Project Report

Visualizing and Predicting Heart Diseases with an Interactive Dash Board

Team ID: PNT2022TMID35649

Team members:

- Adhetya Narayan J.M(Team leader)
- Saikrishna R
- Paavendhan K.S
- Kavin B

Industry Mentor(s) Name: Mahidhar, Saumya

Faculty Mentor(s) Name: Varalakshmi P

1. INTRODUCTION

1.1 Project Overview

Heart disease describes a range of conditions that affect your heart. Diseases under the heart disease umbrella include blood vessel diseases, such as coronary artery disease; heart rhythm problems (arrhythmia); and heart defects you're born with (congenital heart defects), among others.

The main aim of this project is to use IBM Cognos analytics tools to create an interactive dashboard to understand whether a patient has chance of getting heart disease based on certain parameters.

1.2 Purpose

The term "heart disease" is often used interchangeably with the term "cardiovascular disease."Cardiovascular disease refers to conditions characterized by narrowed or blocked blood vessels, which can result in a heart attack, chest pain (angina), or stroke. Other heart conditions, such as those affecting your heart's muscle, valves, or rhythm, are also classified as heart disease. any types of heart disease can be avoided or treated by adopting a healthy lifestyle. Data analytics here can help users understand the risk of getting heart disease. In this project, a dataset is imported which has the most common attributes used for predicting heart disease.

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

S No.	Paper Title	Key Points
1	Design And Implementing Heart Disease Prediction Using Naive Bayesian	An application based Smart heart prediction system is proposed using Naïve Bayes and this model has provided accuracy of 89.77%
2	Heart Disease Identification Method Using Machine Learning Classification in E-Healthcare.	Feature selection algorithm is designed with SVM to identify heart disease. Optimization methods are used to further increase the performance of a predictive system for HD diagnosis.
3	Prediction of Heart Disease by Mining Frequent Items and Classification Techniques.	Data mining classification methods are used for prediction and Naive Bayes has given highest accuracy.
4	An Intelligent Clinical Decision Support System Based on Artificial Neural Network for Early Diagnosis of Cardiovascular Diseases in Rural Areas.	Proposed Correlation-based feature selection (CFS) and Multilayer Perceptron classifier for prediction.
5	Survey on Prediction of Heart Disease Using Data Mining Techniques.	Measured the accuracy using different accuracy parameter of data mining algorithms and proposed that Support Vector Machine technique is an efficient method for predicting heart disease.
6	Intelligent Cardiovascular Disease Risk Estimation Prediction System.	Used K-Nearest Neighbour algorithm and achieved an accuracy of 92.30% and uses less number of attributes for the prediction

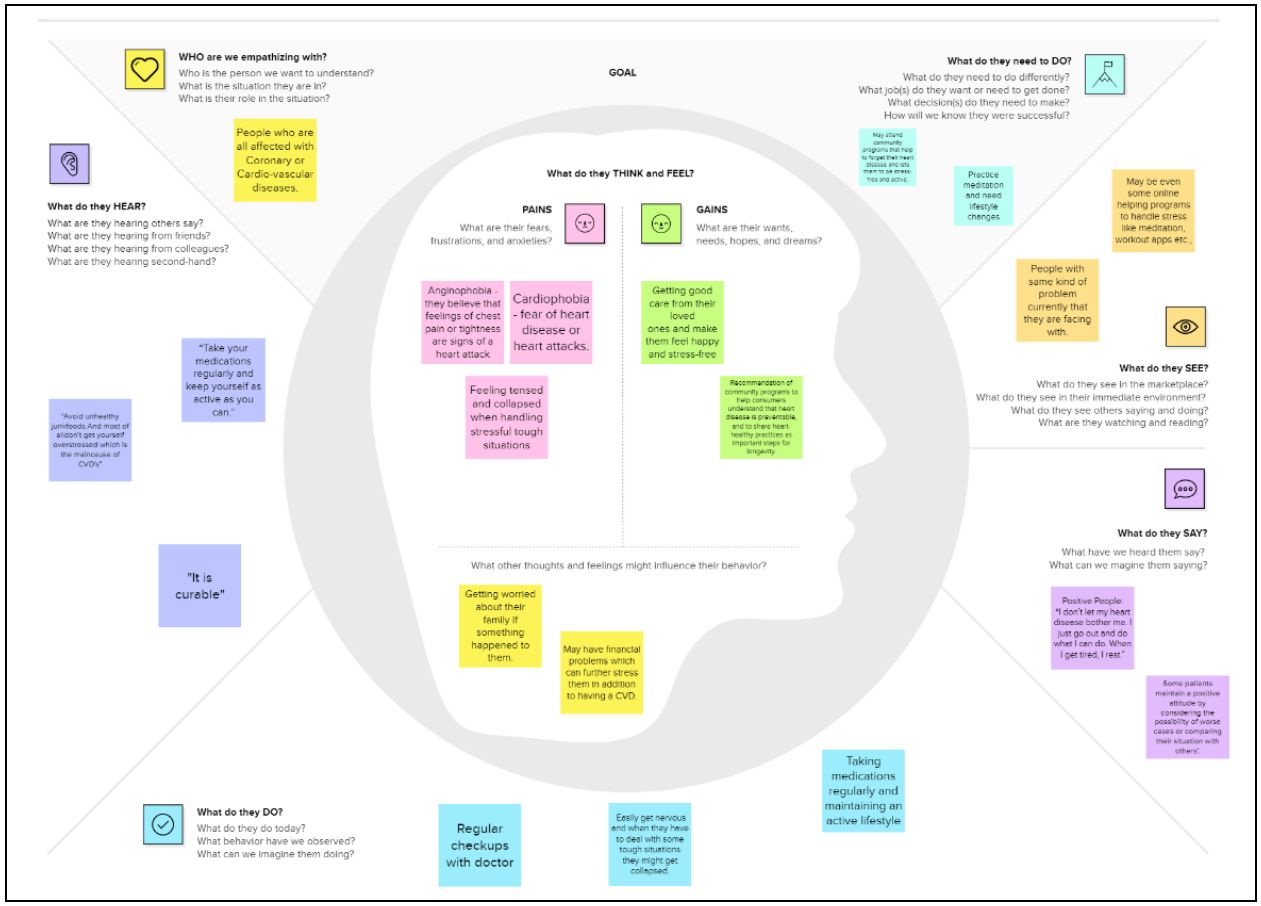
7	Heart diseases prediction with data mining and neural network techniques.	Hybrid techniques are incorporated and various data mining techniques are compared and achieved higher accuracy
8	Heart Disease Prediction using Machine Learning.	Compares the accuracy score of various machine learning algorithms and proposed that random forest algorithm has given highest accuracy score of 90.16%.
9	Evaluating ensemble prediction of coronary heart disease using receiver operating characteristics.	Combines KNN, ANN and SVM using Voting Technique. As ensemble method end up acquiring highest accuracy, more models will increase scope of the trend.
10	An Intelligent Learning System based on Random Search Algorithm and Optimized Random Forest Model for Improved Heart Disease Detection.	Two algorithms were hybridized in this paper, Random search algorithm and Random forest model have achieved the highest accuracy of 92.33%.

