PROJECT REPORT

Visualizing And Predicting Heart Diseases With An Interactive Dash Board

TEAM ID: PNT2022TMID54403

Team members

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Source Code

GitHub & Project Demo Link

1. INTRODUCTION

Project Overview:

In this article, we will be closely working with the heart disease prediction and for that, we will be looking into the heart disease dataset from that dataset from that dataset we will derive various insights that help us know the weightage each feature and how they are interrelated to each other but this time our sole aim is to detect the probability of the person that will be affected by a savior heart problem or not.

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

Title & Author(s)	Year	Technique(s)	Findings/Pros/Cons
"An interactive dashboard to track themes, development maturity, and global equity in clinical artificial intelligence research" Joe Zhang, Stephen Whebell, Jack Gallifant, Sanjay Budhdeo, Heather Mattie, Piyawat Lertvittayakumjorn, Maria del Pilar Arias Lopez, Beatrice J Tiangco, Judy W Gichoya, Hutan Ashrafian, Leo A Celi, James T Teo	2022	End-to-End Natural Language Processing (NLP) pipeline, MEDLINE→Interactive dashboard	While demonstrating state-of-the-art NLP performance, classifier limitations include imperfect accuracy compared with careful human reviewers. Finally, prediction using full articles could increase performance.
"An interactive dashboard for real-time analytics and monitoring of covid-19 outbreak in india: a proof of concept" Arun Mitra, Biju Soman, Gurpreet Singh, Achutha Menon Centre for Health Science Studies, SCTIMST	2021	The application of data science methods and epidemiological techniques	This demonstrates the application of data science methods and epidemiological techniques in public health decision-making while addressing the gap of timely and reliable decision aiding tools.
"An Interactive Dashboard for Monitoring the Spread of COVID-19 in Sudan" A. M. O. Abdelsamad and A. Z. Karrar	*2020*	Dashboard using Tableau and Visual Analysis	The resulted dashboard and the visual analysis provided important insights that can be used to make informed decisions concerning the spread of COVID-19 in Sudan.

"Implementation of Business Intelligence for Sales Data Management Using Interactive Dashboard Visualization in XYZ Stores" R. Akbar, M. Silvana, M. H. Hersyah and M. Jannah	2020	Business Intelligence (BI) application using Interactive Dashboard Visualization	This research produced reports in the form of Interactive Dashboard Visualization which is used by the store managers to make better decisions.
"A novel approach for heart disease prediction using strength scores with significant predictors" Yazdani, A., Varathan, K.D., Chiam, Y.K. *et al*	2021	Weighted Associative Rule Mining	Achieved highest confidence score by utilizing the computed strength scores of significant predictors on Weighted Associative Rule Mining in predicting heart disease.
"Heart disease prediction using machine learning algorithms" Harshit Jindal, Sarthak Agrawal, Rishabh Khera, Rachna Jain and Preeti Nagrath	2021	Logistic regression and KNN	The Given heart disease prediction system enhances medical care and reduces the cost.
"Heart Disease Prediction Using Machine Learning" C. Boukhatem, H. Y. Youssef and A. B. Nassif	2022	Multilayer Perceptron (MLP), Support Vector Machine (SVM), Random Forest (RF), and Naïve Bayes (NB)	The models were evaluated based on the accuracy, precision, recall, and F1-score. The SVM model performed best with 91.67% accuracy.
"Improving the Accuracy for Analyzing Heart Diseases Prediction Based on the Ensemble Method" Xiao-Yan Gao, Abdelmegeid Amin Ali, Hassan Shaban Hassan, and Eman M. Anwar	2021	Linear Discriminant Analysis (LDA) and Principal Component Analysis (PCA)	The experimental results showed that the bagging ensemble learning algorithm with DT and PCA feature extraction method had achieved the best performance.

