

Visualizing and Predicting Heart Diseases with an Interactive Dashboard

NALAIYA THIRAN PROJECT REPORT 2022

Submitted by

Niranjan K	727619BIT026
Vinesh Kumar K	727619BIT006
Dhanabal S	727619BIT008
Selvakumar K	727619BIT022

Team ID: PNT2022TMID08883

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

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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, ecommerce, 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



Brainstorm & idea prioritization

Use this template in your own brainstorming sessions so your team can unleash their imagination and start shaping concepts even if you're not sitting in the same room.

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

➔

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 Superpower 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

How might we analyze and provide data to prevent heart diseases?



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

TIP



You can select a sticky note and hit the pencil [switch to sketch] icon to start drawing!

Niranjan

Person with heart diseases have high risk of getting attacks	Data Analysis is the best way to get data about heart diseases	Insuring the data set from data analysts we might get some knowledge about preventing those diseases
Nowadays treatment for heart diseases is advanced	Eating unhealthy foods leads to heart diseases	

Dhanabai

We can use different machine learning techniques for analysis	Person who maintains good health won't get any heart diseases	Earlier treatment reduce the risks
Must go for regular checkup		

Vineshkumar

Person who smokes more gets heart attack	Undergo cardiac exercises for reducing the risks	Continuously monitor heart rate using smartwatches
Person having heart diseases may get sudden chest pain		

Selvakumar

Heart attack occurs when the flow of blood to the heart is severely reduced or blocked	Obese, Diabetes, High BP leads to heart diseases	Person needs to take immediate attention if they get heart attack
Maintain a healthy weight with a heart-healthy diet		

Person 5

Person 6

Person 7

Person 8

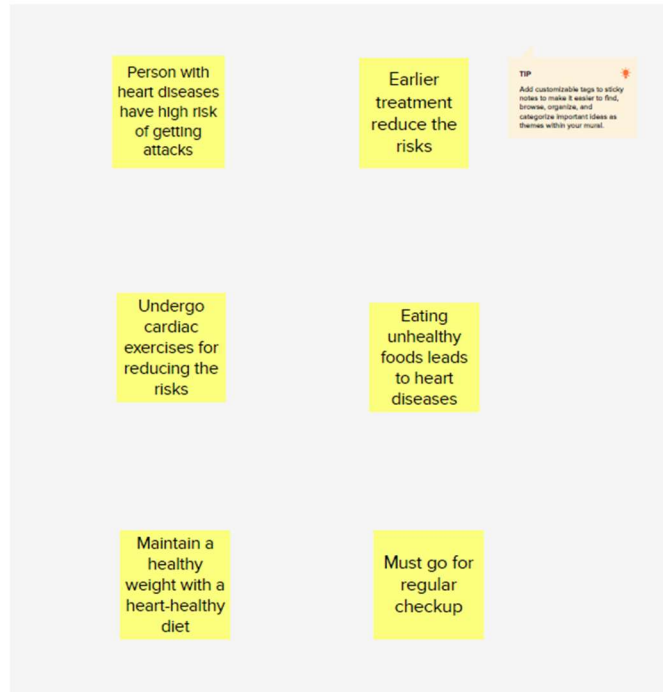
Step-3: Idea Prioritization

3

Group ideas

Take turns sharing your ideas while clustering similar or related notes as you go. In the last 10 minutes, 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

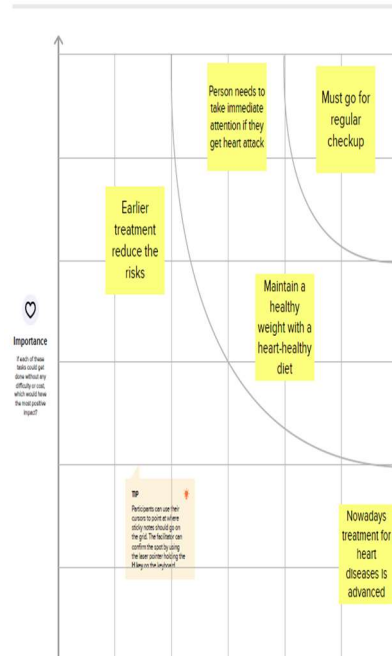


4

Prioritize

Your team should all be on the same page about what's important moving forward. Place your ideas on this grid to determine which ideas are important and which are feasible.

