Visualizing and Predicting Heart Diseases with an Interactive Dashboard

NALAIYA THIRAN PROJECT REPORT

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Submitted by

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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

Healthcare industries generate enormous amount of data, so called big data that accommodates hidden knowledge or pattern for decision making. The huge volume of data is used to make decision which is more accurate than intuition. Exploratory Data Analysis (EDA) detects mistakes, finds appropriate data, checks assumptions and determines the correlation among the explanatory variables. In the context, EDA is considered as analysing data that excludes inferences and statistical modelling. Analytics is an essential technique for any profession as it forecast the future and hidden pattern. Data analytics is considered as a cost effective technology in the recent past and it plays an essential role in healthcare which includes new research findings, emergency situations and outbreaks of disease. The use of analytics in healthcare improves care by facilitating preventive care and EDA is a vital step while analysing data.

2.2 References

"Heart Disease Prediction using Exploratory Data Analysis" A survey :R. Indrakumari, T.Poongodi,Soumya Ranjan Jena

In this paper, the risk factors that causes heart disease is considered and predicted using K-means algorithm and the analysis is carried out using a publicly available data for heart disease. The dataset holds 209 records with 8 attributes such as age, chest pain type, blood pressure, blood glucose level, ECG in rest, heart rate and four types of chest pain. To predict the heart disease, Kmeans clustering algorithm is used along with data analytics and visualization tool. The paper discusses the pre-processing methods, classifier performances and evaluation metrics. In the result section, the visualized data shows that the prediction is accurate.

Prediction of heart disease at early stage using data mining and big data analytics: A survey N. K. Salma Banu, Suma Swamy

Several studies have been carried out for developing prediction model using individual technique and also by combining two or more techniques. This paper provides a quick and easy review and understanding of available prediction models using data mining from 2004 to 2016. The comparison shows the accuracy level of each model given by different researchers. Into practice.

2.3 Problem Statement Definition

Who does the problem affect?

People with unhealthy lifestyles, stress, depression, age above 40 and when their ancestors got heart disease (since heart disease is hereditary).

When does the issue occur?

The issue occurs for people with unhealthy lifestyles and age above 40. Where is the issue occurring? The issue is originating from an unhealthy lifestyle. It mostly occurs in the blood valves of the heart.

What would happen if we didn't solve the problem?

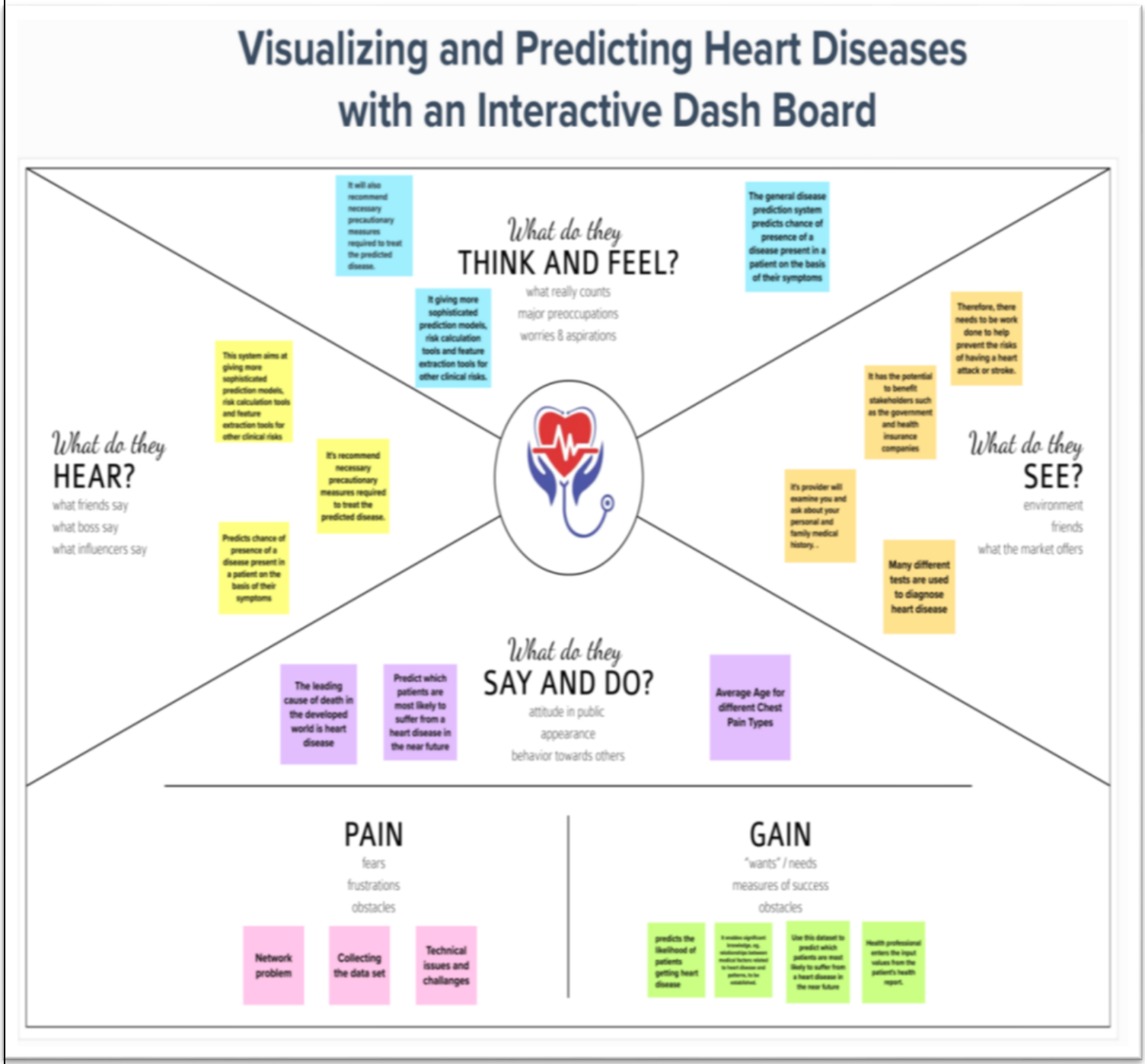
If we don't solve the problem, many people will die at a young age. The death rate due to heart disease will increase rapidly.

Why is it important to fix the problem?

We should predict the problem before giving treatment to the patients. As the problem is predicted early, we can solve it easily and early.