2.3 Problem Statement Definition

People with unhealthy lifestyles, stress, depression, age above 40 and when their ancestors got heart disease since heart disease is hereditary they are getting the heart disease. The disease is originating from an unhealthy lifestyle. It mostly occurs in the blood valves of the heart. If we don't solve the problem, many people will die at a young age. The death rate due to heart disease will be increased rapidly. We should predict the problem before giving treatment to the patients. As if the problem is predicted early, we can solve it easily and early.

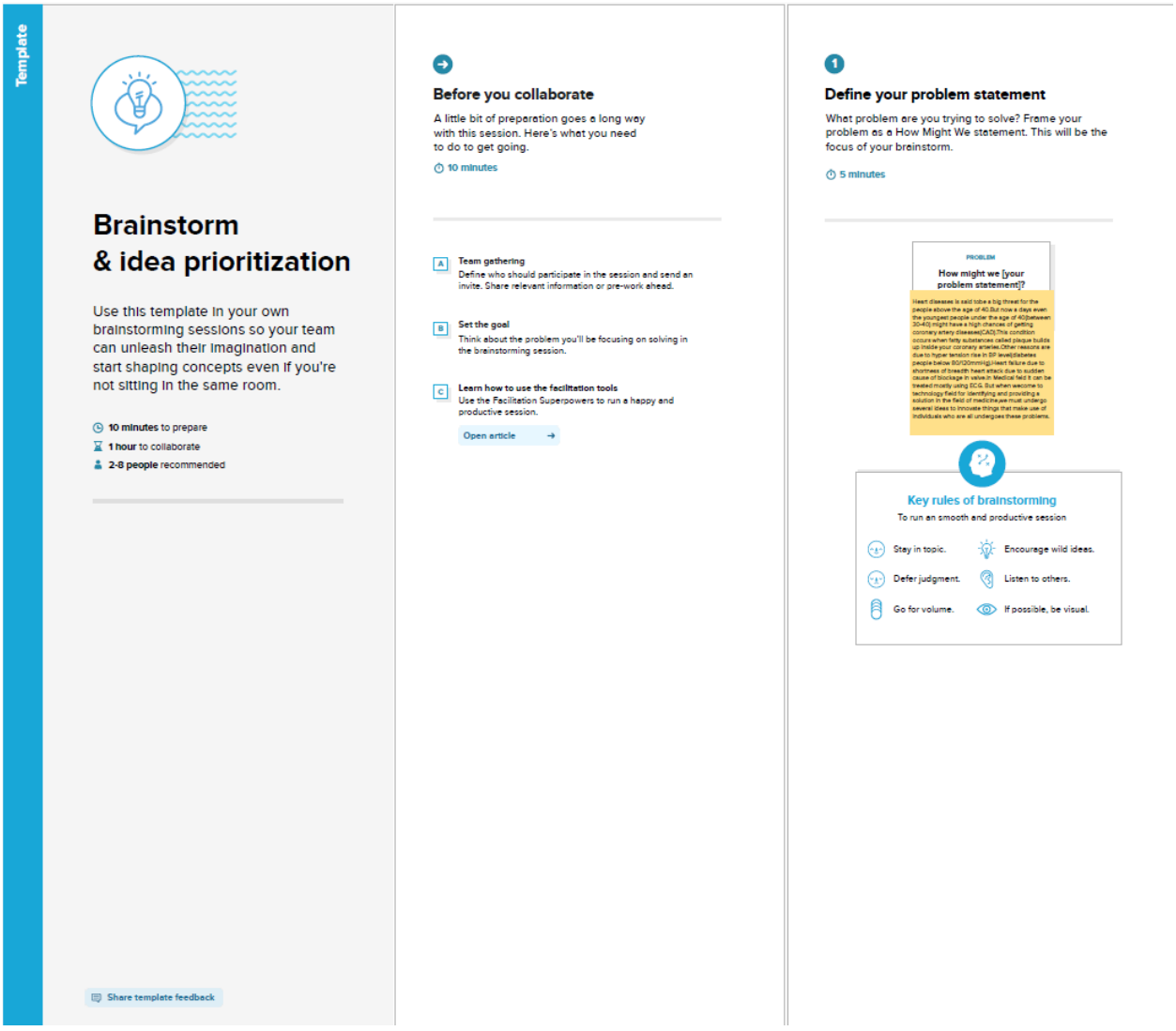
3. IDEATION & PROPOSED SOLUTION

3.1 Empathy Map Canvas

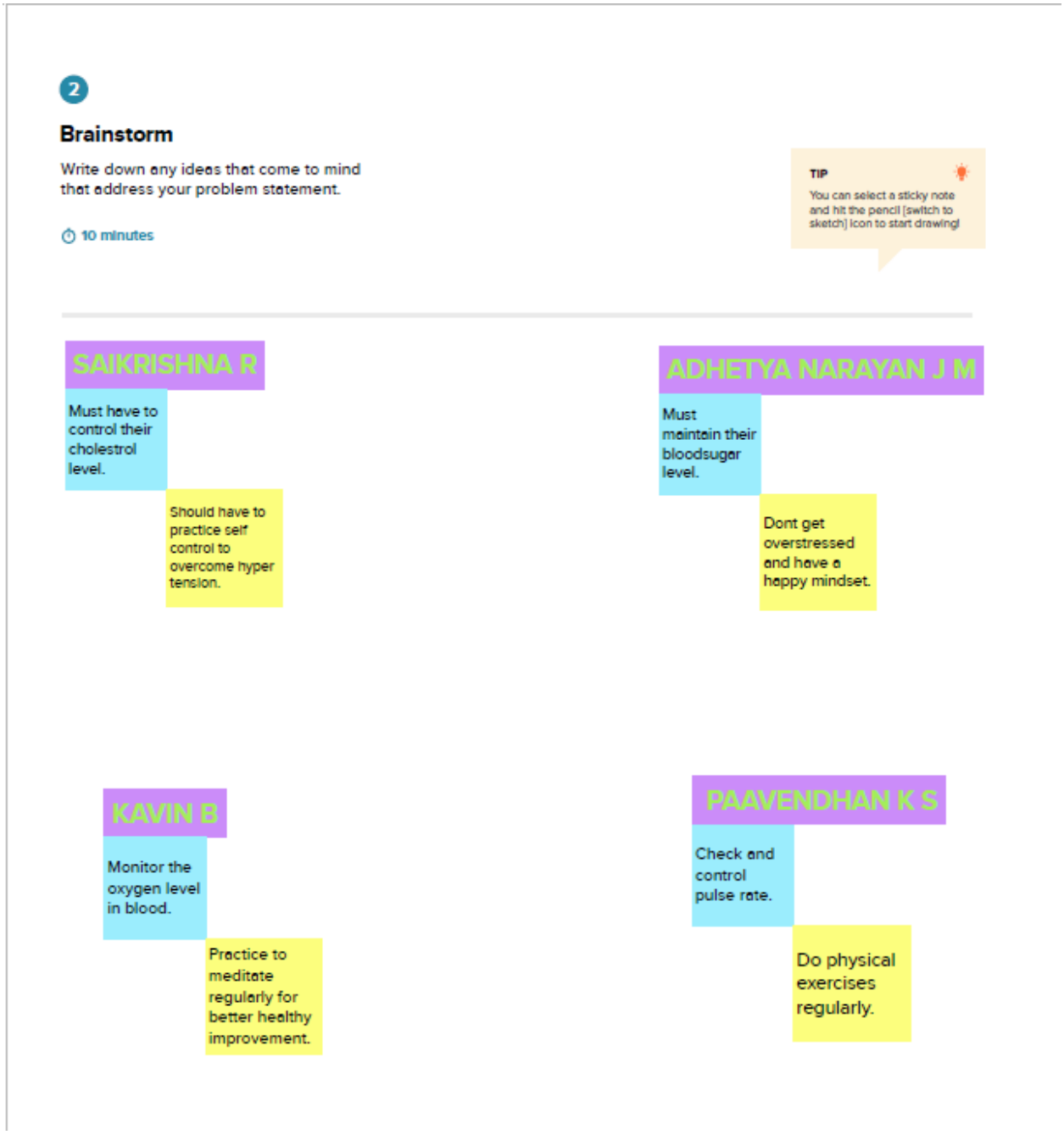


3.2 Ideation & Brainstorming

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



Step-2: Brainstorm, Idea Listing and Grouping

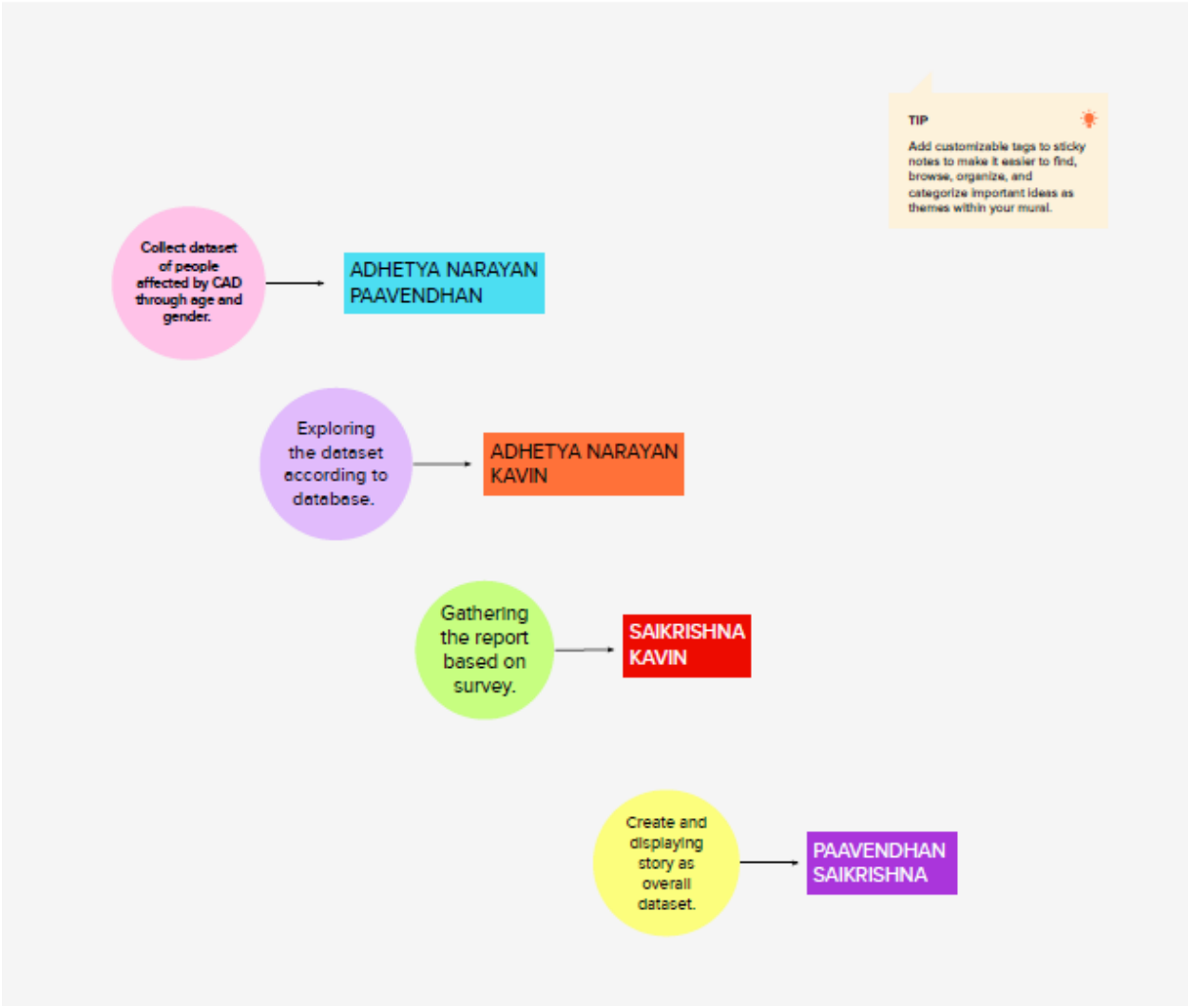


3

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 and break it up into smaller sub-groups.