20 minutes



5

After you collaborate

You can export the mural as an image or pdf to share with members of your company who might find it helpful.

Quick add-ons

- [Share the mural](#)
Share a new link to the mural with stakeholders to keep them in the loop about the outcomes of the session.
- [Export the mural](#)
Export a copy of the mural as a PNG or PDF to attach to email, include in Slack, or save in your drive.

Keep moving forward

- [Strategy blueprint](#)
Define the components of a new idea or strategy.
[Open the template](#)
- [Customer experience journey map](#)
Understand customer needs, motivations, and obstacles for an experience.
[Open the template](#)
- [Strengths, weaknesses, opportunities & threats](#)
Identify strengths, weaknesses, opportunities, and threats (SWOT) to develop a plan.
[Open the template](#)

[Share template feedback](#)

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	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 		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 	

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

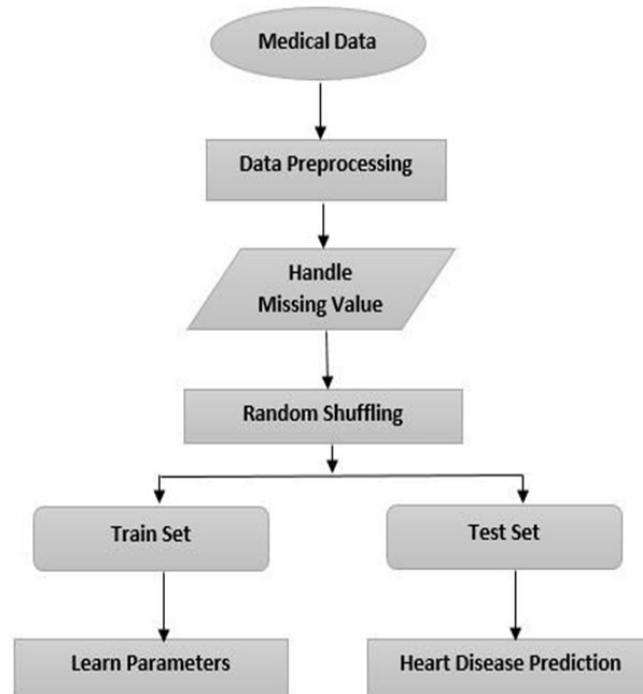
4.2 Non-Functional Requirement

Following are the non-functional requirements of the proposed solution

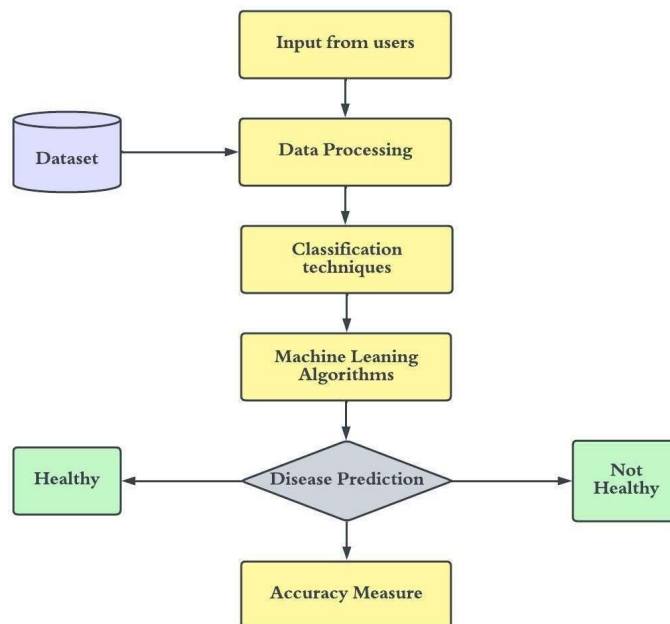
FR No.	Non-Functional Requirement	Description
NFR-1	Usability	Provide a simple UI. Actions can be easily performed by a few clicks. Features will be understandable.
NFR-2	Security	2 step authorization (for register) Have a backup dataset
NFR-3	Reliability	Error must be low.(Improve accuracy) Must work 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