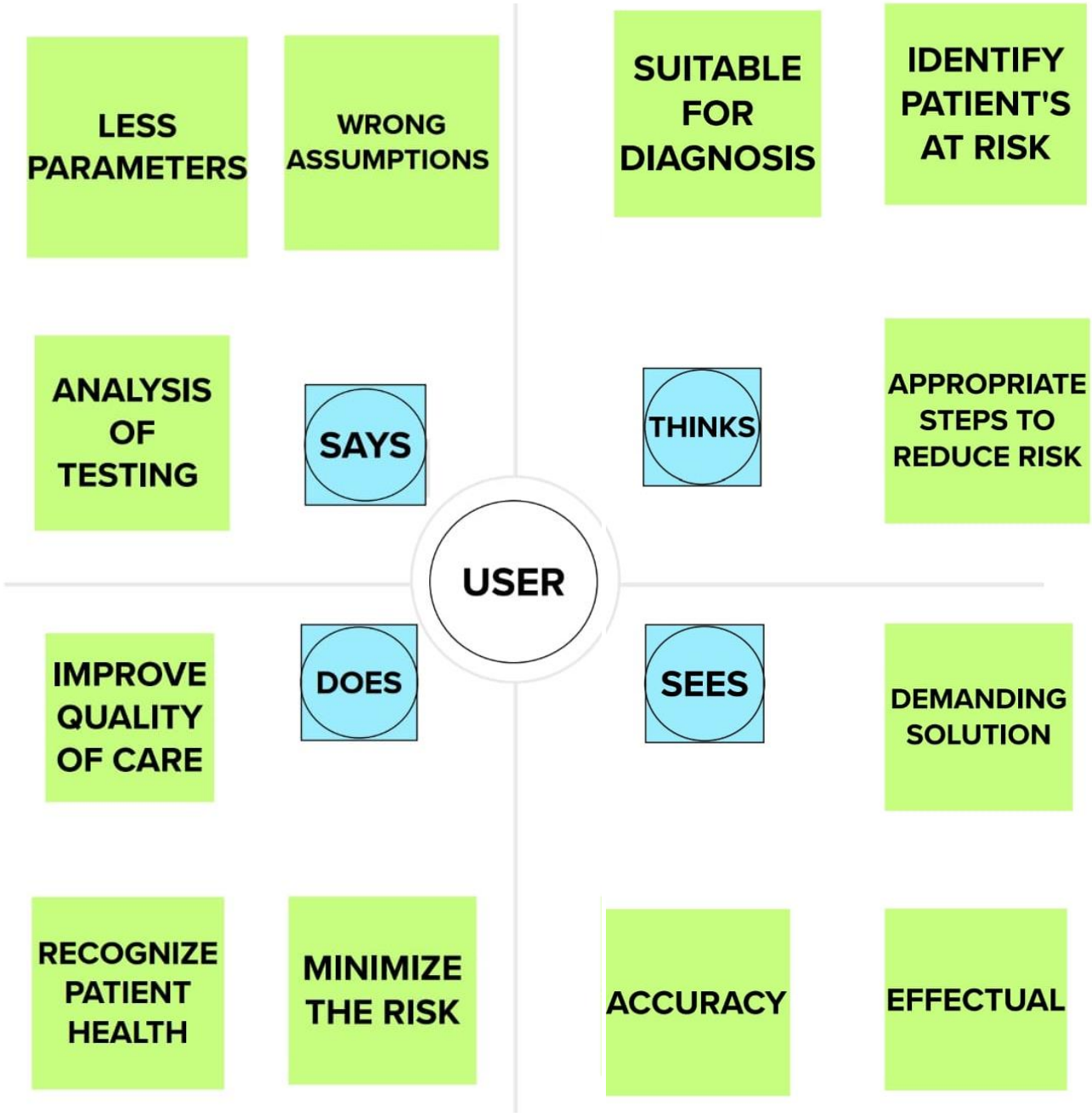
3. IDEATION & PROPOSED SOLUTION

1. The so-called big data produced by the healthcare sector contains vast amounts of information that can be used to make decisions. In order to create decisions that are more accurate than intuition, a vast amount of data is used. EDA identifies errors, locates pertinent data, verifies presumptions, and establishes the relationship between the explanatory factors. In this context, EDA is understood to be data analysis without statistical modeling or inferences. Any profession needs analytics since it can predict the future and reveal hidden patterns. In the recent past, data analytics has been regarded as a cost-effective technology and it now plays a crucial role in healthcare, including new study discoveries, emergency circumstances, and disease outbreaks. EDA is a crucial step when analyzing data, and the application of analytics in healthcare improves treatment by simplifying preventive care. In this study, the K-means algorithm is used to analyze publically available data on heart disease and to forecast the risk variables that lead to heart disease. The dataset contains 209 records with eight parameters, including age, the type of chest pain, blood pressure, blood sugar level, resting ECG, heart rate, and four different types of chest pain. K-means clustering method, together with data analytics and visualization tools, are utilised to forecast cardiac disease.

