

Visualizing and Predicting Heart Diseases with an Interactive Dashboard

**NALAIYA THIRAN PROJECT REPORT
2022**

Submitted by

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Content

1. INTRODUCTION

- 1.1 Project Overview
- 1.2 Purpose

2. LITERATURE SURVEY

- 2.1 Existing problem
- 2.2 References
- 2.3 Problem Statement Definition

3. IDEATION & PROPOSED SOLUTION

- 3.1 Empathy Map Canvas
- 3.2 Ideation & Brainstorming
- 3.3 Proposed Solution
- 3.4 Problem Solution fit

4. REQUIREMENT ANALYSIS

- 4.1 Functional requirement
- 4.2 Non-Functional requirements

5. PROJECT DESIGN

- 5.1 Data Flow Diagrams
- 5.2 Solution & Technical Architecture
- 5.3 User Stories

6. PROJECT PLANNING & SCHEDULING

- 6.1 Sprint Planning & Estimation
- 6.2 Sprint Delivery Schedule
- 6.3 Reports from JIRA

7. CODING & SOLUTIONING (Explain the features added in the project along with code)

- 7.1 Feature 1
- 7.2 Feature 2

8. TESTING

- 8.1 Test Cases
- 8.2 User Acceptance Testing

9. RESULTS

- 9.1 Performance Metrics

10. ADVANTAGES & DISADVANTAGES

11. CONCLUSION

12. FUTURE SCOPE

13. APPENDIX

Source Code

GitHub & Project Demo Link

TEAM ID : PNT2022TMID08900

VISUALIZING AND PREDICTING HEART DISEASES WITH AN INTERACTIVE DASHBOARD

1. Introduction

1.1 Project Overview

The leading cause of death in the developed world is heart disease. Therefore, there needs to be work done to help prevent the risks of having a heart attack or stroke. This project aims to create an interactive Dashboard using IBM Cognos Tool and dataset to predict which patients are most likely to suffer from a heart disease in the near future using the features given.

1.2 Purpose

Heart disease (HD) is a major cause of mortality in modern society. Medical diagnosis is an extremely important but complicated task that should be performed accurately and efficiently. Cardiovascular disease is difficult to detect due to several risk factors, including high blood pressure, cholesterol, and an abnormal pulse rate. Based on the analytics we can analyze which patients are most likely to suffer from heart disease in the near future and based on the patient details we will make decisions to cure them.

2. Literature Survey

2.1 Existing Problem

Even though we have smart watches that constantly monitor various aspects like heart rate, oxygen levels, etc but it doesn't give us any conclusive results on the person's health. We also have applications that give ECG from smart watches.

Heart Disease is a complicated disease which is caused by a lot of attributes. Even though devices give us a lot of data we need to compare, analyze and interpret them to make it useful.

2.2 References

B. Dun, E. Wang, and S. Majumder, "Heart disease diagnosis on medical data using ensemble learning," 2016.

Deep learning, which belongs to a larger family of machine learning techniques, has the ability to effectively examine a lot of data. In this, overview of these machine learning techniques that may be used to improve the functionality and intelligence of an application. Determining the fundamentals of various machine learning approaches and how they can be used in a variety of real-world application areas, including cybersecurity systems, smart cities, healthcare, e-commerce, agriculture, and many more, is thus the core contribution of this work. We also discuss the difficulties and potential possibilities for future research based on our findings. Overall, this work seeks to serve as a resource for decision-makers in a range of practical scenarios and applications, including those in academia and industry.

F. Yaghoubi, F. Yaghoubi, A. Ayatollahi, and R. Soleimani, "Classification of cardiac abnormalities using reduced features".

In this study, a clinical decision support system (CDSS) that analyzes patients with heart failure (HF) and generates a variety of outputs, including an assessment of the severity of the HF, a prediction of the type of HF, and a management interface that contrasts the follow-ups of the various patients. The entire system is made up of an intelligent core component and an HF special-purpose management tool that also serves as an interface for training and using artificial intelligence. A machine learning strategy to put the smart intelligent functions into practice.

World Health Organization, Cardiovascular Diseases, WHO, Geneva, Switzerland, 2020.

By applying different machine learning algorithms and then using deep learning to see what difference comes when it is applied to the data, three approaches were used. In the first approach, normal dataset which is acquired is directly used for classification, and in the second approach, the data with feature selection are taken care of and there is no outliers detection.

American Heart Association, Classes of Heart Failure, American Heart Association, Chicago, IL, USA, 2020.

By providing more reliable and consistent techniques for the detection, classification, reconstruction, denoising, quantification, and segmentation of patterns in biomedical pictures, deep learning and machine learning have made significant advances in the field of biomedical image analysis.