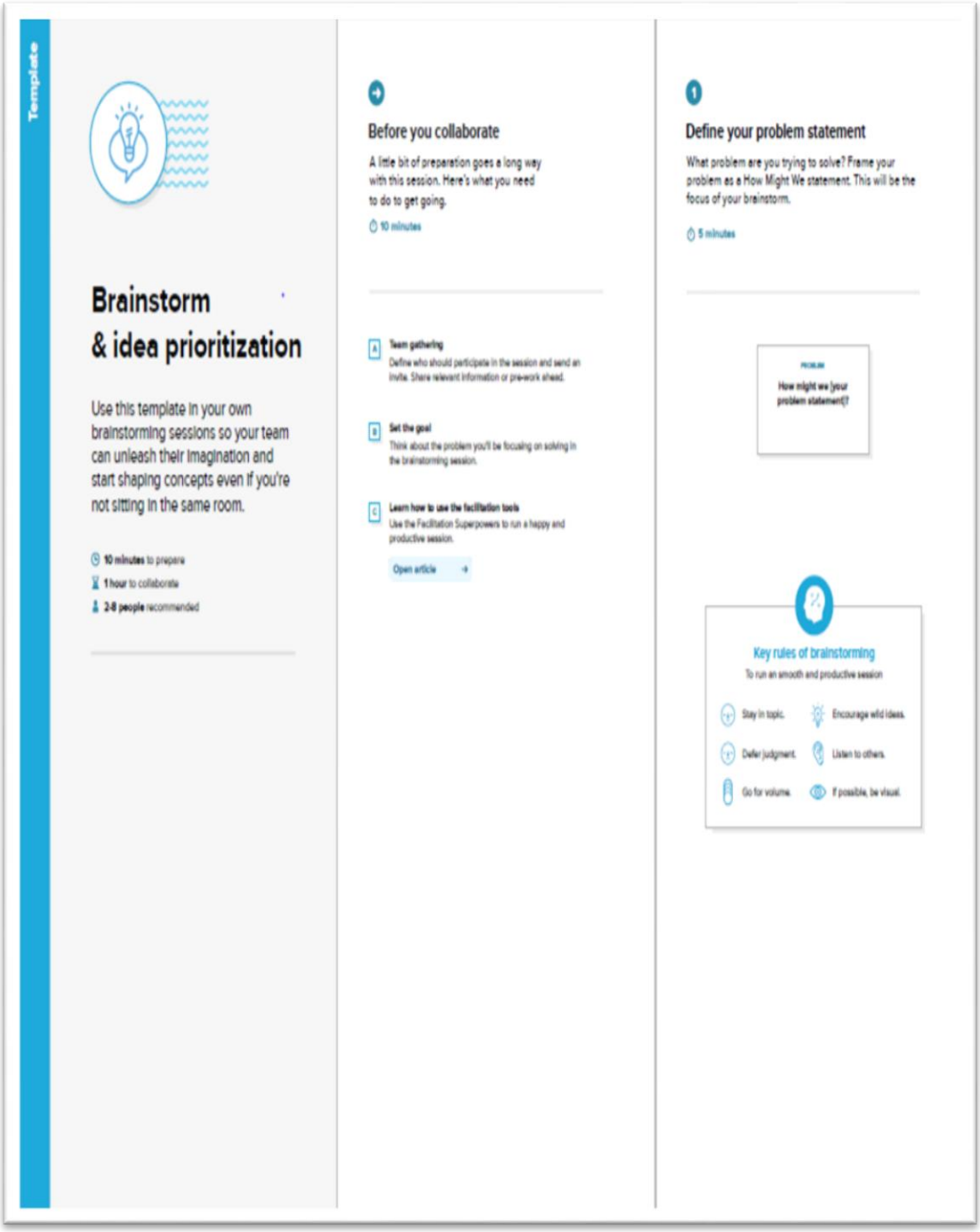
3. Ideation and Proposed Solution

3.1 Empathy Map Canvas

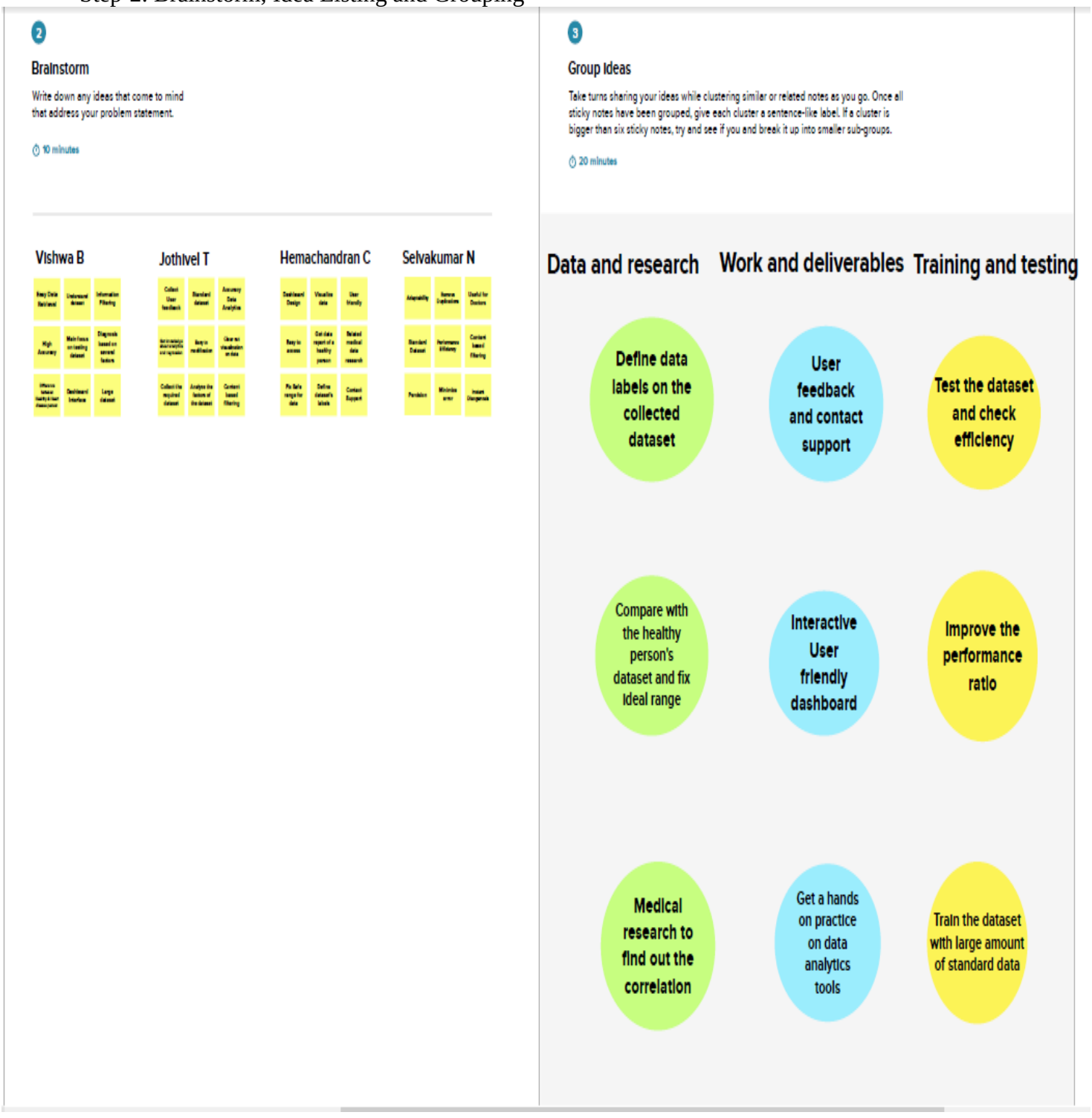


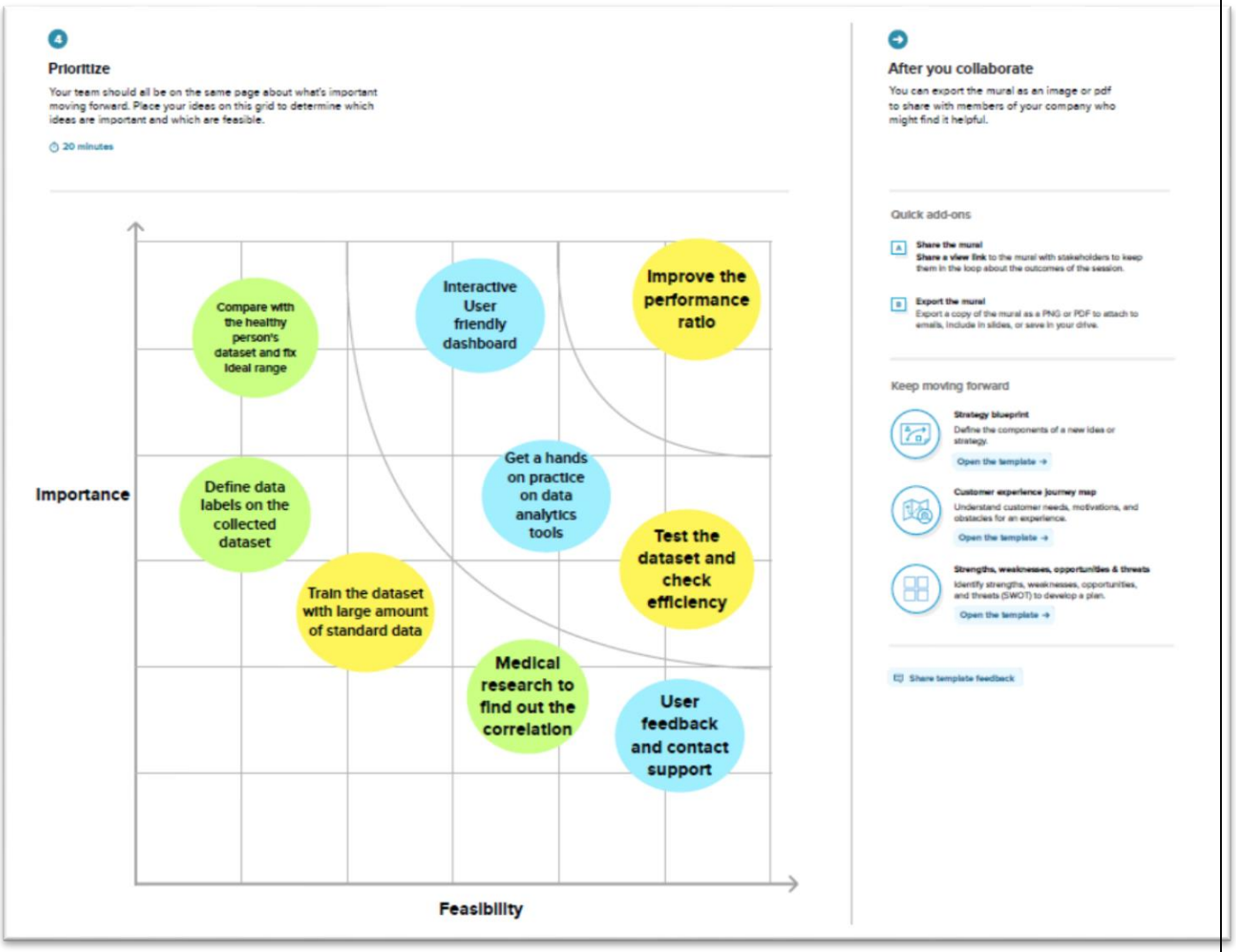
3.2 Ideation and Brainstorming

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