20 minutes



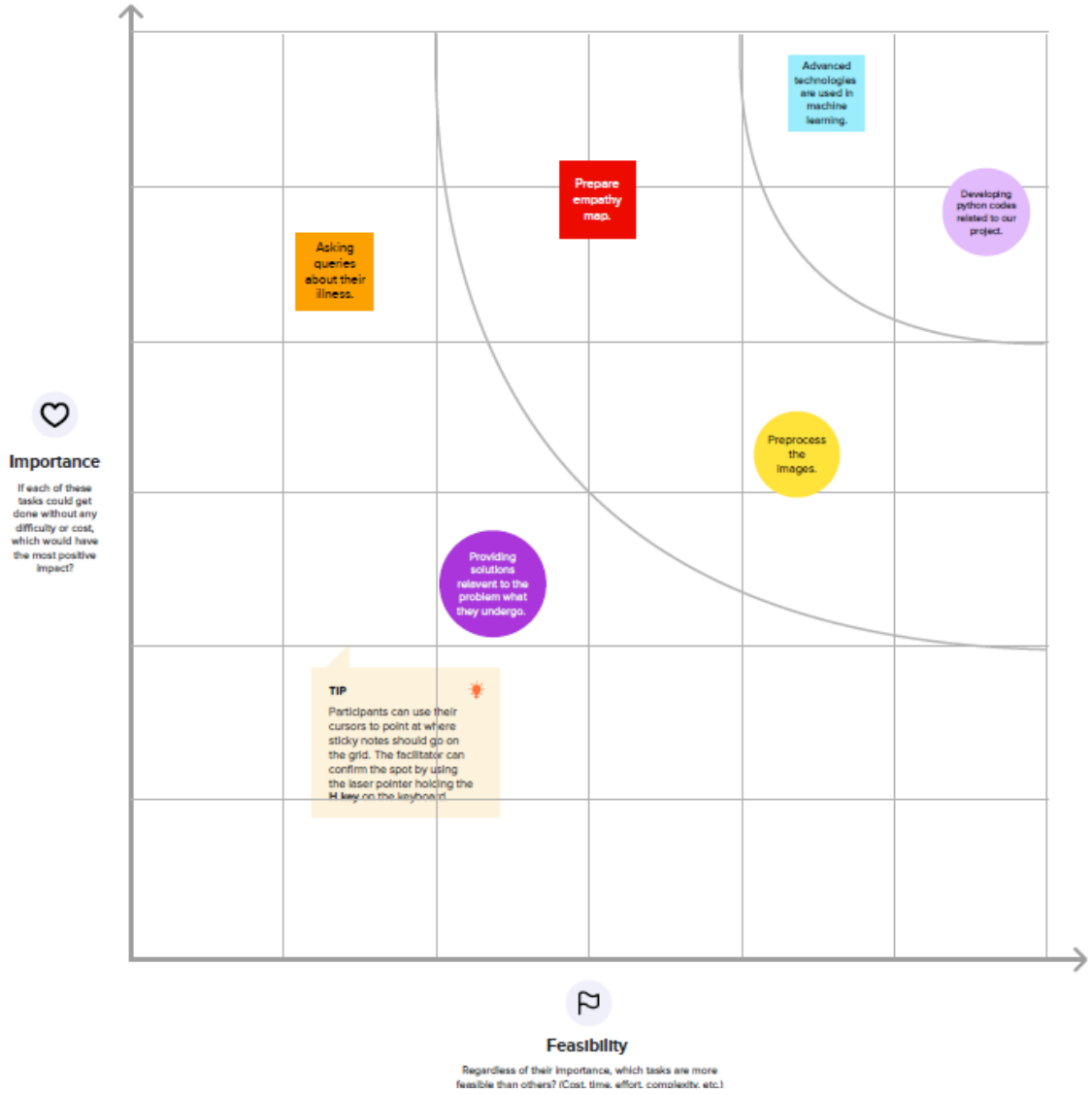
Step-3: Idea Prioritization

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



3.3 Proposed Solution

S. NO.	Parameter	Description
1	Problem Statement (Problem to be solved)	To analyse which patients are most likely to suffer from heart disease based on given parameters
2	Idea / Solution description	Creating an interactive dashboard so that people can easily understand whether they have a chance of getting heart disease.
3	Novelty / Uniqueness	Many tests are taken by doctors to detect presence of heart disease. The parameters used are often understood only by medical professional. During the analysis phase, data is extracted and better decisions can be made to diagnose a patient.
4	Social Impact / Customer Satisfaction	Using the power of data analytics, this method will develop awareness among people regarding the risks associated with heart disease as it gives them valuable insights
5	Business Model (Revenue Model)	This project can be converted to an software kit, webpage or even an application which users can interact with. Hospitals could potentially use this for analysis and prediction of heart disease
6	Scalability of the Solution	Based on number of users, performance will vary. So, the application must be memoryefficient and dynamically allocate resources to ensure smooth performance. This is a lightweight application which can be embedded into other projects.

3.4 Problem Solution fit

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 Gmail
FR-2	User Confirmation	Confirmation via Email
FR-3	User input	Uploading dataset to platform i.e. IBM Cognos
FR-4	Data pre-processing	Data is prepared and processed by cleaning and checking information
FR-5	Data analysis	Data is analysed to find patterns, relationships and trends
FR-6	Data visualization	Data is converted to various visualizations based on user requirements

4.2 Non-Functional requirements

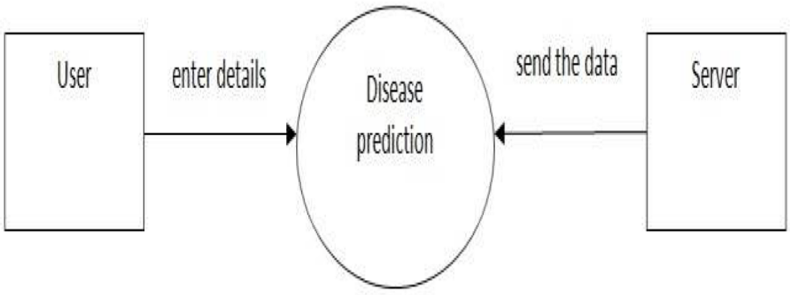
Following are the non-functional requirements of the proposed solution

NFR No.	Non-Functional Requirement	Description
NFR-1	Usability	Even a non- technical person should be able to understanding working of the application and use it
NFR-2	Security	Patient medical data is very sensitive and therefore must be secured so that the data is not misused
NFR-3	Reliability	Application should be fault tolerant. Any changes made need to be committed and backup must be present in case of system crash.
NFR-4	Performance	Application needs to be lightweight and efficient in terms of memory and resources used. Different users have different systems so that must be taken into account.
NFR-5	Availability	Data should be available to users at all times. Data integrity needs to be maintained.
NFR-6	Scalability	Application needs to be able to handle multiple or large amounts of data and produce advanced visualizations without affecting performance.