2.3 Problem Statement Definition

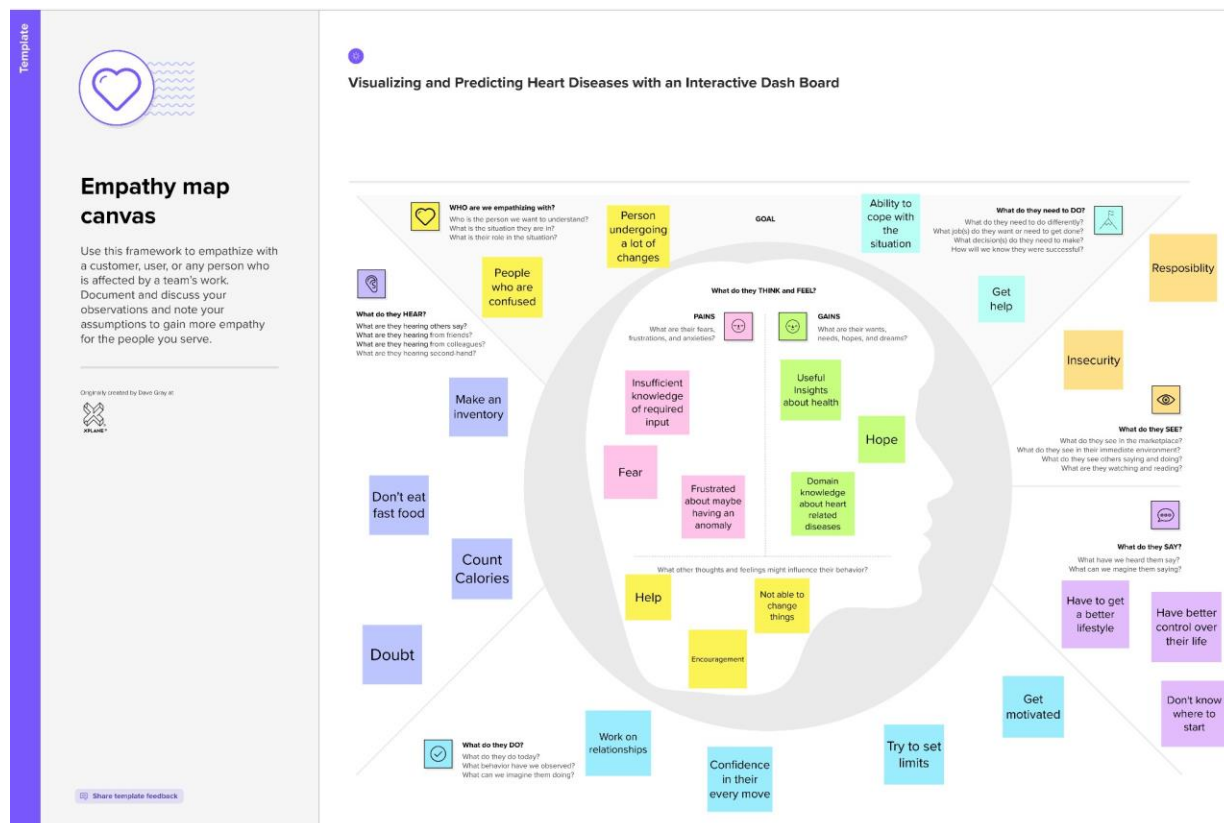
In India in 2016, CVDs (Cardiovascular Diseases) contributed to 28.1% of total deaths and 14.1% of total disability-adjusted life years (DALYs). Most persons with coronary heart disease

who pass away are 65 years of age or older. Although both sexes can get heart attacks in old age, women have a higher mortality rate (within a few weeks). Risk for heart disease can be increased by a number of medical issues, lifestyle, age, and family history. When a person is affected by heart disease, it causes side effects. Chest pain, chest tightness, chest pressure and chest discomfort Breathing difficulties, Neck, jaw, throat, upper abdomen, or back pain. Heart disease - and the conditions that lead to it - can happen at any age. High rates of obesity and high blood pressure among younger people (ages 35–64) are putting them at risk for heart disease earlier in life. CAD happens when coronary arteries struggle to supply the heart with enough blood, oxygen and nutrients. Cholesterol deposits, or plaques, are almost always to blame. These buildups narrow your arteries, decreasing blood flow to your heart. This can cause chest pain, shortness of breath or even a heart attack.

Therefore in order Predict if the patient suffers from heart disease- The health professional enters the input values from the patient's health report. The data is fed into the project model which predicts the probability of having heart disease.

3. Ideation and Proposed Solution


3.1 Empathy Map Canvas



3.2 Ideation and Brainstorming

Step-1: Team Gathering, Collaboration and Select the Problem Statement

Template



Brainstorm & idea prioritization

Brainstorming is a group creativity technique by which efforts are made to find a conclusion for a specific problem by gathering a list of ideas spontaneously contributed by its members.

- 🕒 10 minutes to prepare
- 🕒 1 hour to collaborate
- 👤 2-8 people recommended

Share template feedback

➔

Before you collaborate

A little bit of preparation goes a long way with this session. Here's what you need to do to get going.

🕒 10 minutes

A

Team gathering
Define who should participate in the session and send an invite. Share relevant information or pre-work ahead.

B

Set the goal
Think about the problem you'll be focusing on solving in the brainstorming session.

C

Learn how to use the facilitation tools
Use the Facilitation Superpowers to run a happy and productive session.

Open article ➔

1


Define your problem statement

What problem are you trying to solve? Frame your problem as a How Might We statement. This will be the focus of your brainstorm.

🕒 5 minutes

PROBLEM

Visualizing and Predicting Heart Diseases with an Interactive Dash Board



Key rules of brainstorming

To run a smooth and productive session

🗣️ Stay in topic.

💡 Encourage wild ideas.

🙅 Defer judgment.

👂 Listen to others.

🗣️ Go for volume.

👁️ If possible, be visual.

Step-2: Brainstorm, Idea Listing and Grouping

2

Brainstorm
Write down any ideas that come to mind that address your problem statement.

🕒 10 minutes

Sushiridha A(Team Leader)

Use Machine Learning Algorithm

Provide list of renewed cardiologist

Data Processing at period intervals

Simple UI

List treatment options

Use Flask/ Django

Abdul Anees A

Results should be send to user's email

linearity in the prediction

capture the real time view of the solution

Maintain Privacy (high security)

It simulates the nature of the application features

confident results for first time users

Arun Kumar S

Find more datasets

autuomation in performing the right task

it is equipped with latest ML techniques

processing the request of the users using automated tasks

it examines the user expectations and improves further work

good impression of validating the user request

Koppala Manasa

Java Stack

Provide tips for improving the health

Provide warnings

Interactive dashboard using python

List treatment options

Account creations and save results for future purposes

3

Group ideas
Take turns sharing your ideas while clustering similar or related notes as you go. Once all sticky notes have been grouped, give each cluster a sentence-like label. If a cluster is bigger than six sticky notes, try and see if you can break it up into smaller sub-groups.