2. Early heart disease diagnosis may help somewhat to lower the death rate. This program aids in the early diagnosis and prediction of heart disease. Healthcare businesses now generate massive amounts of data, yet those data are incredibly fragmented. This data can be used to predict cardiac illnesses with simplicity if it is properly organized using data mining techniques. To create a decision tree-based system for the J-48 algorithm that detects and implements heart disease utilising the two methods of crossvalidation and percentage split.

3. The deadliest disease and one of the main causes of death worldwide is heart disease. The medical field is highly dependent on machine learning. In this study, ensemble learning methods are used to improve the accuracy of heart disease prediction. Principal component analysis (PCA) and linear discriminant analysis (LDA) are two characteristics of extraction methods that are used to choose crucial features from the dataset. Selected features are used to compare machine learning algorithms and ensemble learning techniques. Models are evaluated using a variety of techniques, including accuracy, recall, precision, Fmeasure, and ROC. The outcomes demonstrate that the decision tree-based bagging ensemble learning method produced the best results

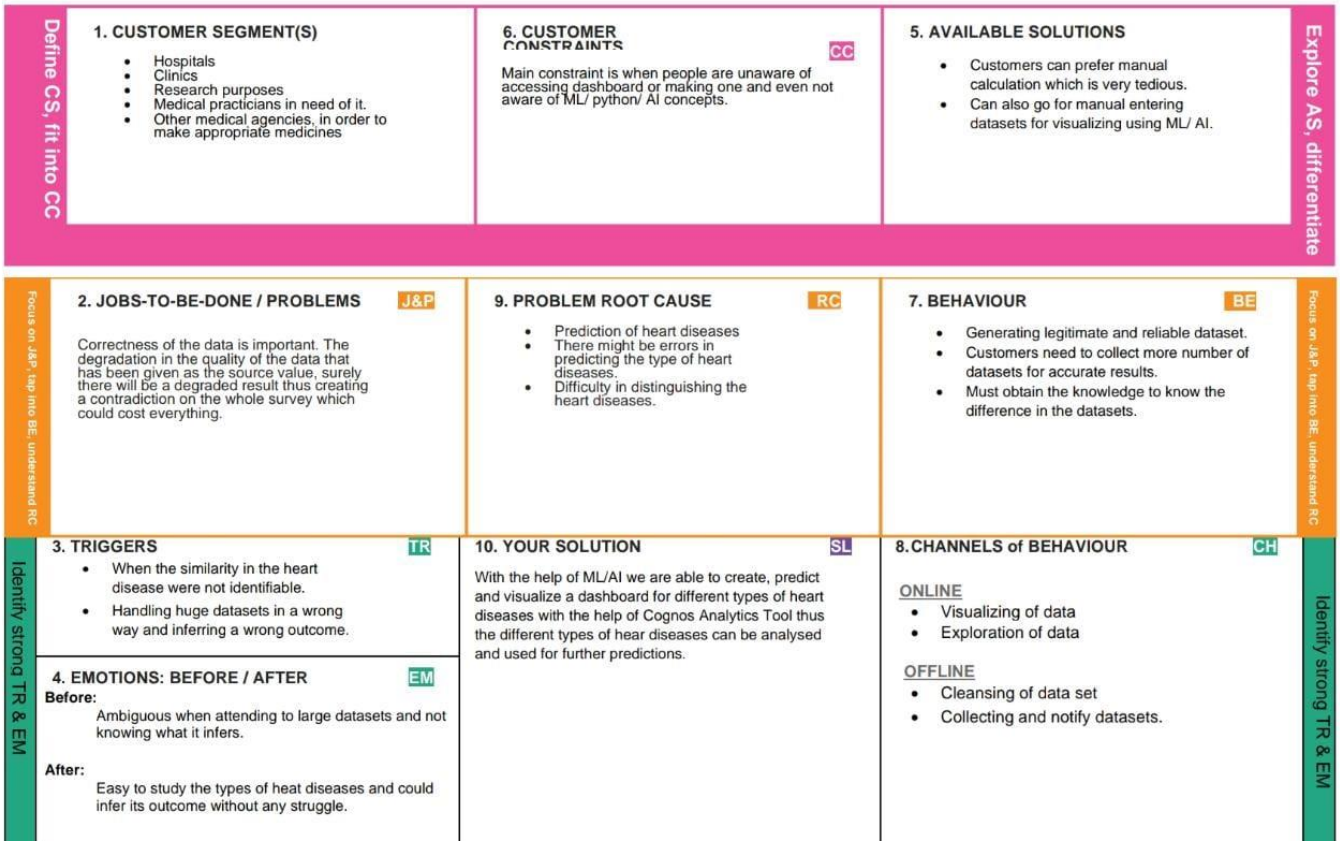
Empathy Map Canvas



Proposed Solution

S.No.	Parameter	Description
1.	Problem Statement (Problem to be solved)	✓ To develop an interactive dashboard to predict the heart disease exactly with the presence of few tests
