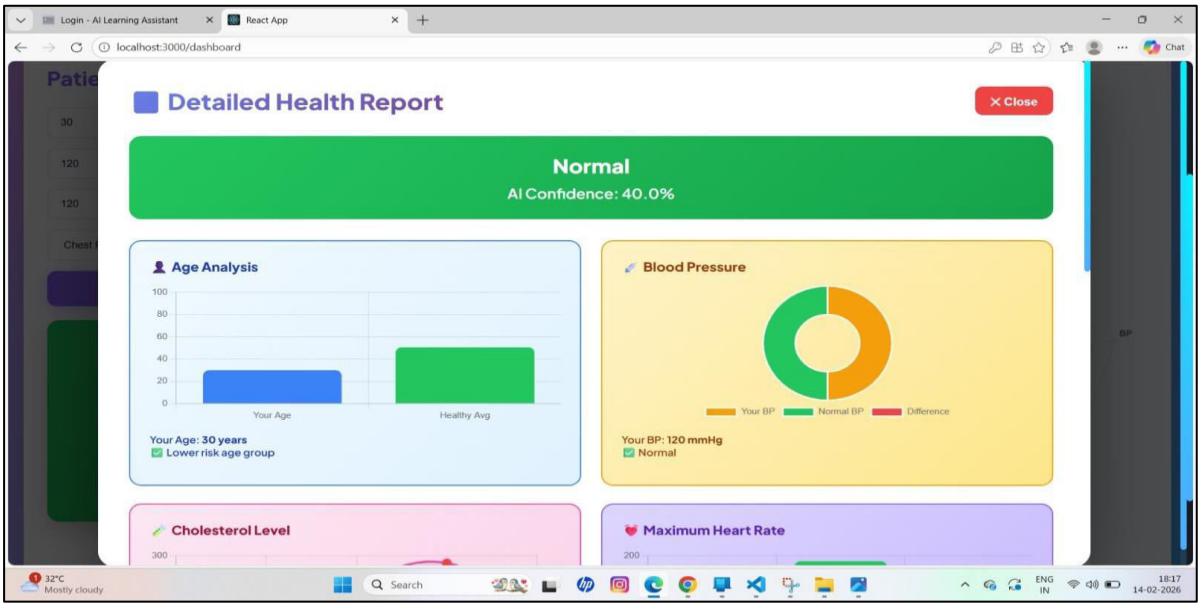


5.2 Graphical Health Report



The graphical representation module was built to help users easily understand the patient's health condition. Once I filled in the necessary information in the diagnosis section and ran the report, the system showed a Detailed Health Report window with the final prediction result. In this case, the overall condition was labeled as "Normal."The report showed an AI confidence level of 40.0% shows how much the trained machine learning model backs up the prediction.

The module showed the patient's medical data using visuals like bar graphs and pie charts. These visuals made it simple for users to see how their health measurements stacked up against typical healthy values. For example, the Age Analysis graph showed the patient's age alongside the usual healthy age group, making it easier for users to see age-related risk factors. The Blood Pressure chart showed if the patient's blood pressure was in the normal range. Charts showing cholesterol level and maximum heart rate were added to give a fuller picture of the patient's health.

This visual method made the results simpler to follow, especially for people without a technical background. It made things clearer and easier to understand by showing the information in a visual and organized way. The graphical report helped people make better decisions by showing the prediction results clearly and in a way that was easy to understanad

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VI. CONCLUSION

We built a Heart Disease Prediction System that uses machine learning to spot people at risk for heart disease. To get there, we started by cleaning up our data with Pandas—fixing missing values, converting categories to numbers, and scaling the features so everything lined up nicely. The data itself came from a reliable source, so we knew we were working with something solid.

We looked at important medical info: age, blood pressure, cholesterol, chest pain type, heart rate. Then we tested different algorithms—Logistic Regression, Decision Tree, and Random Forest—to see what worked best. Random Forest really stood out. It gave us the most accurate and consistent results, so we ran with that.

Once the model was trained, we set it up in a web app. Flask took care of the backend, React handled the frontend. Users could plug in their medical details and get instant predictions. The app even generated clear, visual health reports, making it easy to see what's going on at a glance.

In the end, this project proves that machine learning actually helps with early detection of heart disease. It saves time, speeds up decision-making, and gives both doctors and patients better info to work with.
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