🕒 20 minutes

Tech Stack

Angular

Flask

Privacy

Confident Results for first time users

Ensure privacy of users data

Validation users requests

Automation in performing the right task

Website Features

Provide indeapth analysis of result

Account creations and save results for future purposes

Sending results to user's email

FAQs Section

List of treatment options

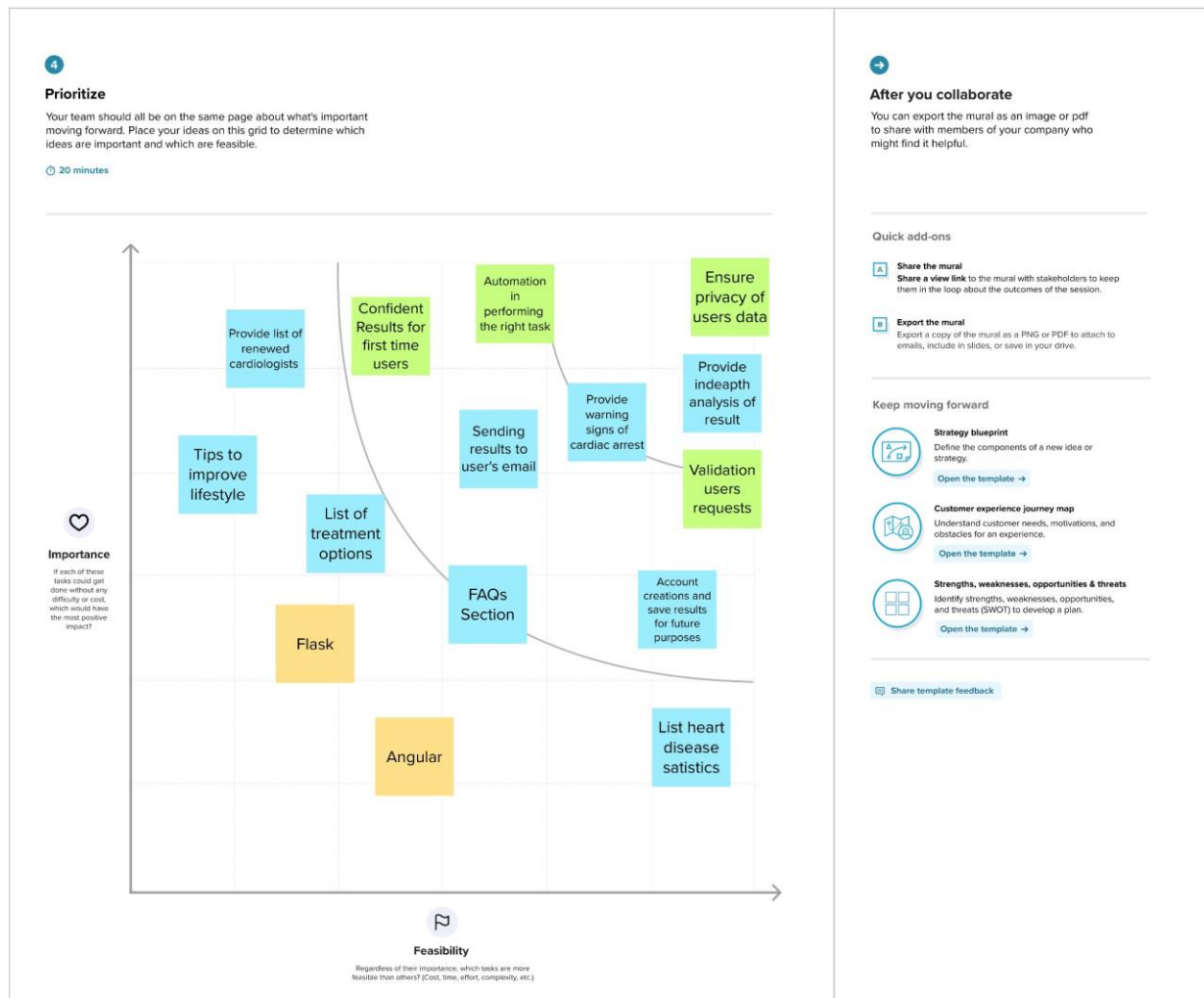
Provide list of renewed cardiologists

Tips to improve lifestyle

List heart disease satistics

Provide warning signs of cardiac arrest

Step-3: Idea Prioritization



3.3 Proposed Solution

S.No.	Parameter	Description
1.	Problem Statement (Problem to be solved)	The leading cause of death in the developed world is heart disease. As a result, work must be done to reduce the risks of having a heart attack or stroke. It is infeasible for a common man to frequently undergo tests for ECG and so on. Hence , it requires a replacement that is both convenient and dependable.
2.	Idea / Solution description	The proposed solution proposes an interactive dashboard for visualizing and forecasting heart disorders, in which the user may observe his/her

		medical report analysis as well as the projected end result. IBM Cognos will be used to create the dashboard. Machine learning Algorithms will be used to forecast cardiac disease.
3.	Novelty / Uniqueness	Makes recommendations to the user based on that person's medical analysis.
4.	Social Impact / Customer Satisfaction	It helps with disease prediction at an early stage and frequently alerts the user to their current health status. Both the user and the doctor can benefit from the system's improved decision-making regarding cardiac disease
5.	Business Model (Revenue Model)	Can be deployed by Hospitals or NFOs, so that it makes the analysis in a fast manner.
6.	Scalability of the Solution	The solution can work effectively on long and small datasets. It can also be changed to predict various other diseases depending on the dataset