2.	Idea / Solution description	✓ Examining the data and recognizing the heart disease affected by the patients using Cognos analysis
3.	Novelty / Uniqueness	✓ To provide a significant contribution in computing the strength scores with significant predictors in heart disease prediction.
4.	Social Impact / Customer Satisfaction	✓ Reduces patient's risk level ✓ Reduces the medical cost ✓ Reduces the decision making of the doctors to overcome the mistakes ✓ Save human lives ✓ Handy interactive dashboard
5.	Business Model (Revenue Model)	✓ Updates will be updated according to the necessity for the patients ✓ No complexity in usage ✓ Data security
6.	Scalability of the Solution	✓ Machine learning ✓ Scalable dataset ✓ Adding new characteristics ✓ In Windows, Mac platform can be used

Problem Solution fit



4. REQUIREMENT ANALYSIS

Functional Requirements:

Following are the functional requirements of the proposed solution.

FR No.	Functional Requirement (Epic)	Sub Requirement (Story / Sub-Task)
FR-1	User Registration	Permit the user to make registrations through Gmail for the application
FR-2	User Confirmation	After the completion of registration, the user tend to get the confirmation via Gmail
FR-3	Visualizing Data	The respected user can visualize the current trends on the prediction of heart disease through the interactive dashboard created using the IBM Cognos Analytics
FR-4	Generating Report	User can view his/her health report and then can make the decisions