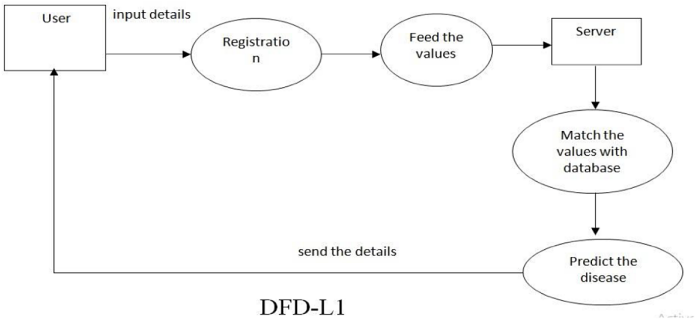
5. PROJECT DESIGN

5.1 Data Flow Diagrams

DFD-L0

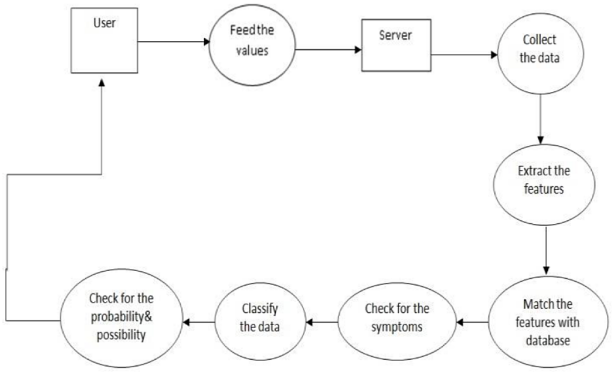


DFD-L1

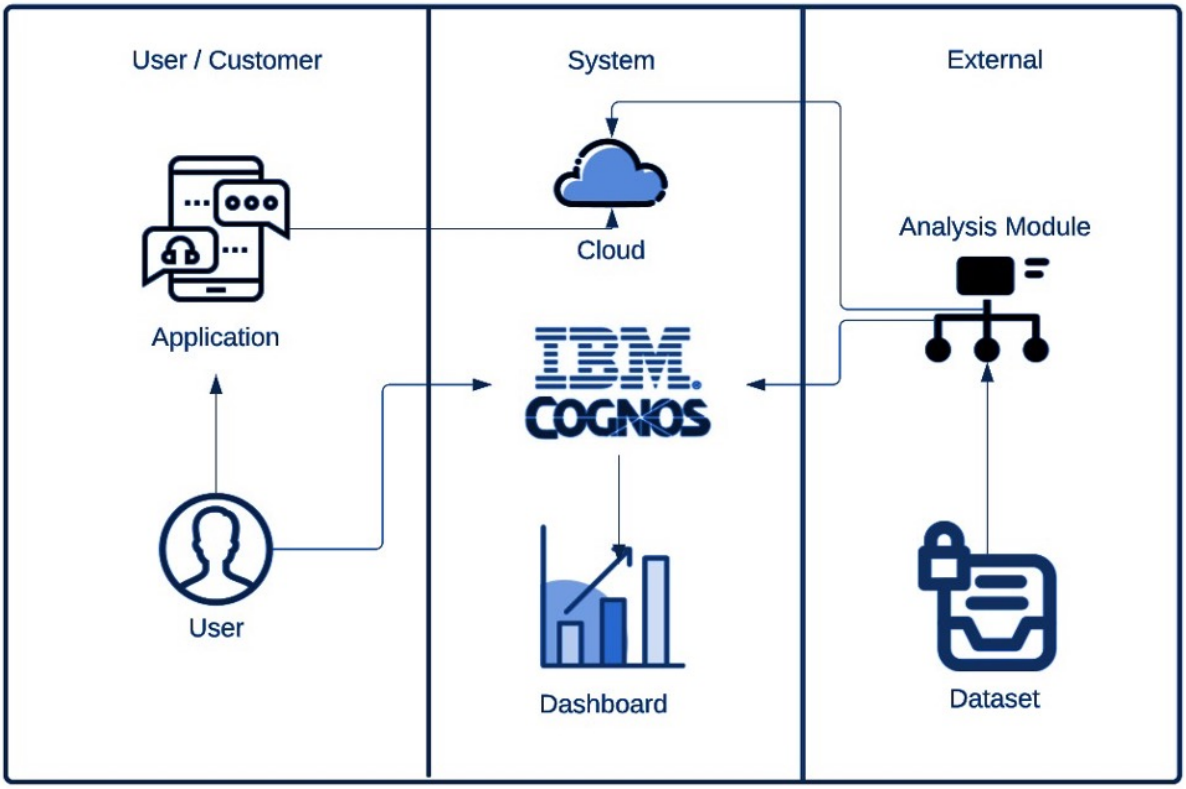


DFD-L1

DFD-L2



5.2 Solution & Technical Architecture



Components and Technologies

S.No	Component	Description	Technology
1	User interface	How user interacts with application e.g. Web UI, Mobile App, Chatbot etc.	IBM Cognos
2	Storage infrastructure	Medical data related to heart is uploaded in cloud through cloud	IBM Cloud
3	Working with dataset	Uploading, cleaning and pre-processing dataset	IBM Cognos + Cloud
4	Data exploration	Uploaded data is explored to identify trends	IBM Cognos
5	Data visualization	Multiple types of graphs are shown according to patient medical data and requirements	IBM Cognos Dashboard
6	Cloud database	Database Service on Cloud	IBM Cognos, IBM Cloud etc.
7	Viewing Data	User logins to application to view visualizations for uploaded data	IBM Cognos Dashboard

Application characteristics

S.No	Characteristics	Description	Technology
1	Open-Source Frameworks	List the open-source frameworks used	IBM Cognos, IBM Cloud, IBM Watson
2	Security Implementations	Secure user information and data	Active Directory
3	Scalable Architecture	Supports various data sizes	Web 3.0 IBM Cloud
4	Availability	Multi page layout providing various visualizations of data and provide full support irrespective of platform and device specifications	Cognos Business Intelligence Server
5	Performance	Withstand huge data and process them without crashing	IBM Cognos, Performance Management Hub

5.3 User Stories

User Type	Functional Requirement (Epic)	User Story Number	User Story / Task	Acceptance criteria	Priority	Release
Customer (Mobile user)	Registration	USN-1	As a user, I can register for the application by entering my email, password, and confirming my password.	I can access my account / dashboard	High	Sprint-1
		USN-2	As a user, I will receive confirmation email once I have registered for the application	I can receive confirmation High email and click confirm	High	Sprint-1
		USN-3	As a user, I can register for the application through Facebook	I can register and access the dashboard with Facebook Login	Low	Sprint-2

		USN-4	As a user, I can register for the application through Gmail		Medium	Sprint-1
		USN-5	As a user, I can log into the application by entering email and password		High	Sprint-1
		USN-6	I can access the dashboard and access the analytics reports based on data uploaded.		High	Sprint-3