3.4 Problem Solution Fit

Define CS, fit into CC	1. CUSTOMER SEGMENT(S) CS <ul style="list-style-type: none"> Patients Smokers Family members of patients People who experience symptoms like chest pain, shortness of breath, etc Curious users People with family history of CADs 	6. CUSTOMER CONSTRAINTS CC <ul style="list-style-type: none"> Economical background Limited access to hospitals Frequent visits to doctors Lack of support system Lack of knowledge about CADs Not able to quit Smoking Stress Management 	5. AVAILABLE SOLUTIONS AS <ul style="list-style-type: none"> Quit smoking Visit cardiologist Exercise regularly Regular medical checkup 	Explore AS, differentiate
	2. JOBS-TO-BE-DONE / PROBLEMS J&P <ul style="list-style-type: none"> Early prediction of heart disease. Suggest them proper way to maintain health based on prediction. 	9. PROBLEM ROOT CAUSE RC <ul style="list-style-type: none"> Unhealthy lifestyle High stress levels Fast food Lack of exercise Smoking Bad diet 	7. BEHAVIOUR BE <ul style="list-style-type: none"> Stress Management Bettering lifestyle Visiting doctor Quit smoking Maintain physique 	
Identify strong TR & EM	3. TRIGGERS TR <ul style="list-style-type: none"> Discomfort Common symptoms like chest pain, shortness of breath, etc emotional stress 	10. YOUR SOLUTION SL <ul style="list-style-type: none"> Early prediction of heart diseases. Predicting heart disease can help in getting better cures for the same disease. Suggest lifestyle changes that are required 	8. CHANNELS of BEHAVIOUR CH 8.1 ONLINE <ul style="list-style-type: none"> Finding possible cures Booking online appointment Searching health related website 8.2 OFFLINE <ul style="list-style-type: none"> Visit Cardiologist Maintaining fitness Bettering lifestyle 	Identify strong TR & EM
	4. EMOTIONS: BEFORE / AFTER EM <p>Before:</p> <ul style="list-style-type: none"> Worried Fear Anxious <p>After:</p> <ul style="list-style-type: none"> Relieved Better control on emotions Clarity Visit doctor if required 			

4. Requirement Analysis

4.1 Functional Requirement

Following are the functional requirements of the proposed solution.

FR No.	Functional Requirement (Epic)	Sub Requirement (Story / Sub-Task)
FR-1	User Registration	Registration through Email
FR-2	User Confirmation	Confirmation via Email
FR-3	Visualizing Data	Visualize the trends on heart disease through Dashboard created using IBM Cognos Analytics
FR-4	Generation Report	Report can be viewed by the users

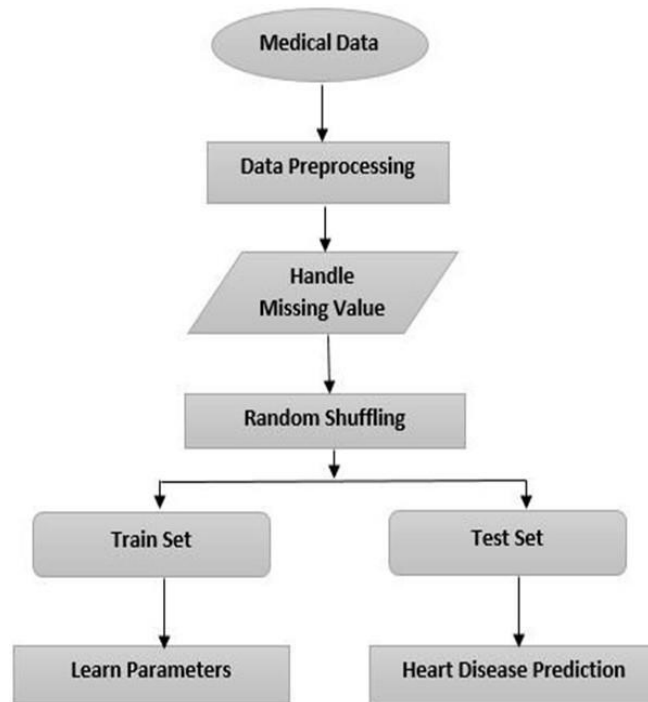
4.2 Non-Functional Requirement

Following are the non-functional requirements of the proposed solution.

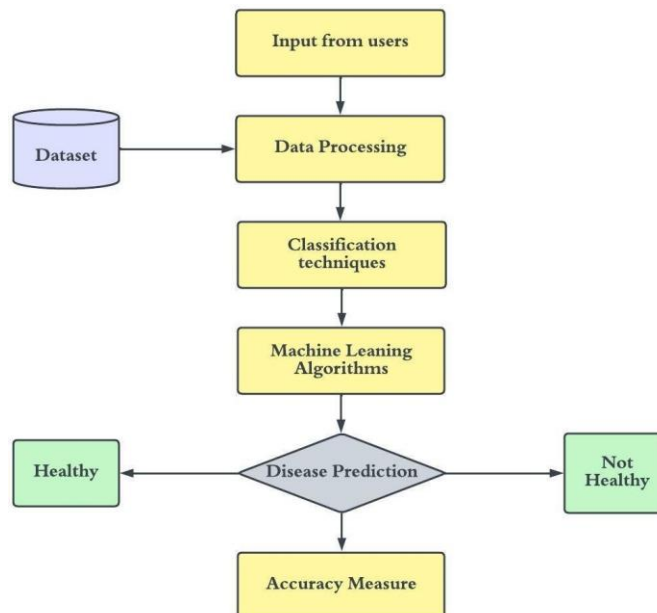
FR No.	Non-Functional Requirement	Description
NFR-1	Usability	Provide a simple UI. Actions can be easily performed by a few clicks. Features will be understandable.
NFR-2	Security	2 step authorization (for register) Have a backup dataset
NFR-3	Reliability	Error must be low.(Improve accuracy) Must work without glitches
NFR-4	Performance	It is affected by the implementing algorithm. Depending on the error metrics we have to choose an algorithm with high response time.
NFR-5	Availability	Must be available for the user 24 x 7 without interruptions
NFR-6	Scalability	Should withstand a high number of users and large datasets.