Step-2: Brainstorm, Idea Listing and Grouping



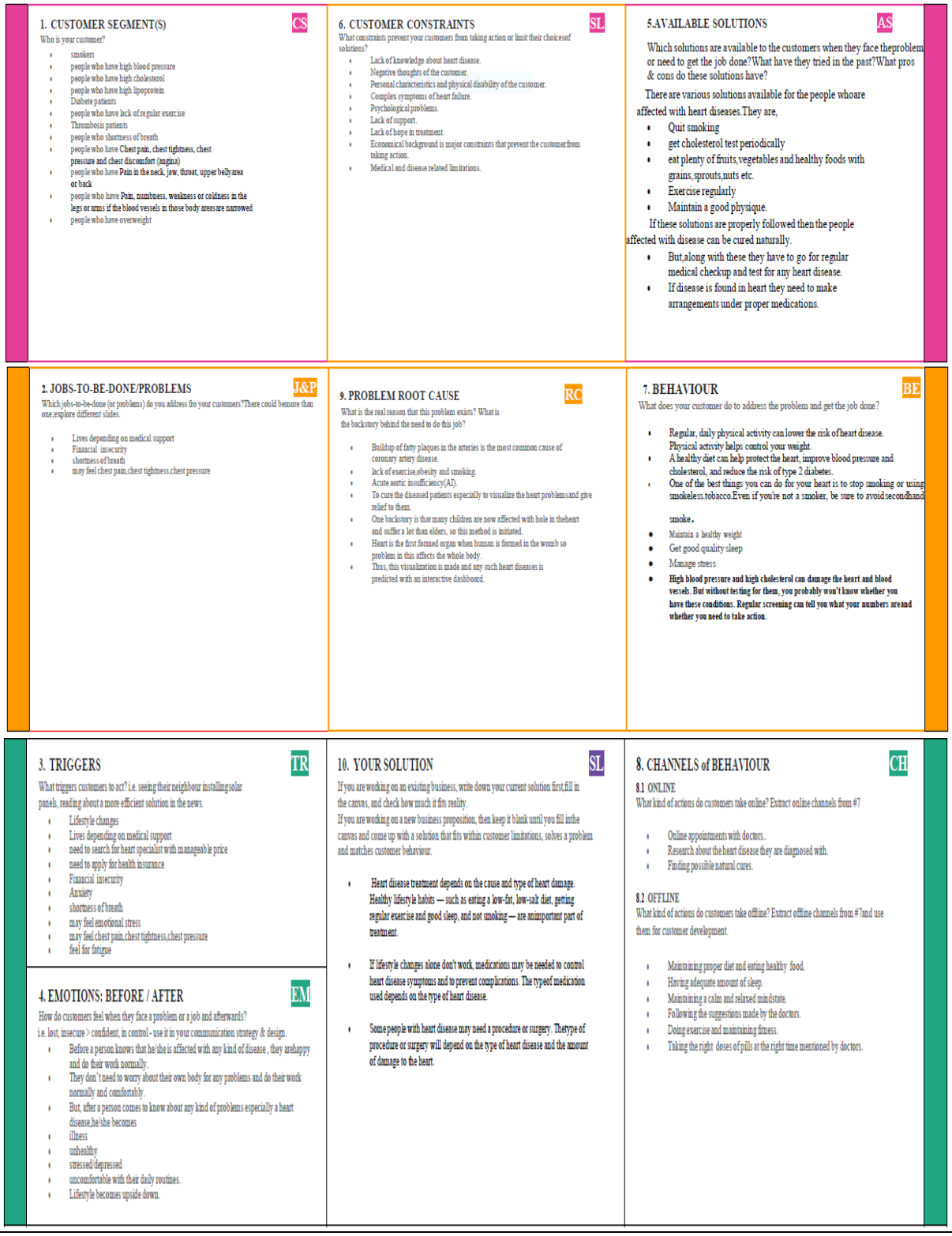


3.3 Proposed Solution

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



1. CUSTOMER SEGMENT(S) — CS

Who is your customer?