6. PROJECT PLANNING & SCHEDULING

6.1 Sprint Planning & Estimation

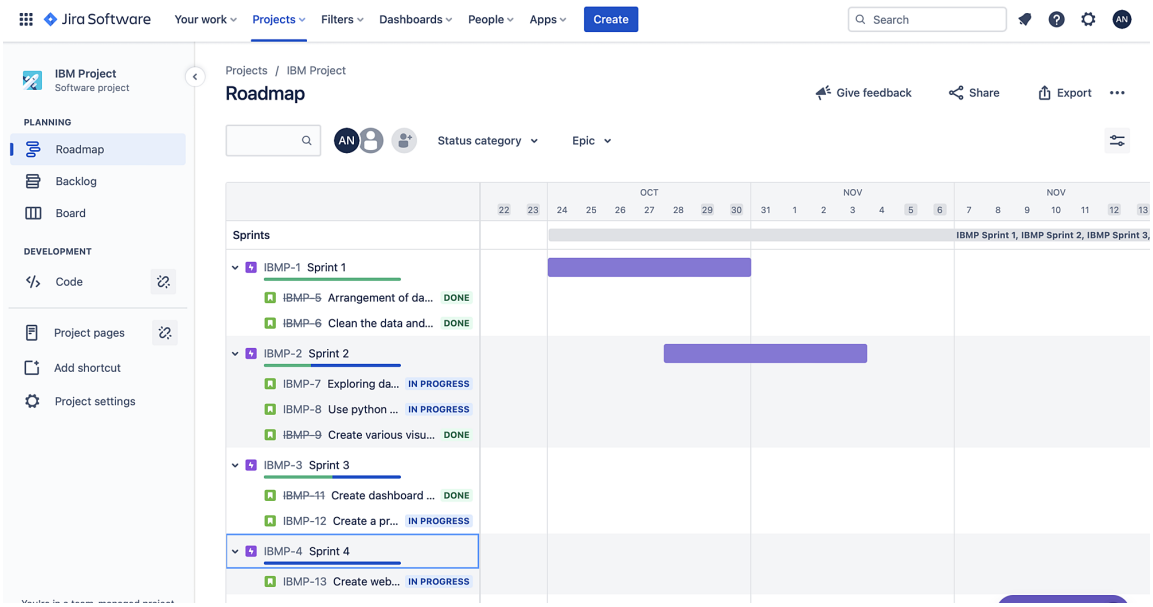
Sprint	Functional Requirement (Epic)	User Story Number	User Story / Task	Story Points	Priority Team	Members
Sprint 1	Arrangement of data set	USN -1	Upload the dataset in IBM Cognos platform and create data module	5	High	Sai Krishna
Sprint 1		USN -2	Clean the data and create simple visualizations using python libraries	3	High	Adhetya Narayan, Kavin B
Sprint 2	Exploring data and creating mode	USN -3	As an analyst, I would like to find relationships between attributes to understand its importance	2	Low	Paavendhan K.S
Sprint 2		USN -4	Use python to analyse correlation between variables. Visualised in the form of correlation matrix and use classifier algorithms like decision tree	3	Medium	Adhetya Narayan
Sprint 2		USN -5	Create various visualizations using IBM	3	High	Sai Krishna,

			Cognos			Paavendhan K.S
Sprint 3	Dashboard	USN -6	Create dashboard in IBM Cognos to get a clear understanding of visualizations	3	Medium	Kavin B
Sprint 3	Story	USN -7	As an analyst, I will use IBM Cognos to create a story to understand the animated presentation of dataset	3	Medium	Paavendhan K S
Sprint 4	Creation of web page	USN -8	Create webpage so that users can easily access the dashboard and story created in IBM Cognos	3	High	Adhetya Narayan

6.2 Sprint Delivery Schedule

Sprint	Total Story Points	Duration	Sprint Start date	Sprint End Date	Story Points Completed (as on Planned End Date)	Sprint Release Date (Actual)
Sprint 1	20	6 Days	24 Oct 2022	29 Oct 2022	5	29 Oct 2022
Sprint 2	20	6 Days	31 Oct 2022	05 Nov 2022	5	05 Nov 2022
Sprint 3	20	6 Days	07 Nov 2022	12 Nov 2022	5	14 Nov 2022
Sprint 4	20	6 Days	14 Nov 2022	19 Nov 2022	5	18 Nov 2022

6.3 Reports from JIRA



7. CODING & SOLUTIONING

7.1 Machine learning models

Using classification algorithms

We will test some classification algorithms: Logistic regression, svm, stochastic gradient descent , decision tree, random forest.

In [8]:
```
from sklearn.linear_model import LogisticRegression
from sklearn import svm
from sklearn.linear_model import SGDClassifier
from sklearn import tree
from sklearn.ensemble import RandomForestClassifier
from sklearn.metrics import accuracy_score
from sklearn.model_selection import train_test_split

y = data['Heart Disease']

X = data.drop('Heart Disease',axis=1)
X_train,X_test,y_train,y_test = train_test_split(X,y,test_size=0.3,random_state=0)
LR_classifier = LogisticRegression(random_state=0)
clf = svm.SVC()
sgd=SGDClassifier()
forest=RandomForestClassifier(n_estimators=20, random_state=12,max_depth=6)
treee = tree.DecisionTreeClassifier(criterion = 'entropy',random_state=0,max_depth = 6)
LR_classifier.fit(X_train, y_train)
clf.fit(X_train, y_train)
sgd.fit(X_train, y_train)
treee.fit(X_train, y_train)
forest.fit(X_train, y_train)
```

```
C:\Users\adhet\anaconda3\envs\project\lib\site-packages\sklearn\linear_model\_logistic.py:444: ConvergenceWarning: lbfgs f
ailed to converge (status=1):
STOP: TOTAL NO. of ITERATIONS REACHED LIMIT.
```

Out[8]:
```
RandomForestClassifier(max_depth=6, n_estimators=20, random_state=12)
```

Training model

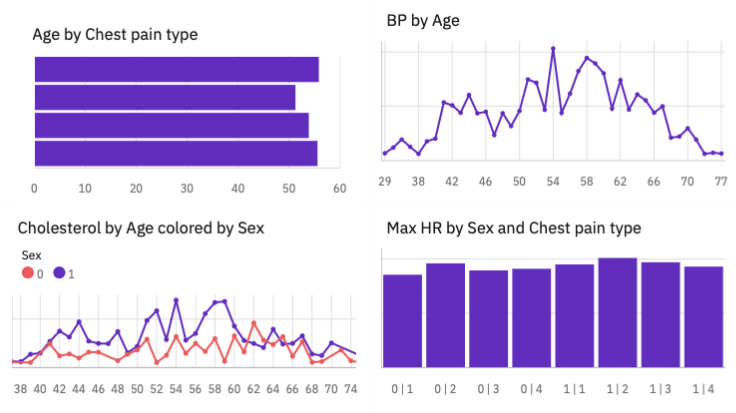
In [9]:
```
y_pred=LR_classifier.predict(X_train)
y_predsvm=clf.predict(X_train)
y_predsgd=sgd.predict(X_train)
y_predtree=treee.predict(X_train)
y_predforest=forest.predict(X_train)
```

In [10]:
```
print(accuracy_score(y_train, y_pred))
print(accuracy_score(y_train, y_predsvm))
print(accuracy_score(y_train, y_predsgd))
print(accuracy_score(y_train, y_predtree))
print(accuracy_score(y_train, y_predforest))
```