5. Project Design

5.1 Data Flow Diagram



5.2 Solution and Technical Architecture



5.3 User stories

Sprint	Functional Requirement (Epic)	User Story Number	User Story / Task	Story Points	Priority
Sprint-1	Registration	USN-1	As a user, I can register for the application by entering my email, password, and confirming my password.	3	High
Sprint-1		USN-2	As a user, I will receive confirmation email once I have registered for the application	3	High
Sprint-1		USN-3	As a user, I can register for the application through Gmail	3	Medium
Sprint-1	Login	USN-4	As a user, I can log into the application by entering email & password	6	High
Sprint-2	Dashboard	USN-5	Attractive dashboard For the Application	3	Medium
Sprint-2		USN-6	Profile - view & update your profile	5	Low
Sprint-2		USN-7	Home - Analyze your Heart problem	2	High
Sprint-2		USN-8	The user will have to fill in the below 13 fields for the system to predict a disease -Age in year -Gender -Chest pain Type -Fasting Blood Sugar -Resting Electrographic Results -Exercise Induced Angina -Trust Blood Pressure	7	High
Sprint-3	Support	USN-9	Get feedback from users	10	Medium
Sprint-3		USN-10	Responds to user queries via telephone,email etc.	3	Medium
Sprint-3		USN-11	The team must respond immediately to the queries based on the priority	5	High
Sprint-4	System Requirements	USN-12	Hardware Requirement 1. Laptop or PC • i5 processor system or higher • 4 GB RAM or higher • 128 GB ROM or higher 2. Mobile • (12.0 and above)	5	Low
Sprint-4		USN-13	Software Requirement 1. Laptop or PC • Windows 10 or higher • Android Studio	8	Medium

6. Project Planning and Scheduling

6.1 Script Planning and Execution

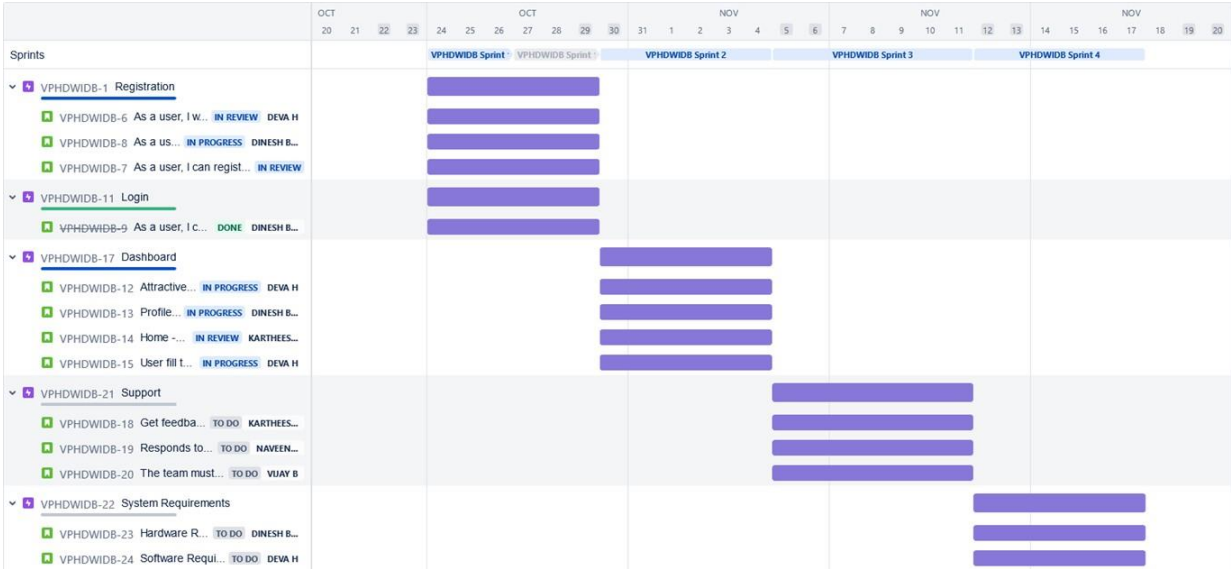
Sprint	Functional Requirement (Epic)	User Story Number	User Story / Task	Story Points	Priority	Team Members
Sprint-1	Registration	USN-1	As a user, I can register for the application by entering my email, password, and confirming my password.	3	High	1
Sprint-1		USN-2	As a user, I will receive confirmation email once I have registered for the application	3	High	3
Sprint-1		USN-3	As a user, I can register for the application through Gmail	3	Medium	1
Sprint-1	Login	USN-4	As a user, I can log into the application by entering email & password	6	High	5
Sprint-2	Dashboard	USN-5	Attractive dashboard For the Application	3	Medium	3
Sprint-2		USN-6	Profile - view & update your profile	5	Low	2
Sprint-2		USN-7	Home - Analyze your Heart problem	2	High	4
Sprint-2		USN-8	The user will have to fill in the below 13 fields for the system to predict a disease -Age in year -Gender -Chest pain Type -Fasting Blood Sugar -Resting Electrographic Results -Exercise Induced Angina -Trust Blood Pressure	7	High	2
Sprint-3	Support	USN-9	Get feedback from users	10	Medium	3
Sprint-3		USN-10	Responds to user queries via telephone,email etc.	3	Medium	2
Sprint-3		USN-11	The team must respond immediately to the queries based on the priority	5	High	5
Sprint-4	System Requirements	USN-12	Hardware Requirement 3. Laptop or PC • i5 processor system or higher • 4 GB RAM or higher • 128 GB ROM or higher 4. Mobile • (12.0 and above)	5	Low	2
Sprint-4		USN-13	Software Requirement 2. Laptop or PC	8	Medium	4

			<ul style="list-style-type: none"> Windows 10 or higher Android Studio 			
--	--	--	--	--	--	--

6.2 Sprint Delivery Schedule

Sprint	Total Points	Story	Duration	Sprint Start Date	Sprint End Date (Planned)	Story Points Completed (as on Planned End Date)	Sprint Release Date (Actual)
Sprint-1	20		6 Days	24 Oct 2022	29 Oct 2022	20	29 Oct 2022
Sprint-2	20		6 Days	30 Oct 2022	04 Nov 2022	17	04 Nov 2022
Sprint-3	20		6 Days	05 Nov 2022	11 Nov 2022	18	11 Nov 2022
Sprint-4	20		6 Days	12 Nov 2022	17 Nov 2022	19	17 Nov 2022

6.3 Jira Report



7 Coding And Solutioning

7.1 Machine Learning

Learning which model is best for the given Dataset

Out[]:	Estimators	Accuracy
0	Linear Regression	0.565830
3	K-Nearest Neighbor	0.729167
4	Random Forest	0.854167
5	Bagging Decision Tree	0.854167
6	Hard coting classifier	0.854167
2	Gaussian Naive Bayes	0.875000
1	Logistic Regression	0.895833

From the above result we can conclude that Logistic Regression has the hisgest accuracy for this particular dataset.