- smokers
- people who have high blood pressure
- people who have high cholesterol
- people who have high lipoprotein
- Diabete patients
- people who have lack of regular exercise
- Thrombosis patients
- people who shortness of breath
- people who have Chest pain, chest tightness, chest pressure and chest discomfort (angina)
- people who have Pain in the neck, jaw, throat, upper bellyarea or back
- people who have Pain, numbness, weakness or coldness in the legs or arms if the blood vessels in those body areasare narrowed
- people who have overweight

6. CUSTOMER CONSTRAINTS — SL

What constraints prevent your customers from taking action or limit their choicesof solutions?

- Lack of knowledge about heart disease.
- Negative thoughts of the customer.
- Personal characteristics and physical disability of the customer.
- Complex symptoms of heart failure.
- Psychological problems.
- Lack of support.
- Lack of hope in treatment.
- Economical background is major constraints that prevent the customerfrom taking action.
- Medical and disease related limitations.

5.AVAILABLE SOLUTIONS — AS

Which solutions are available to the customers when they face theproblem or need to get the job done?What have they tried in the past?What pros & cons do these solutions have?

There are various solutions available for the people whoare affected with heart diseases.They are,

- Quit smoking
- get cholesterol test periodically
- eat plenty of fruits,vegetables and healthy foods with grains,sprouts,nuts etc.
- Exercise regularly
- Maintain a good physique.

If these solutions are properly followed then the people affected with disease can be cured naturally.

- But,along with these they have to go for regular medical checkup and test for any heart disease.
- If disease is found in heart they need to make arrangements under proper medications.

2. JOBS-TO-BE-DONE/PROBLEMS — J&P

Which jobs-to-be-done (or problems) do you address fro your customers?There could bemore than one,explore different sides.

- Lives depending on medical support
- Financial insecurity
- shortness of breath
- may feel chest pain,chest tightness,chest pressure

9. PROBLEM ROOT CAUSE — RC

What is the real reason that this problem exists? What is the backstory behind the need to do this job?

- Buildup of fatty plaques in the arteries is the most common cause of coronary artery disease.
- lack of exercise,obesity and smoking.
- Acute aortic insufficiency(AI).
- To cure the diseased patients especially to visualize the heart problemsand give relief to them.
- One backstory is that many children are now affected with hole in theheart and suffer a lot than elders, so this method is initiated.
- Heart is the first formed organ when human is formed in the womb so problem in this affects the whole body.
- Thus, this visualization is made and any such heart diseases is predicted with an interactive dashboard.

7. BEHAVIOUR — BE

What does your customer do to address the problem and get the job done?

- Regular, daily physical activity can lower the risk of heart disease. Physical activity helps control your weight.
- A healthy diet can help protect the heart, improve blood pressure and cholesterol, and reduce the risk of type 2 diabetes.
- One of the best things you can do for your heart is to stop smoking or using smokeless tobacco.Even if you're not a smoker, be sure to avoid secondhand smoke.
- Maintain a healthy weight
- Get good quality sleep
- Manage stress
- **High blood pressure and high cholesterol can damage the heart and blood vessels. But without testing for them, you probably won't know whether you have these conditions. Regular screening can tell you what your numbers areand whether you need to take action.**

3. TRIGGERS — TR

What triggers customers to act? i.e. seeing their neighbour installingsolar panels, reading about a more efficient solution in the news.

- Lifestyle changes
- Lives depending on medical support
- need to search for heart specialist with manageable price
- need to apply for health insurance
- Financial insecurity
- Anxiety
- shortness of breath
- may feel emotional stress
- may feel chest pain,chest tightness,chest pressure
- feel for fatigue

4. EMOTIONS: BEFORE / AFTER — EM

How do customers feel when they face a problem or a job and afterwards?
i.e. lost, insecure > confident, in control - use it in your communication strategy & design.

- Before a person knows that he/she is affected with any kind of disease , they arehappy and do their work normally.
- They don't need to worry about their own body for any problems and do their work normally and comfortably.
- But, after a person comes to know about any kind of problems especially a heart disease,he/she becomes
- illness
- unhealthy
- stressed/depressed
- uncomfortable with their daily routines.
- Lifestyle becomes upside down.

10. YOUR SOLUTION — SL

If you are working on an existing business, write down your current solution first,fill in the canvas, and check how much it fits reality.
If you are working on a new business proposition, then keep it blank until you fill inthe canvas and come up with a solution that fits within customer limitations, solves a problem and matches customer behaviour.

- **Heart disease treatment depends on the cause and type of heart damage. Healthy lifestyle habits — such as eating a low-fat, low-salt diet, getting regular exercise and good sleep, and not smoking — are animportant part of treatment.**
- **If lifestyle changes alone don't work, medications may be needed to control heart disease symptoms and to prevent complications. The typeof medication used depends on the type of heart disease.**
- **Some people with heart disease may need a procedure or surgery. Thetype of procedure or surgery will depend on the type of heart disease and the amount of damage to the heart.**

8. CHANNELS of BEHAVIOUR — CH

8.1 ONLINE

What kind of actions do customers take online? Extract online channels from #7

- Online appointments with doctors..
- Research about the heart disease they are diagnosed with.
- Finding possible natural cures.

8.2 OFFLINE

What kind of actions do customers take offline? Extract offline channels from #7and use them for customer development.

- Maintaining proper diet and eating healthy food.
- Having adequate amount of sleep.
- Maintaining a calm and relaxed mindstate.
- Following the suggestions made by the doctors.
- Doing exercise and maintaining fitness.
- Taking the right doses of pills at the right time mentioned by doctors.