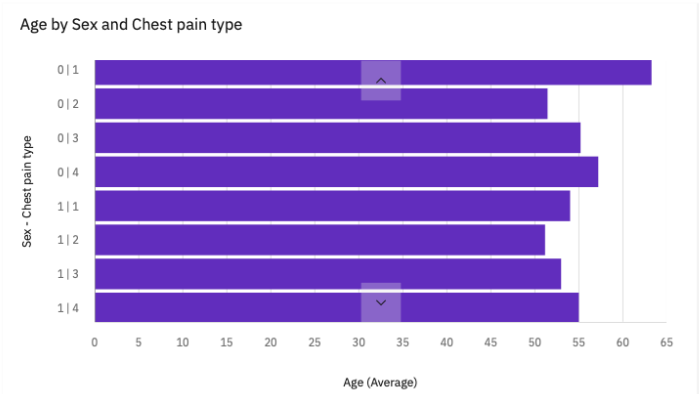
```
0.8677248677248677
0.6984126984126984
0.7248677248677249
0.9841269841269841
0.9735449735449735
0.8677248677248677
0.6984126984126984
0.7248677248677249
0.9841269841269841
0.9735449735449735
```

7.2 Dashboard

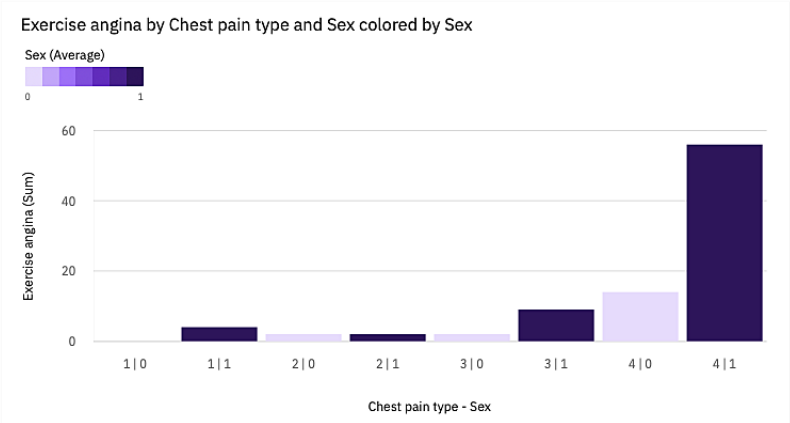
Tab 1



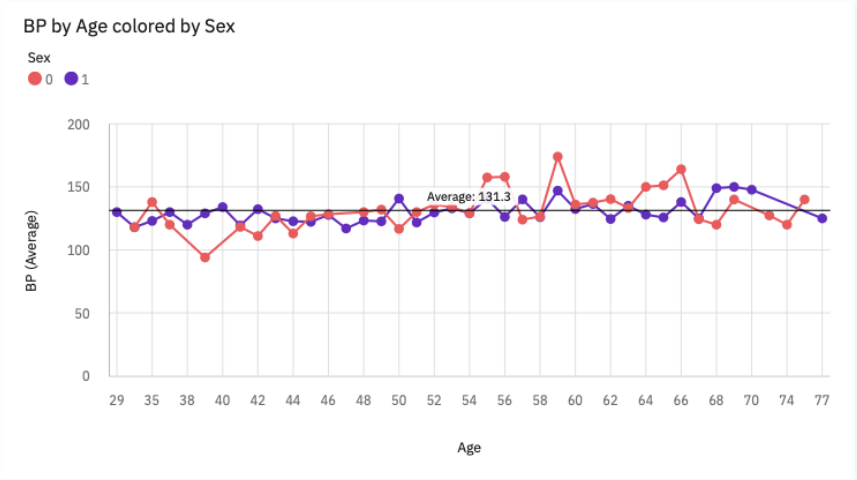
Tab 2



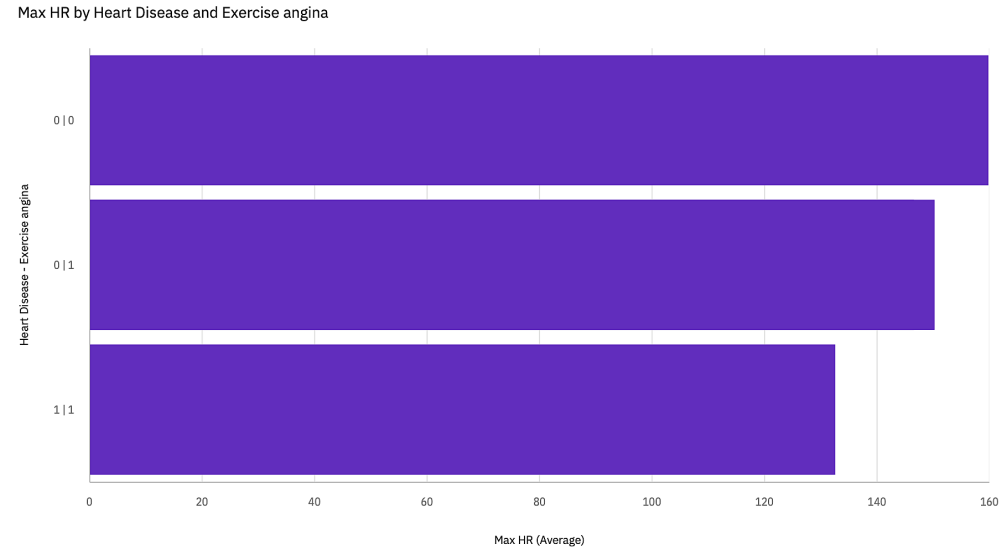
Tab 3



Tab 4



Tab 5

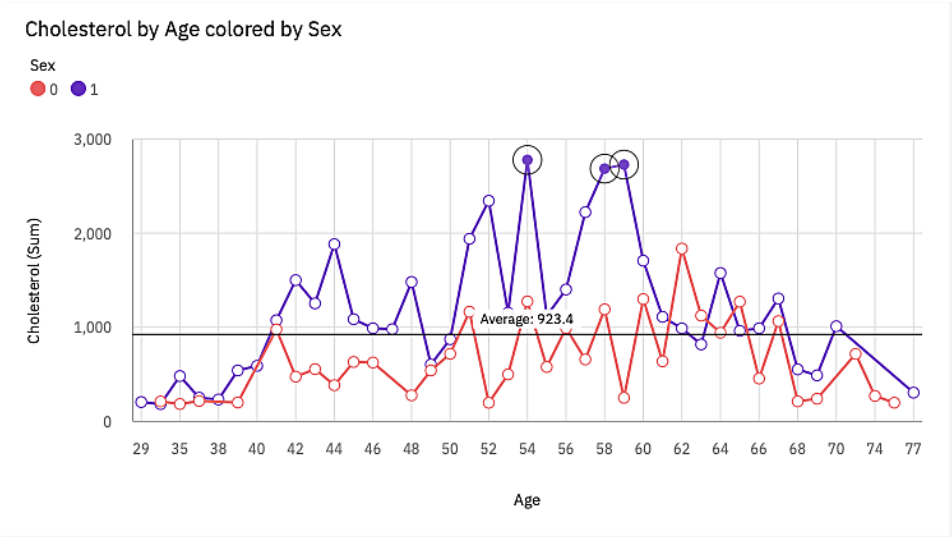


Tab 6

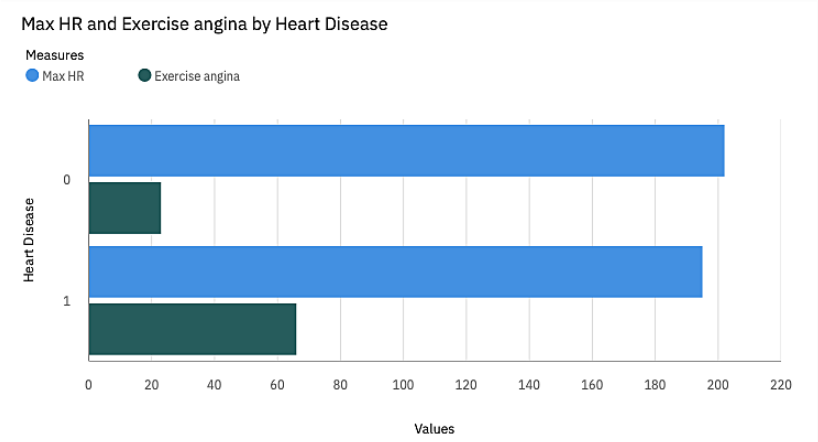
Heart Disease for Chest pain type and Sex

Heart Disease	.	2	3	4	Summary
0	4	16	32	35	**87**
1	16	26	47	94	**183**
Summary	**20**	**42**	**79**	**129**	**270**

Tab 7


Cholesterol by Age colored by Sex
Sex
0
1
3,000
2,000
1,000
0
Cholesterol (Sum)
Average: 923.4
29
35
38
40
42
44
46
48
50
52
54
56
58
60
62
64
66
68
70
74
77
Age

Tab 8


Max HR and Exercise angina by Heart Disease
Measures
Max HR
Exercise angina
0
1
Heart Disease
0
20
40
60
80
100
120
140
160
180
200
220
Values

8. TESTING

8.1 Test Cases

In [11]:
```
y_pred=LR_classifier.predict(X_test)
y_predsvm=clf.predict(X_test)
y_predsgd=sgd.predict(X_test)
y_predtree=treee.predict(X_test)
y_predforest=forest.predict(X_test)
```

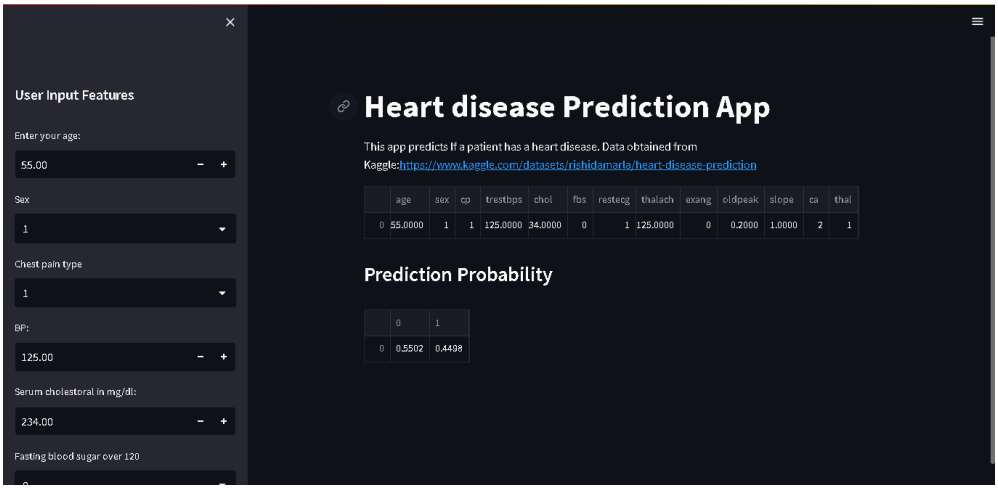
In [12]:
```
print(accuracy_score(y_test, y_pred))
print(accuracy_score(y_test, y_predsvm))
print(accuracy_score(y_test, y_predsgd))
print(accuracy_score(y_test, y_predtree))
print(accuracy_score(y_test, y_predforest))
```

```
0.8518518518518519
0.7407407407407407
0.5802469135802469
0.6419753086419753
0.7777777777777778
0.8518518518518519
0.7407407407407407
0.5802469135802469
0.6419753086419753
0.7777777777777778
```

In [13]:
```
import pickle
pickle.dump(forest, open('model.pkl', 'wb'))
```

Logistic Regression is the best model

8.2 User Acceptance Testing



9. RESULTS

9.1 Performance Metrics

In [11]:
```
y_pred=LR_classifier.predict(X_test)
y_predswm=clf.predict(X_test)