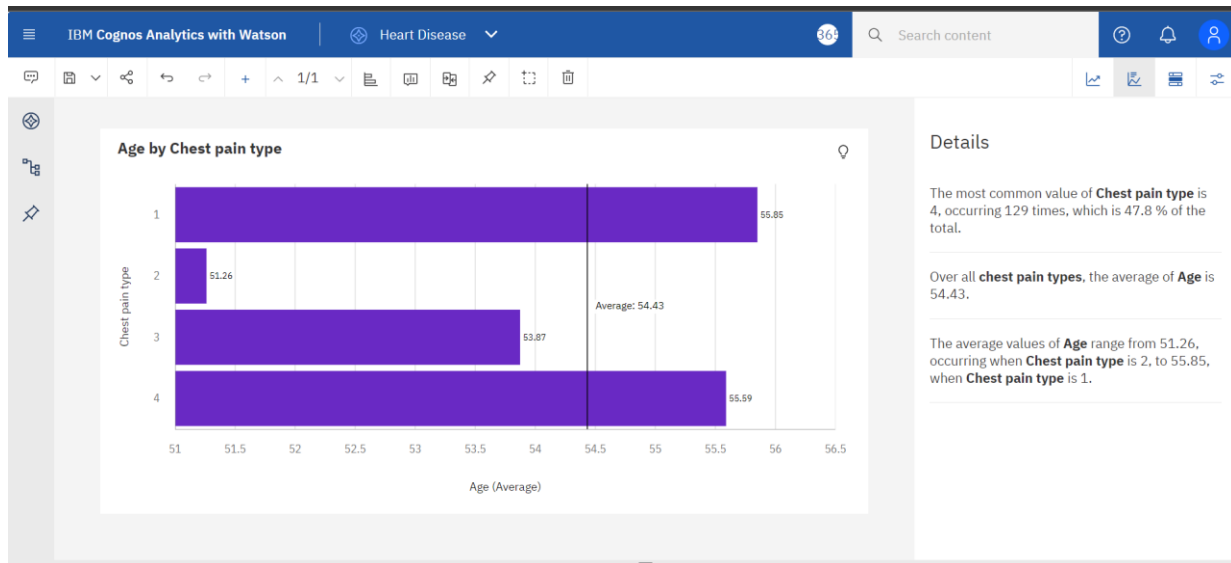
Comparing it with the accuracy gotten from Decision Tree:

```
TP=cm[0][0] #cm=Confusion Matrix
TN=cm[1][1]
FN=cm[1][0]
FP=cm[0][1]
print('Testing Accuracy for Decision Tree:',(TP+TN)/(TP+TN+FN+FP))
print('Testing Sensitivity for Decision Tree:',(TP/(TP+FN)))
print('Testing Specificity for Decision Tree:',(TN/(TN+FP)))
print('Testing Precision for Decision Tree:',(TP/(TP+FP)))
```

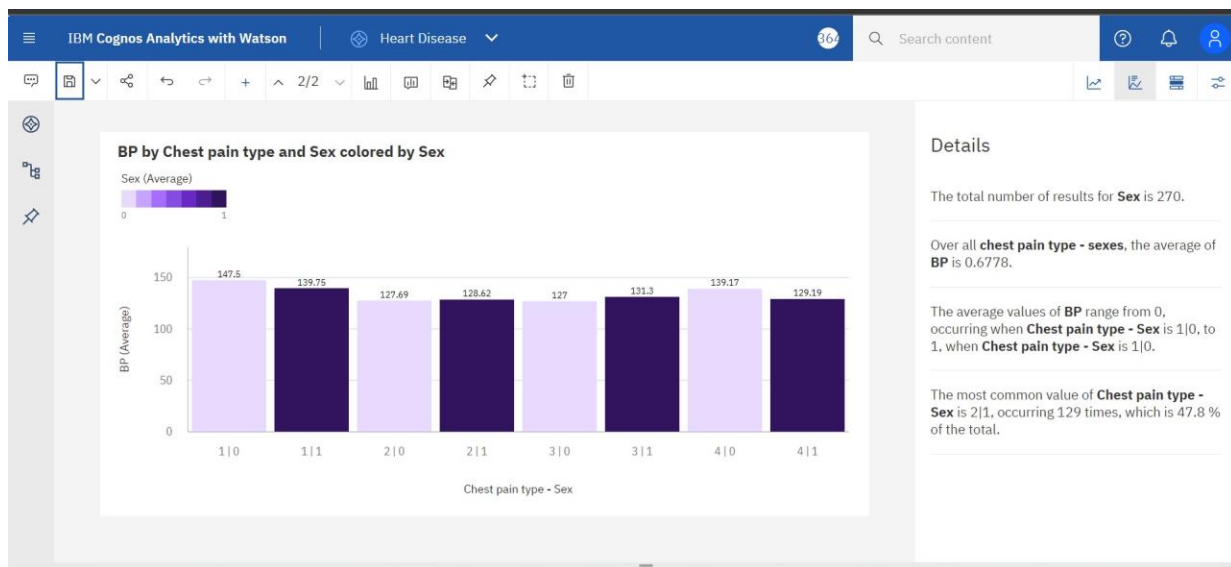
```
Testing Accuracy for Decision Tree: 0.9264705882352942
Testing Sensitivity for Decision Tree: 0.8888888888888888
Testing Specificity for Decision Tree: 1.0
Testing Precision for Decision Tree: 1.0
```