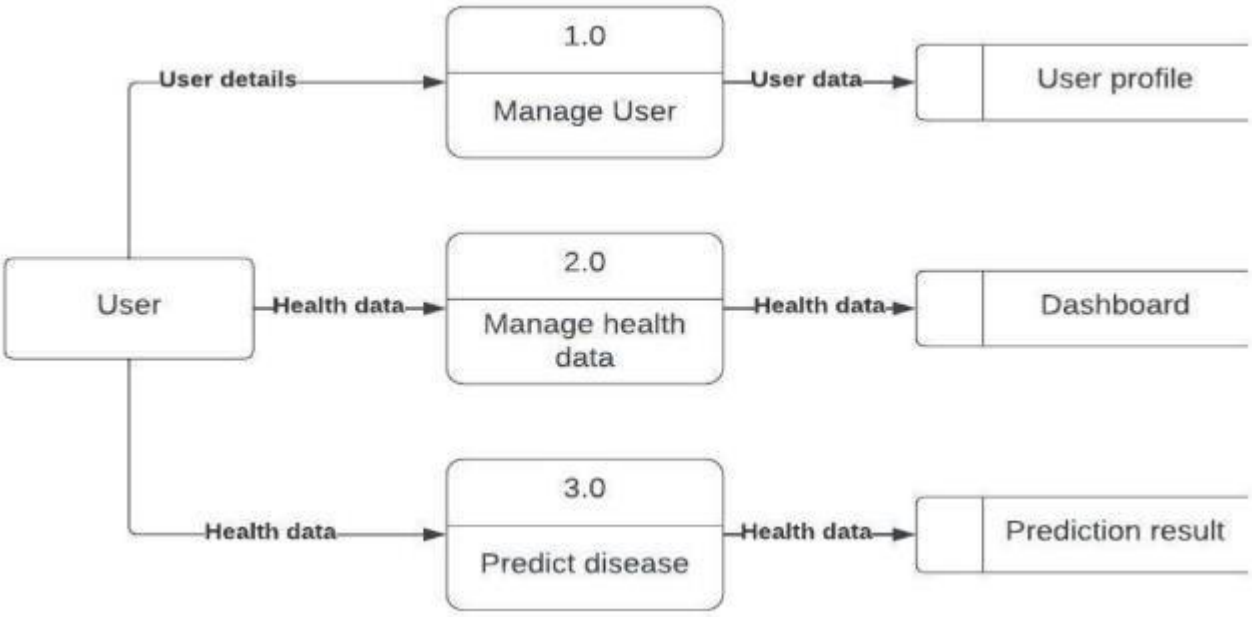
Non-functional Requirements:

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

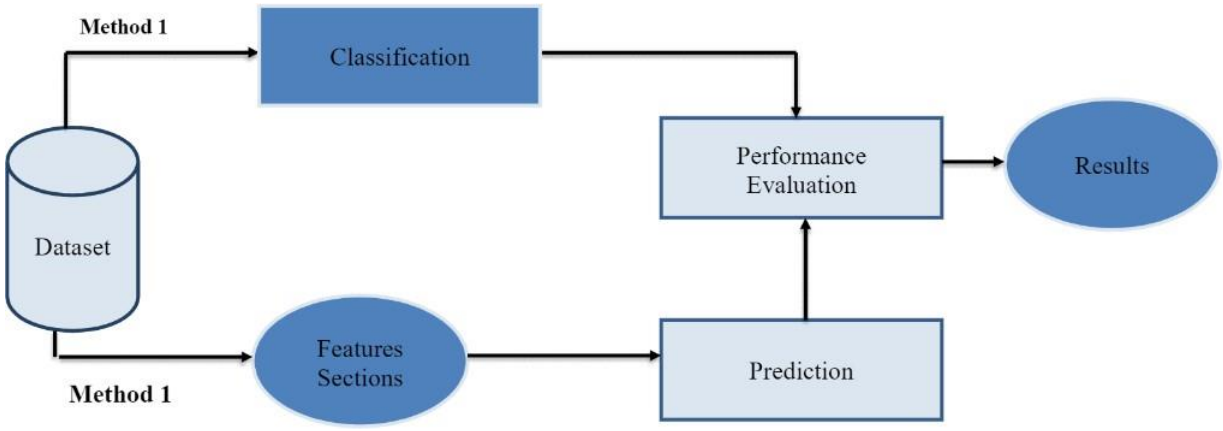
FR No.	Non-Functional Requirement	Description
NFR-1	**Usability**	Application posses a user friendly graphical interface. Features of the application need to be understand by the user
NFR-2	**Security**	Database replication should be used for security of the application, all the important data must be safe.
NFR-3	**Reliability**	The application has to work without failure in environment and it has to be compatible
NFR-4	**Performance**	Performance depends on the response time and speed of data. Response time which is faster depends on the executed algorithm
NFR-5	**Availability**	The application has to be available for 24x7 without any interference
NFR-6	**Scalability**	The application wish to develop the higher versions and it increase in the number of users