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	Enables user to make registration for the application through Gmail
FR-2	User Confirmation	Once after registration, the user will get confirmation via Email
FR-3	Visualizing Data	User can visualize the trends on the heart disease through Dashboard created using IBM Cognos Analytics
FR-4	Generation Report	User can view his/her health report and can make decisions accordingly

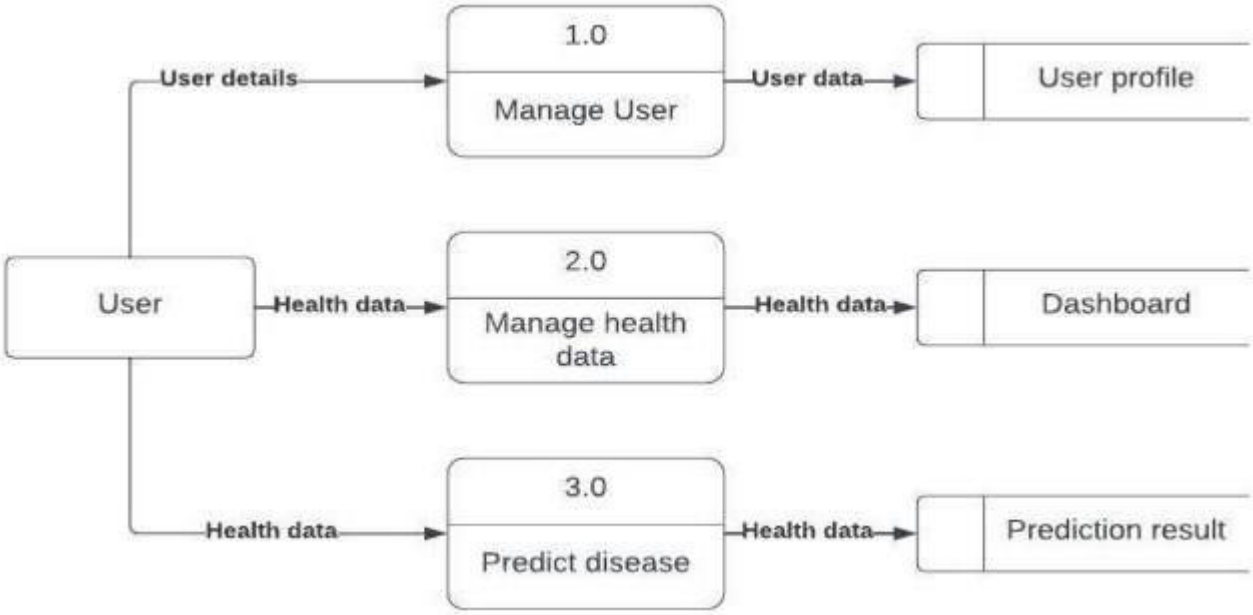
4.2 Non-Functional Requirement

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

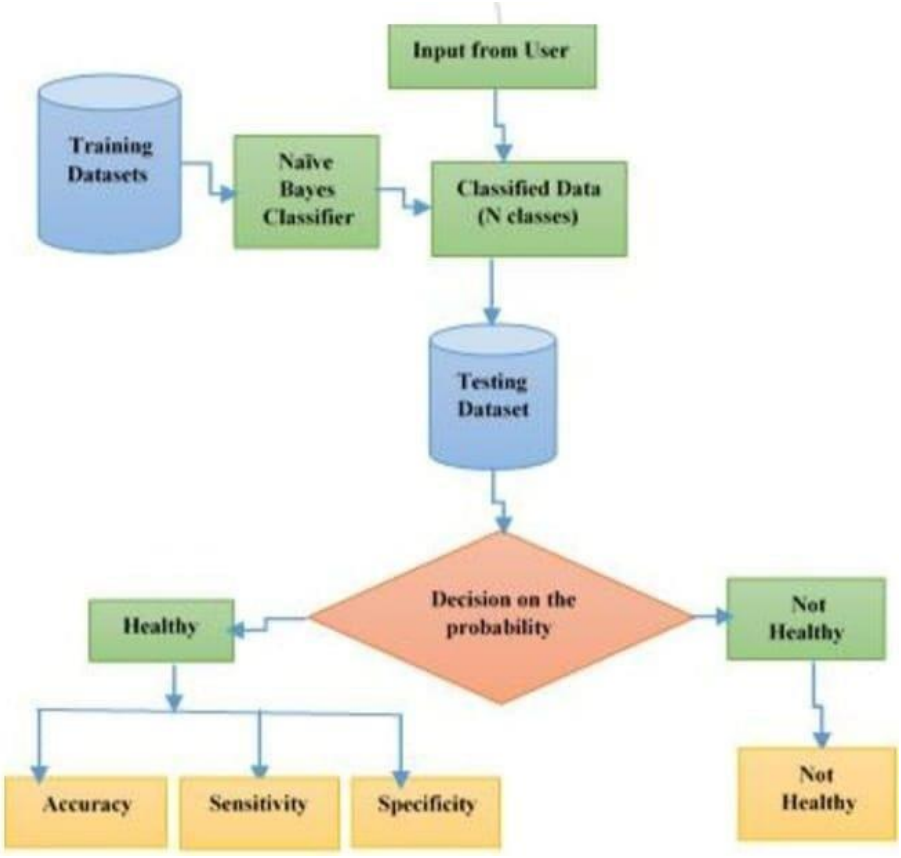
FR No.	Non-Functional Requirement	Description
NFR-1	**Usability**	The application will have a simple and user friendly graphical interface. Users will be able to understand and use all the features of the application easily. Any action has to be performed with just a few clicks
NFR-2	**Security**	For security of the application the technique known as database replication should be used so that all the important data should be kept safe. Incase of crash, the system should be able to backup and recover the data
NFR-3	**Reliability**	The application has to be consistent at every scenario and has to work without failure in any environment
NFR-4	**Performance**	Performance of the application depends on the response time and the speed of the data submission. The response time of the application is direct and faster which depends on the efficiency of implemented algorithm
NFR-5	**Availability**	The application has to be available 24 x 7 for users without any interruption
NFR-6	**Scalability**	The application can withstand the increase in the no. of users and has to be able to develop Higher versions

5. Project Design

5.1 Data Flow Diagram



5.2 Solution and Technical Architecture 5.3



6.Project Planning and Scheduling

6.1Script Planning and Execution

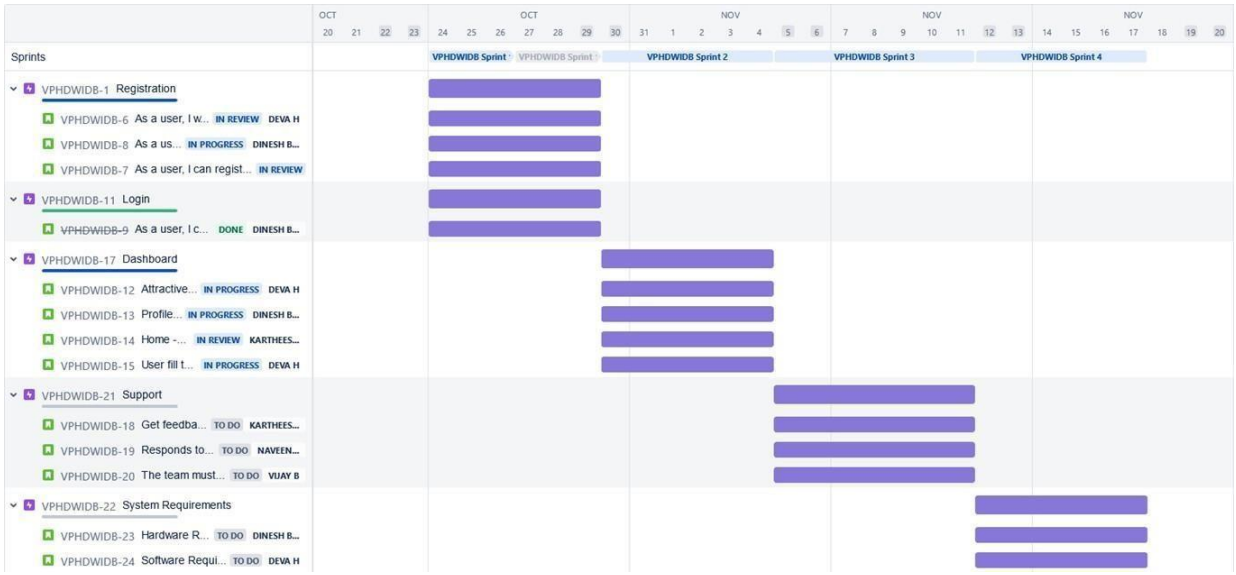
Sprint	Functional Requirement (Epic)	User Story Number	User Story / Task	Story Points	Priority	Team Members
Sprint-1	Registration	USN-1	As a user, I can register for the application by entering my email, password, and confirming my password	3	High	1
Sprint-1		USN-2	As a user, I will receive confirmation 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 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.