7.2 Dashboard

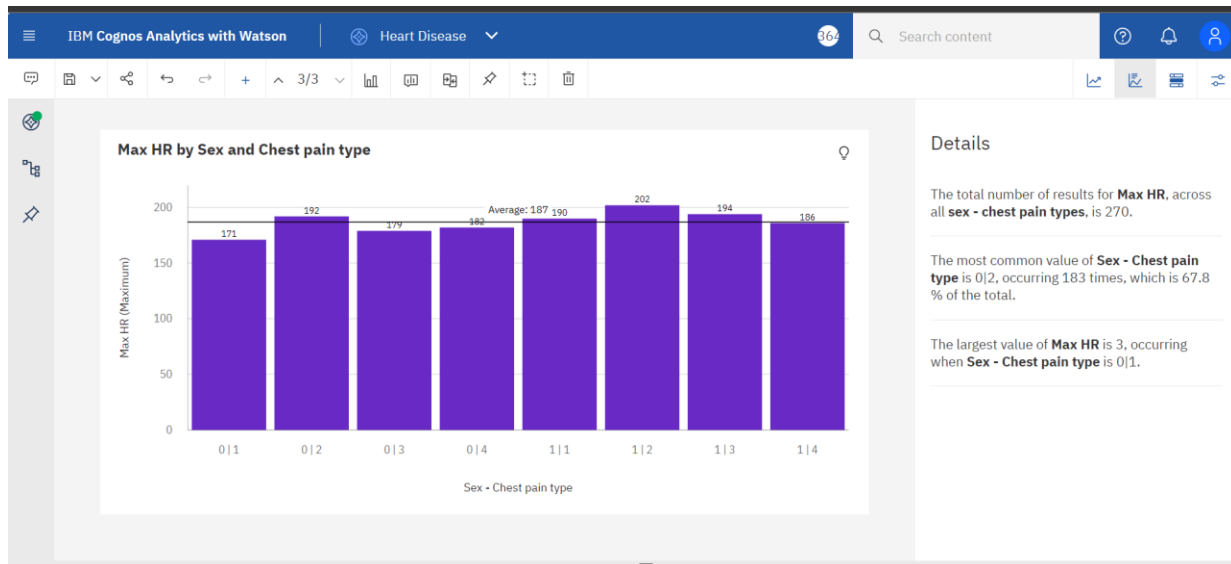
Age By Chest Pain type comparison.



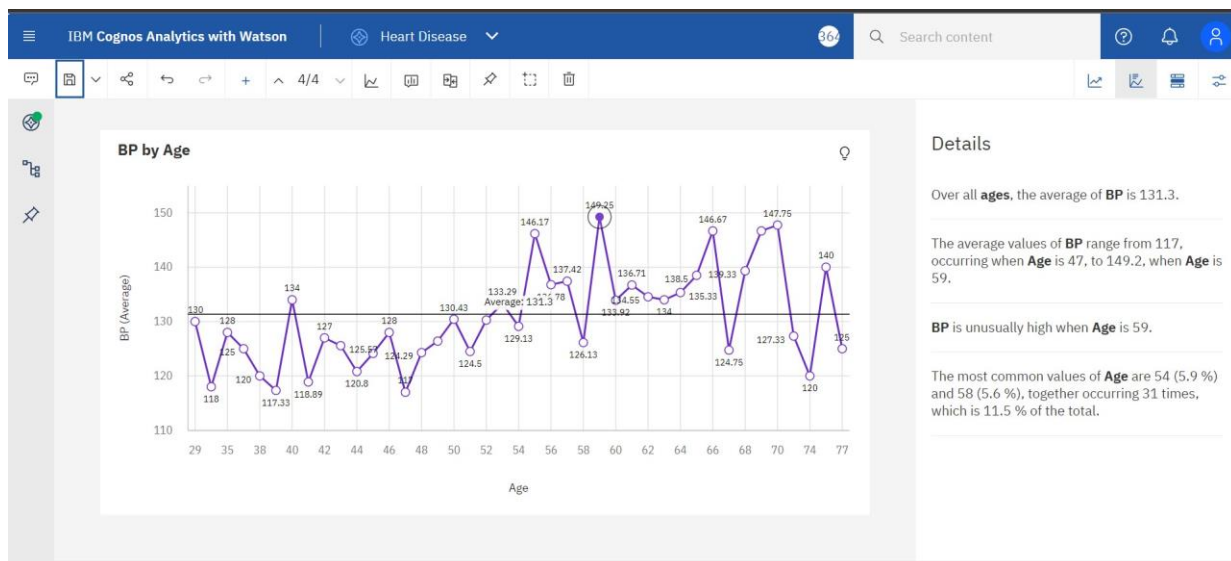
Exploration Of BPvsChestPainType And Gender:



Exploration Of Max Heart Rate During The Chest Pain:



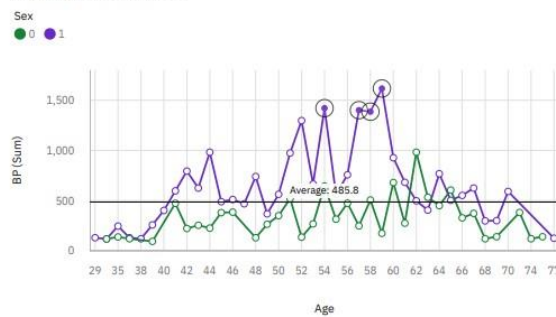
Exploration Of BP By Age:



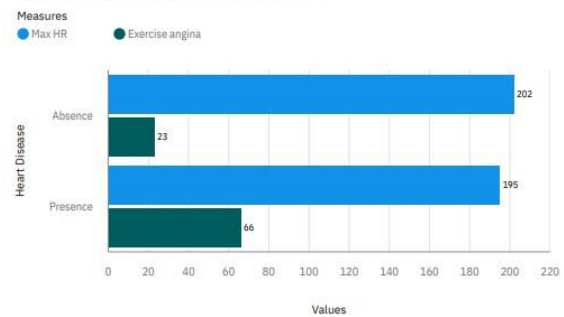
Dashboard Showing Different Types Of Visuals:

Tab 8

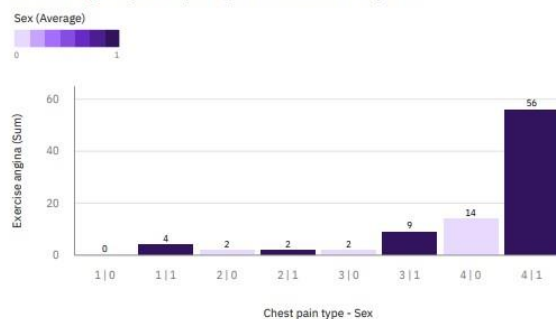
BP by Age colored by Sex



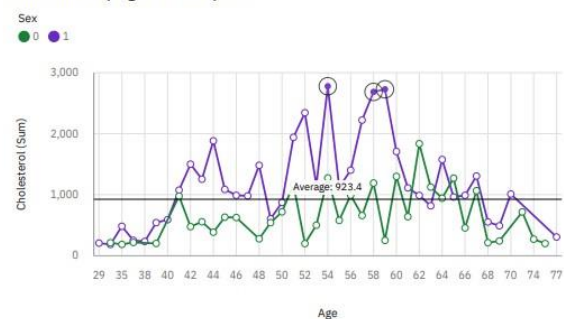
Max HR and Exercise angina by Heart Disease



Exercise angina by Chest pain type and Sex colored by Sex



Cholesterol by Age colored by Sex



8. Testing

8.1 Test Cases

Testing the data model for various input values.

```
In [ ]: from sklearn.metrics import accuracy_score
input=(63,1,3,145,200,150,98,0,0,0,0,0)
input_as_numpy=np.asarray(input)
input_resaped=input_as_numpy.reshape(1,-1)
pre1=tree_model.predict(input_resaped)
print(pre1)
a1 = accuracy_score(pre1,model1.predict(input_resaped)) * 100
print(a1)

['Absence']
100.0

In [ ]: from sklearn.metrics import accuracy_score
input=(70,1,4,130,322,0,2,109,0,2,4,2,3)
input_as_numpy=np.asarray(input)
input_resaped=input_as_numpy.reshape(1,-1)
pre1=tree_model.predict(input_resaped)
print(pre1)
a1 = accuracy_score(pre1,model1.predict(input_resaped)) * 100
print(a1)

['Presence']
100.0
```

8.2 User acceptance Testing

Testing a case where user has heart disease

The screenshot shows a web browser window with the title "Heart Disease Prediction" and the address bar displaying "localhost:4200". A modal dialog box is open, displaying the message "localhost:4200 says" and "The patient is likely to have heart disease!". Below the dialog, the form contains the following fields and values:

- ST depression: 2.4
- Slope of ST: 2
- Number of vessels fluoro (number of major vessels (0-3) colored by flourosopy): 3
- Thallium: 3 = normal; 6 = fixed defect; 7 = reversable defect: 3

A large purple "Submit" button is visible at the bottom of the form.

Testing a case where user does not have heart disease

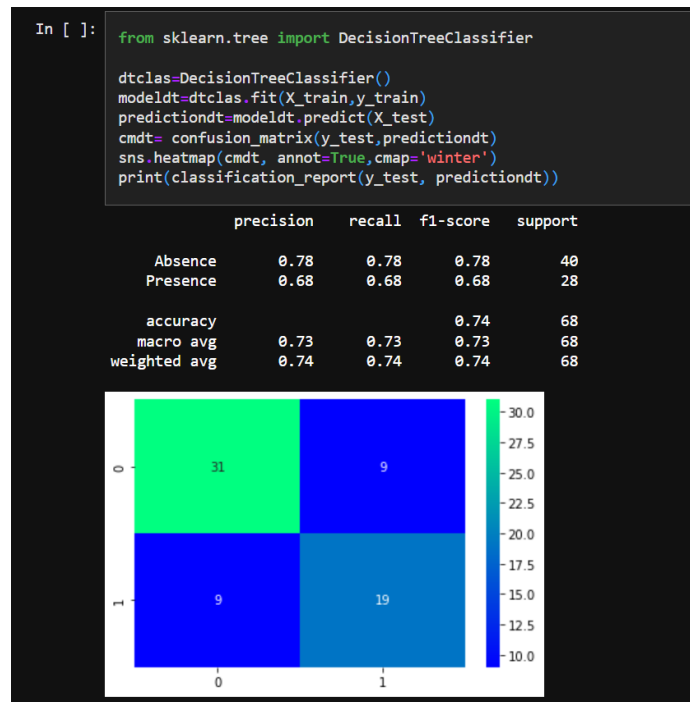
The screenshot shows a web browser window with the title "Heart Disease Prediction" and the address bar displaying "localhost:4200". A modal dialog box is open, displaying the message "localhost:4200 says" and "The patient is not likely to have heart disease!". Below the dialog, the form contains the following fields and values:

- Exercise angina (exercise induced): 0
- ST depression: 1.6
- Slope of ST: 2
- Number of vessels fluoro (number of major vessels (0-3) colored by flourosopy): 0
- Thallium: 3 = normal; 6 = fixed defect; 7 = reversable defect: 7

9. Result

9.1 Performance Metrics

The confusion matrix below shows the performance metrics of the machine learning model.



10. Advantages Disadvantages

Advantages:

- This is one of the fastest ways to determine if a person is likely to suffer from a heart disease or not.
- Useful for medical practitioners to easily classify their patients.
- User Friendly
- Easy to understand
- Secure
- Dashboard provides insightful informations

Disadvantages:

- Needs work
- Users need to know all the fields
- Does Not take null value as input
- Does not provide suggestions to user

11. Conclusion

Complications of heart disease include heart attack and stroke. You can reduce the risk of complications with early diagnosis and treatment. So the suggestion that we get from the website might help save patients. It is always to get treated in the early stages of heart disease.

12. Future Scope

Like the saying goes “Prevention is better than cure”. We have to look into methods to prevent heart diseases altogether other than just predicting it in early stages.

To use this website we need to take a lot of tests beforehand. So it would be better if we require less attributes and still give an effective result

13. Appendix

Source Code: <https://github.com/IBM-EPBL/IBM-Project-1755-1658411857>

DemoLink: <https://drive.google.com/file/d/1QzJzpDrq73txF8Xf56b8wZn2xcC4E5PV/view?usp=sharing>