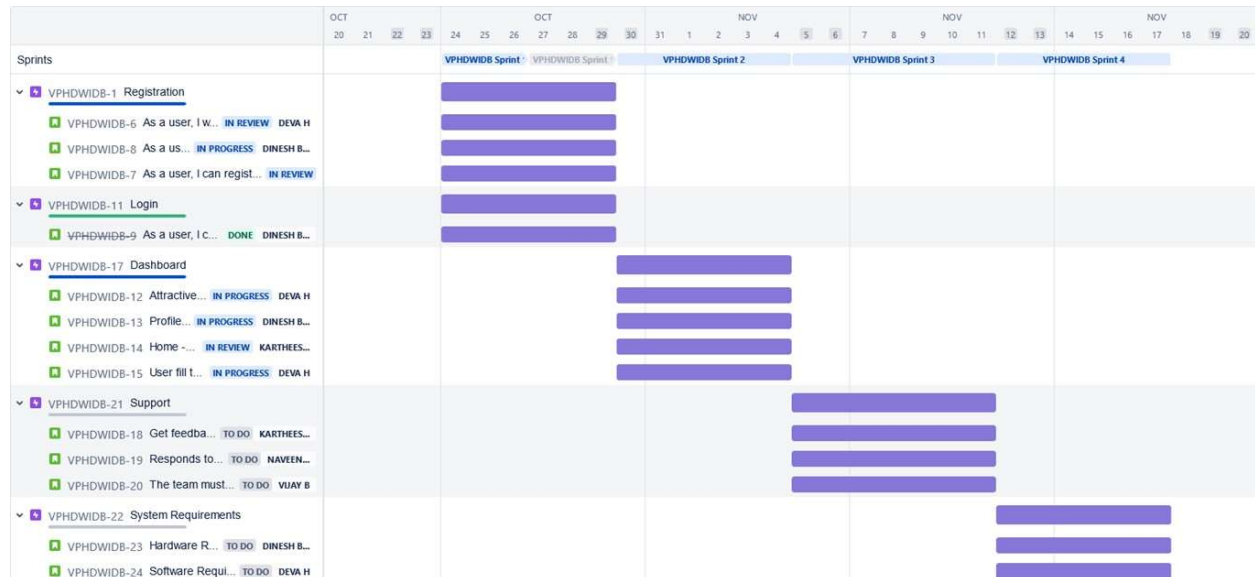
Sprint	Functional Requirement (Epic)	User Story Number	User Story / Task	Story Points	Priority	Team Members
Sprint-1	Registration	USN-1	As a user, I can register for the application by entering my email, password, and confirming my password.	3	High	1
Sprint-1		USN-2	As a user, I will receive confirmation 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 1. Laptop or PC • Windows 10 or higher • Android Studio	8	Medium	4

6.2 Sprint Delivery Schedule

Sprint	Total Story Points	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:

$$TP = cm[0][0] \text{ \#cm = Confusion Matrix}$$

$$TN = cm[1][1]$$

$$FN = cm[1][0]$$

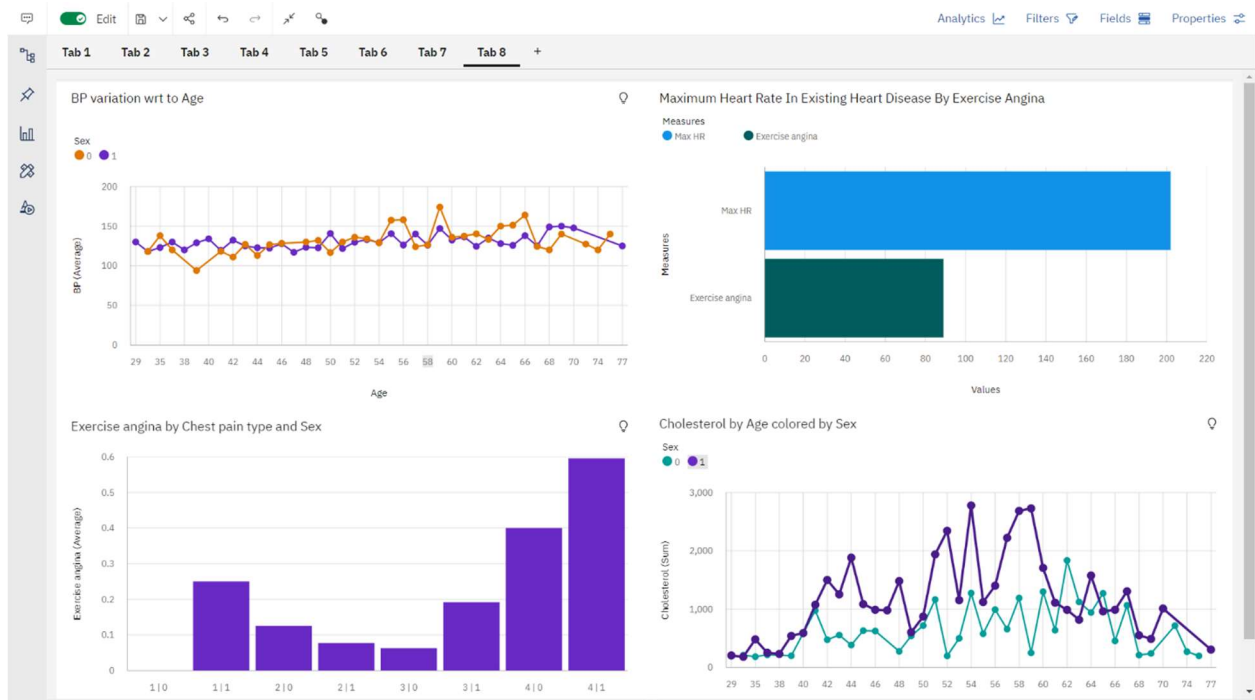
$$FP = cm[0][1]$$

```
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

Dashboard Showing Different Types Of Visuals:



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=(70,1,4,130,322,0,2,109,0,2,4,2,3,3)
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 have heart disease

Heart Disease Prediction

localhost:4200

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

Submit

localhost:4200 says
The patient is likely to have heart disease!

OK

Testing a case where user does not have heart disease

Heart Disease Prediction

localhost:4200

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

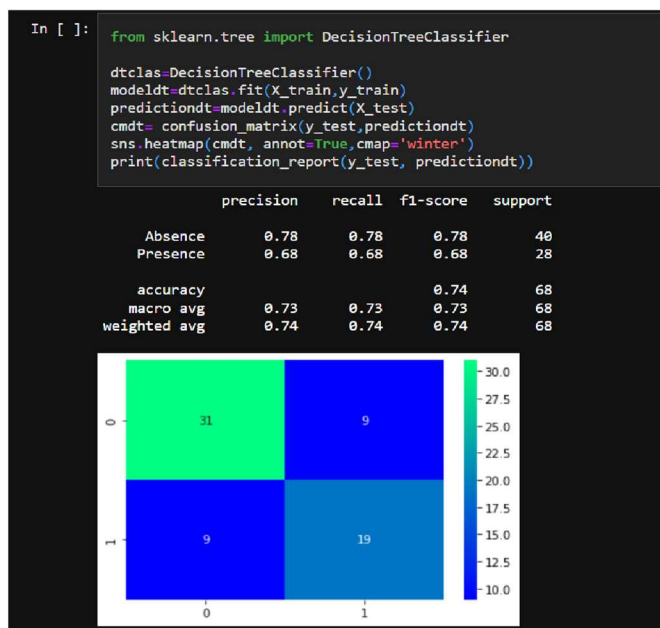
localhost:4200 says
The patient is not likely to have heart disease!

OK

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-2330-1658469808>

Demo Video Link:

<https://drive.google.com/file/d/1psNGnnwmBb7u3MrXymvpDVS0z0RBrs9u/view?usp=drivesdk>