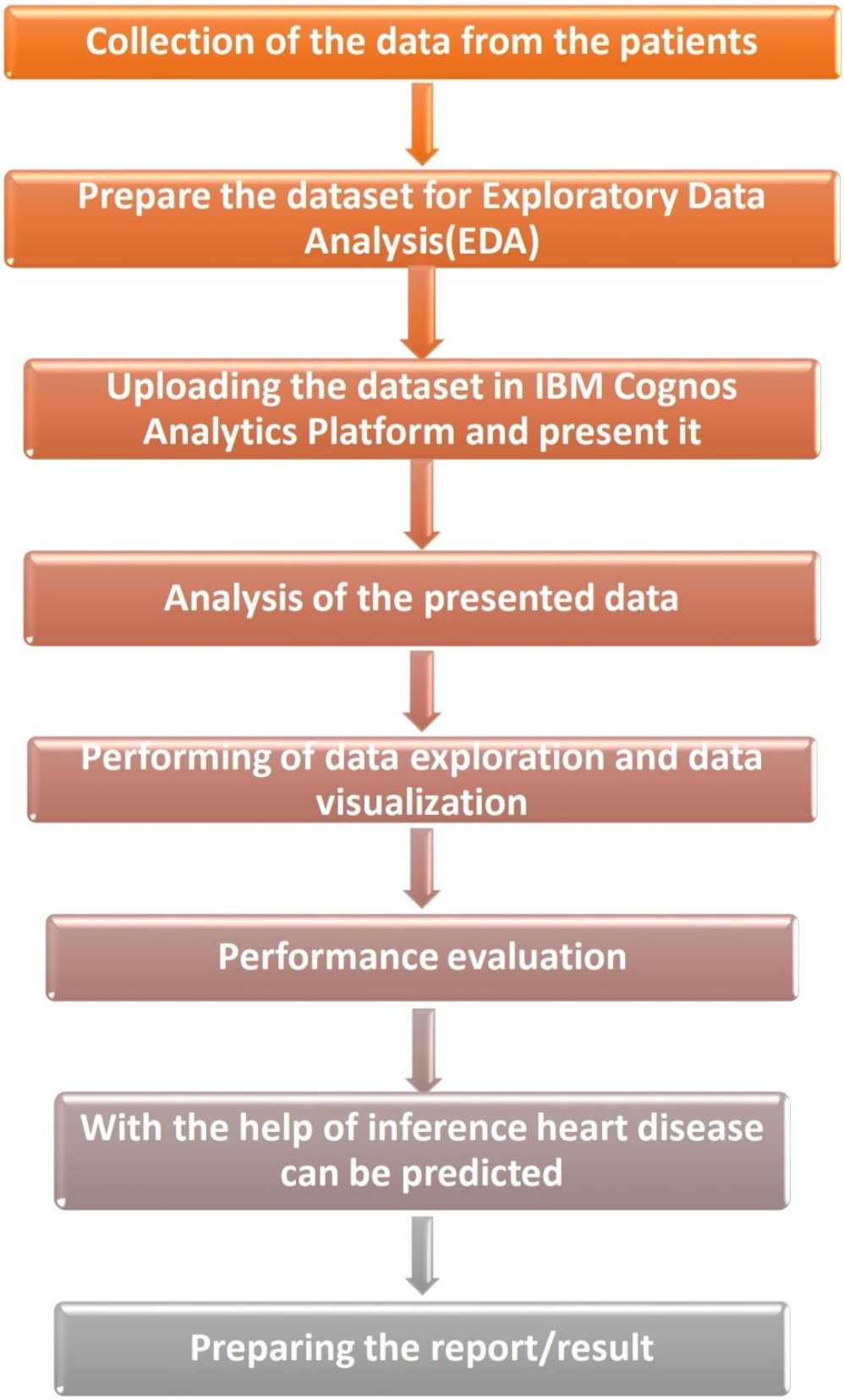
5. Project Design

Data Flow Diagram



Solution and Technical Architecture5.3




Collection of the data from the patients
Prepare the dataset for Exploratory Data Analysis(EDA)
Uploading the dataset in IBM Cognos Analytics Platform and present it
Analysis of the presented data
Performing of data exploration and data visualization
Performance evaluation
With the help of inference heart disease can be predicted
Preparing the report/result