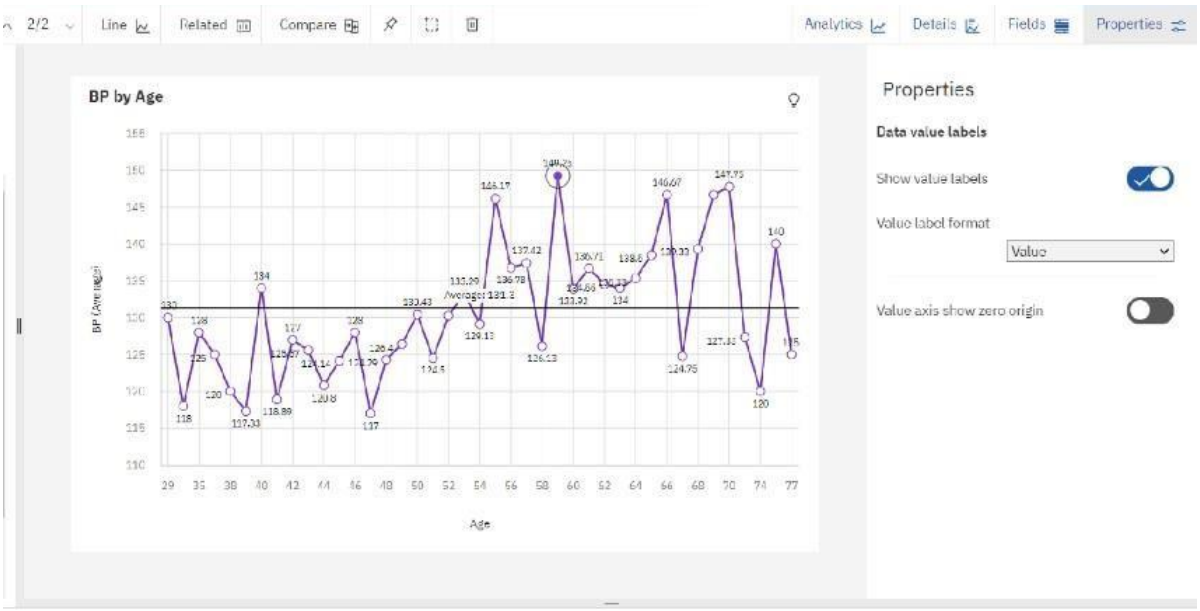
Comparing it with the accuracy gotten from Decision Tree:

```
TP=cm[0][0] #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
```