y_predsgd=sgd.predict(X_test)
y_predtree=treee.predict(X_test)
y_predforest=forest.predict(X_test)
```

In [12]:
```
print(accuracy_score(y_test, y_pred))
print(accuracy_score(y_test, y_predswm))
print(accuracy_score(y_test, y_predsgd))
print(accuracy_score(y_test, y_predtree))
print(accuracy_score(y_test, y_predforest))
```

```
0.8518518518518519
0.7407407407407407
0.5802469135802469
0.6419753086419753
0.7777777777777778
0.8518518518518519
0.7407407407407407
0.5802469135802469
0.6419753086419753
0.7777777777777778
```

In [13]:
```
import pickle
pickle.dump(forest, open('model.pkl', 'wb'))
```

Logistic Regression is the best model

10. ADVANTAGES & DISADVANTAGES

Advantages:

- Very easy to use and understand for the user.
- Secure
- Dashboard provides useful insight to the user
- Can be used to easily classify users who have heart disease to those who do not.

Disadvantages:

- User needs to know value of all parameters.
- Does not provide suggestions to user.
- Cannot enter null value so will be an issue if user does not know value of all parameters.
- Still needs more work to improve accuracy

11. CONCLUSION

If not detected early, people who get heart disease can get a heart attack or stroke which could be fatal. Therefore, it is better for users to adopt a healthy lifestyle to minimize risk of getting heart disease. This website can help users analyze their health based on certain parameters and hopefully help them get the required treatment early

on if they show symptoms of heart disease.

12. FUTURE SCOPE

For this website, a lot of parameters are required some of which the user may not be aware of. Therefore, it would be better if it is possible to simplify the model to improve usability.

13. APPENDIX

Source Code

https://github.com/IBM-EPBL/IBM-Project-4903-1658742306

Project Demo Link

https://drive.google.com/file/d/12LKDLeQF46dItlRndCQydIWA-rDl-qPA/view?usp=share_link