6. Project Planning and Scheduling

Script Planning and Execution

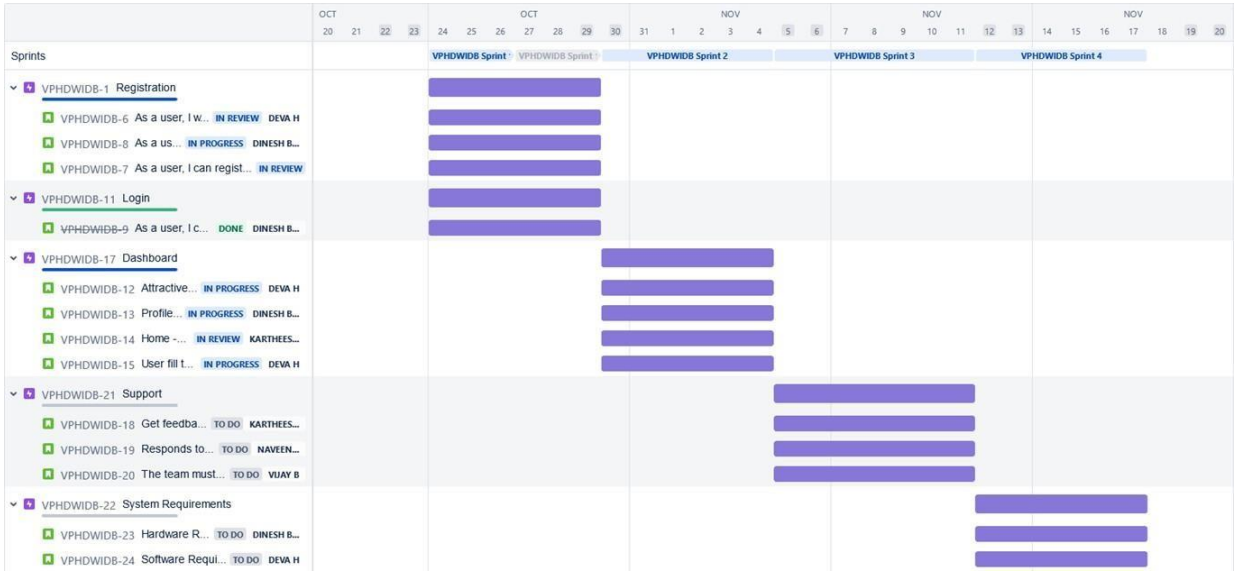
Sprint	Functional Requirement (Epic)	User Story Number	User Story / Task	Story Points	Priority	Team Members
Sprint-1	Registration	USN-1	As a user, I can register for the application by entering my email, password, and confirming my password	3	High	1
Sprint-1		USN-2	As a user, I will receive confirmation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

			• Windows 10 or higher • Android Studio			

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

MODEL'S ACCURACY

```
data = {'Estimators':['Linear Regression',
                      'Logistic Regression',
                      'K-Nearest Neighbor',
                      'Random Forest',
                      'Bagging Decision Tree', ],
        "Accuracy":[r2,
                    LogisticRegressionScore,
                    KNC_accuracy,
                    rnd_clf_accuracy,
                    bag_clf_accuracy,
                    ]
        }
data = pd.DataFrame(data)

data.sort_values('Accuracy', ascending='False')
```

	Estimators	Accuracy
0	Linear Regression	0.470357
2	K-Nearest Neighbor	0.772727
3	Random Forest	0.795455
1	Logistic Regression	0.818182
4	Bagging Decision Tree	0.840909

LINEAR REGRESSION

In [46]:

```
from sklearn.linear_model import LinearRegression
from sklearn.metrics import mean_squared_error, r2_score

lr = LinearRegression()
lr.fit(X_train, y_train)

predicted = lr.predict(X_test)

RMSE = np.sqrt(mean_squared_error(y_test, predicted))
r2 = r2_score(y_test, predicted)

print('Root mean squared error: ', RMSE)
print("r2: ", r2)
```