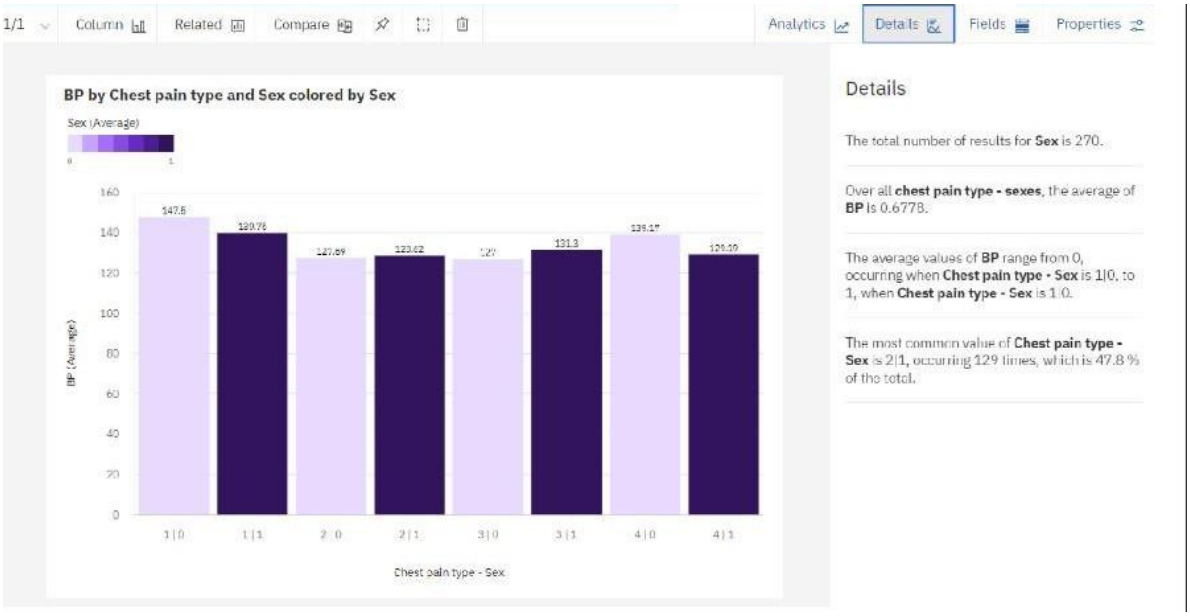
7.2 Dashboard

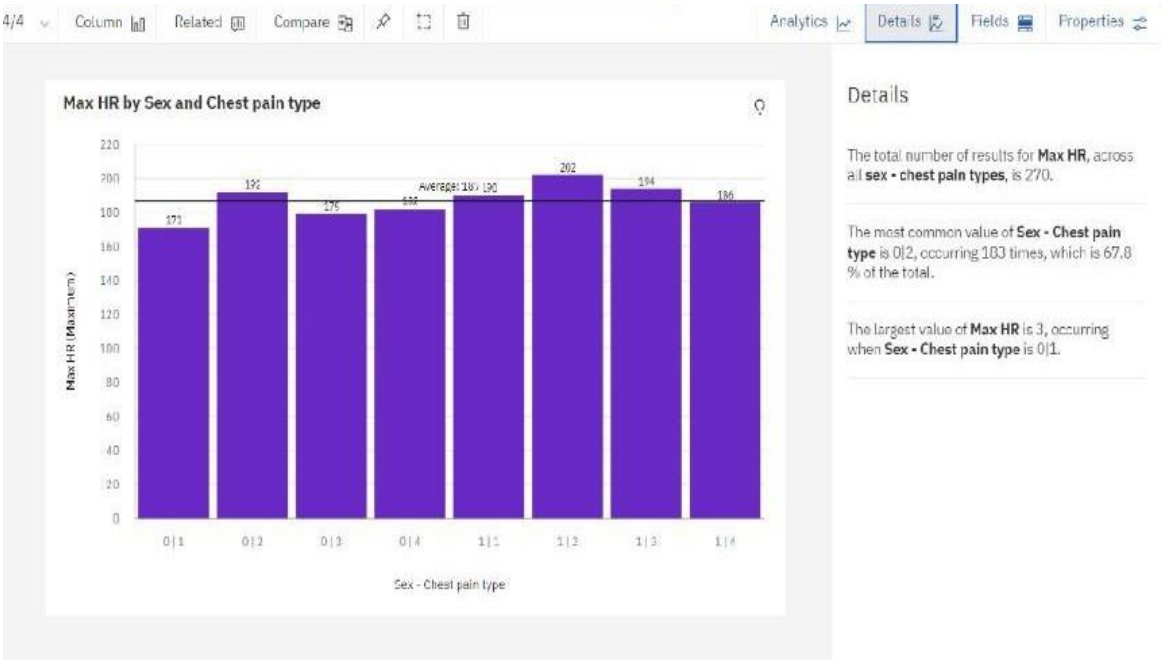
Average BP during chest pain



Exploration Of BPvsChestPainType And Gender:

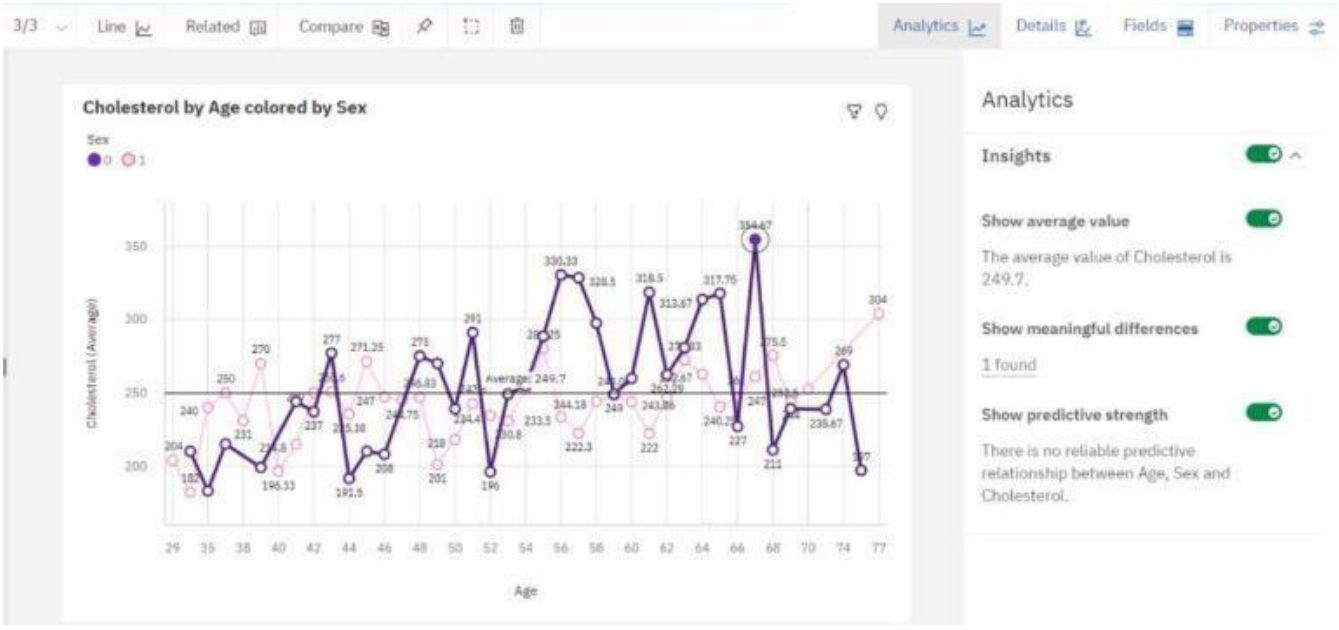
Exploration Of Max Heart Rate During The Chest Pain:

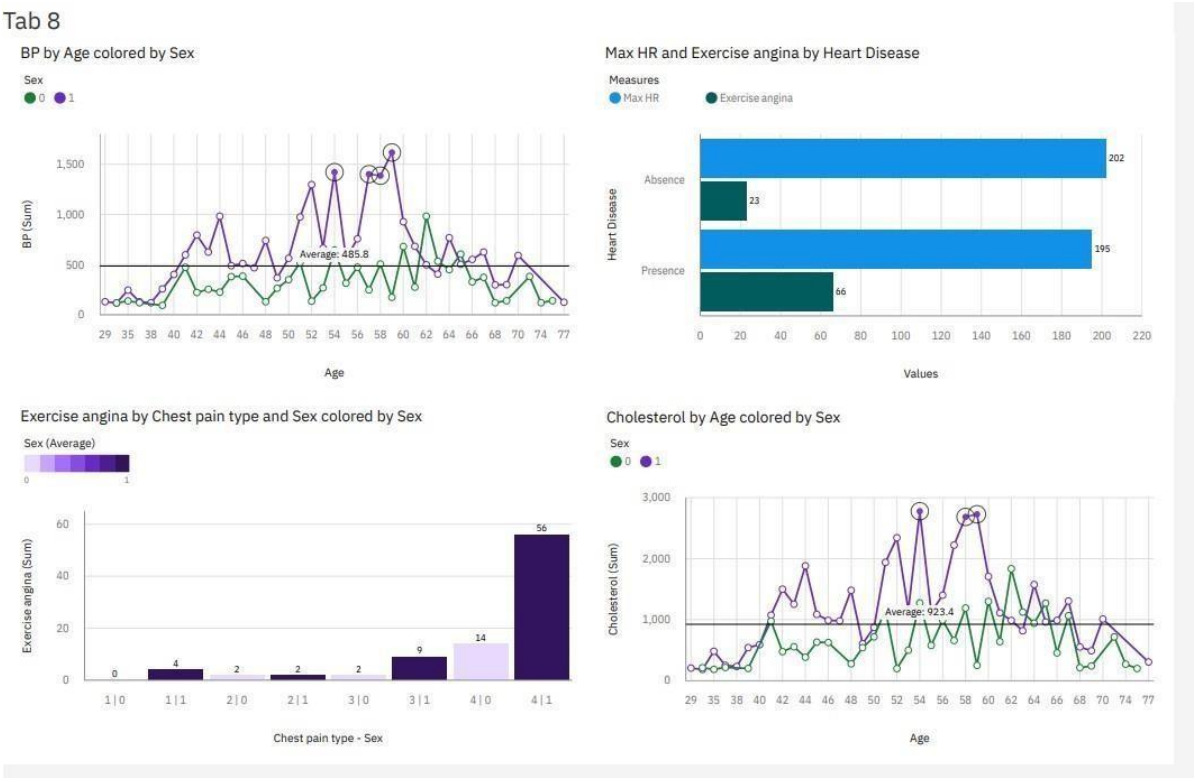




Exploration Of Cholesterol by age and Gender:

Dashboard Showing Different Types Of Visuals:





8. Testing

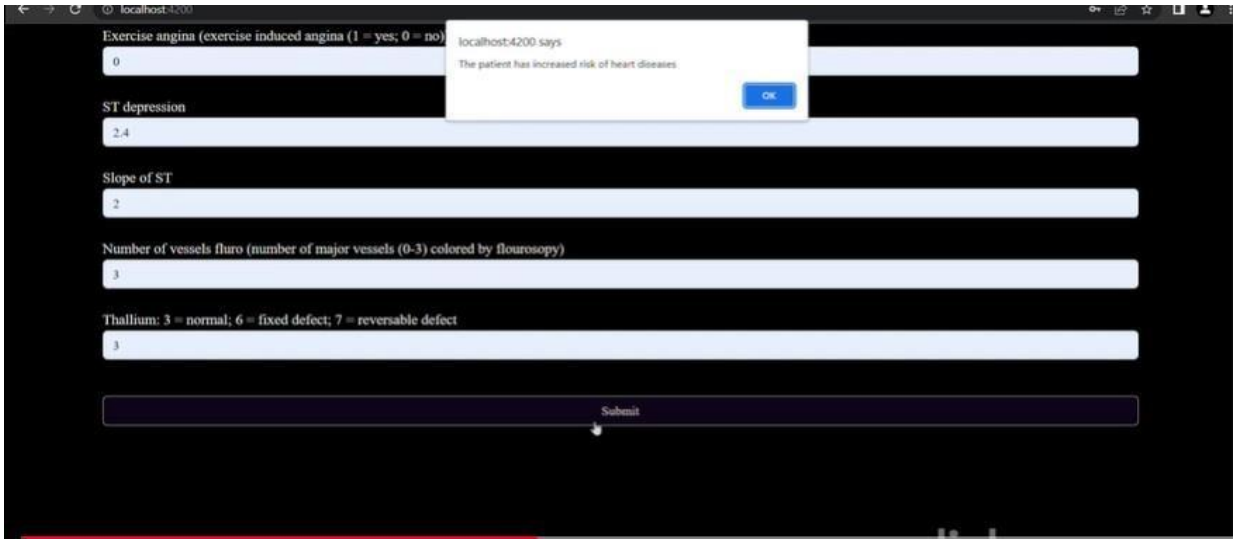
8.1 Test Cases

Testing the data model for various input values.

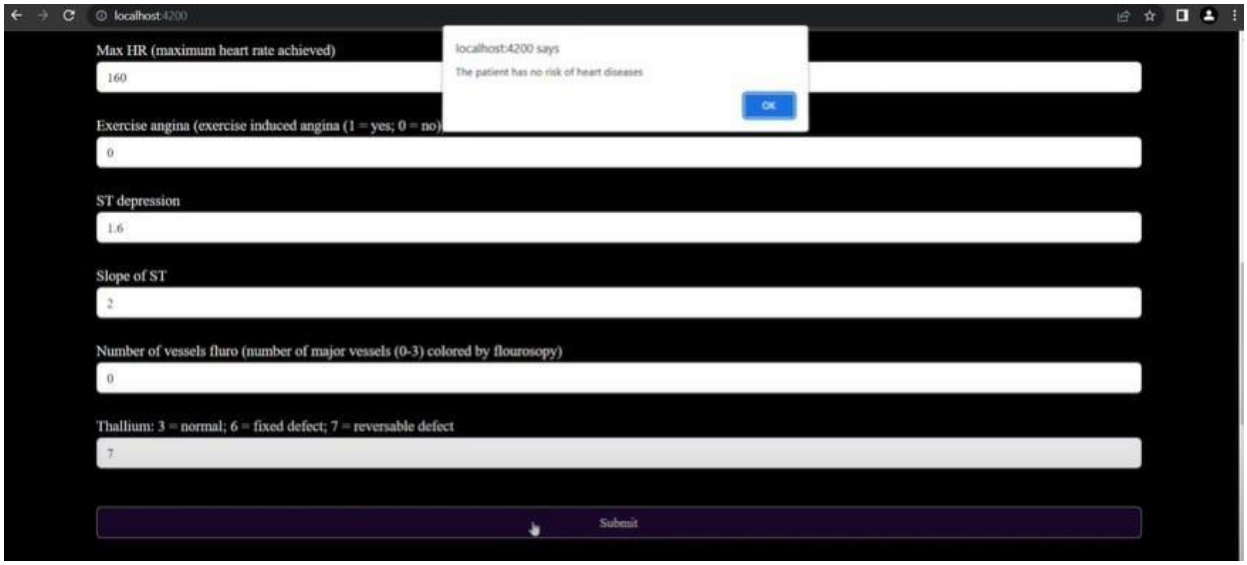
```
In [ ]: from sklearn.metrics import accuracy_score
        input=(63,1,3,145,200,150,98,0,0,0,0,0,0)
        input_as_numpy=np.asarray(input)
        input_reshaped=input_as_numpy.reshape(1,-1)
        pre1=tree_model.predict(input_reshaped)
        print(pre1)
        a1 = accuracy_score(pre1,model1.predict(input_reshaped))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

        ['Presence']
        100.0
```

8.2 User acceptance Testing

Testing a case where user has heart disease



Testing a case where user does not have heart disease



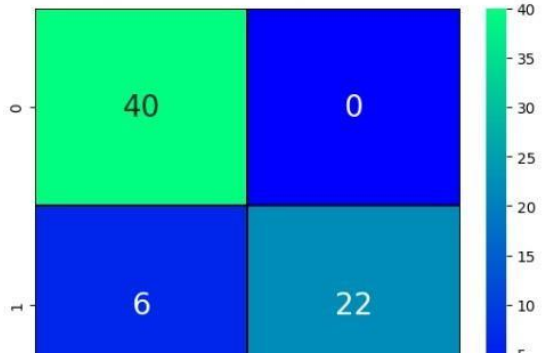
9. Result

9.1 Performance Metrics

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

```
from sklearn.model_selection import RandomizedSearchCV
from sklearn.tree import DecisionTreeClassifier

tree_model = DecisionTreeClassifier(max_depth=5,criterion='entropy')
cv_scores = cross_val_score(tree_model, x, y, cv=10, scoring='accuracy')
m=tree_model.fit(x, y)
prediction=m.predict(X_test)
cm= confusion_matrix(y_test,prediction)
sns.heatmap(cm, annot=True,cmap='winter',linewidths=0.3, linecolor='black',annot_kws={"size": 20})
print(classification_report(y_test, prediction))

TP=cm[0][0]
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)))
```

```
              precision    recall  f1-score   support

     Absence       0.87      1.00      0.93        40
    Presence       1.00      0.79      0.88        28

    accuracy                           0.91        68
   macro avg       0.93      0.89      0.91        68
weighted avg       0.92      0.91      0.91        68

Testing Accuracy for Decision Tree: 0.9117647058823529
Testing Sensitivity for Decision Tree: 0.8695652173913043
Testing Specificity for Decision Tree: 1.0
Testing Precision for Decision Tree: 1.0
```



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:
https://github.com/IBM-EPBL/IBM-Project-46643-1660752463/tree/main/Final%20Deliverables

Demo video link:
https://drive.google.com/file/d/1mq13SGB3EdigfbPlNmRcQKTUD0Dl4pMS/view?usp=sharing