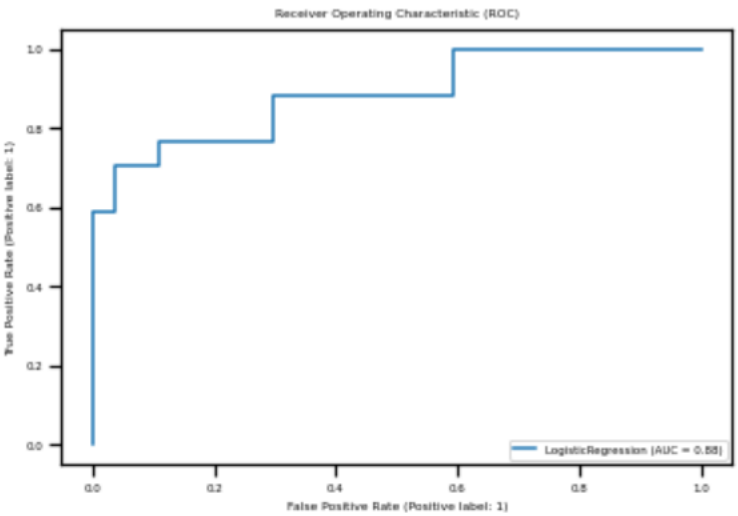
Out[54]:

	Actual Value	Predicted Value	Difference
48	1	0.872176	0.127824
24	0	0.299159	-0.299159
8	1	0.981655	0.018345
122	1	1.135426	-0.135426
192	0	0.298798	-0.298798
197	0	-0.100531	0.100531
40	1	0.512318	0.487682
25	0	-0.051051	0.051051
146	1	0.392789	0.607211
99	0	-0.046375	0.046375
168	0	0.331794	-0.331794
54	0	0.031149	-0.031149
139	0	0.544057	-0.544057
4	0	0.366958	-0.366958
93	1	0.704095	0.295905
31	0	0.660750	-0.660750
177	1	0.300652	0.699348
118	0	0.195649	-0.195649

LOGISTIC REGRESSION

In [55]:

```
from sklearn.linear_model import LogisticRegression
from sklearn.metrics import accuracy_score
from sklearn import metrics
from sklearn.metrics import roc_curve

logit = LogisticRegression()
logit.fit(X_train, y_train)

predicted_logit = logit.predict(X_test)

LogisticRegressionScore = accuracy_score(predicted_logit, y_test)


plt.figure()
metrics.plot_roc_curve(logit, X_test, y_test)
plt.title("Receiver Operating Characteristic (ROC)")
plt.show()

print("Logistic Regression score: ", LogisticRegressionScore)
```




```
Logistic Regression score:  0.8181818181818182
```

K NEIGHBOUR CLASSIFIER

In [57]:

```
from sklearn.neighbors import KNeighborsClassifier

KNC = KNeighborsClassifier(n_neighbors=2)
KNC.fit(X_train, y_train)

KNC_pred = KNC.predict(X_test)

KNC_accuracy = metrics.accuracy_score(y_test, KNC_pred)

print("KNeighbourClassifier score: ", KNC_accuracy)
```

```
KNeighbourClassifier score:  0.7727272727272727
```

RANDOM FOREST CLASSIFIER

In [60]:

```
from sklearn.ensemble import RandomForestClassifier

rnd_clf = RandomForestClassifier(n_estimators=500, max_leaf_nodes=16, n_jobs=-1)
rnd_clf.fit(X_train, y_train)

rnd_clf_pred = rnd_clf.predict(X_test)

rnd_clf_accuracy = metrics.accuracy_score(y_test, rnd_clf_pred)
print("RandomForest score: ", rnd_clf_accuracy)
```

```
RandomForest score:  0.7954545454545454
```

BAGGING DECISION TREE

In [64]:

```
from sklearn.ensemble import BaggingClassifier
from sklearn.tree import DecisionTreeClassifier

bag_clf = BaggingClassifier(
    DecisionTreeClassifier(), n_estimators = 500, oob_score=True,
    max_samples=100, bootstrap = True, n_jobs=-1)

bag_clf.fit(X_train, y_train)

bag_clf_oob = bag_clf.oob_score_

bag_clf_pred = bag_clf.predict(X_test)
bag_clf_accuracy = metrics.accuracy_score(y_test, bag_clf_pred)
print("Bagging Decision Tree score: ", bag_clf_accuracy, "Out of the bag: ", bag_clf_oob)
```

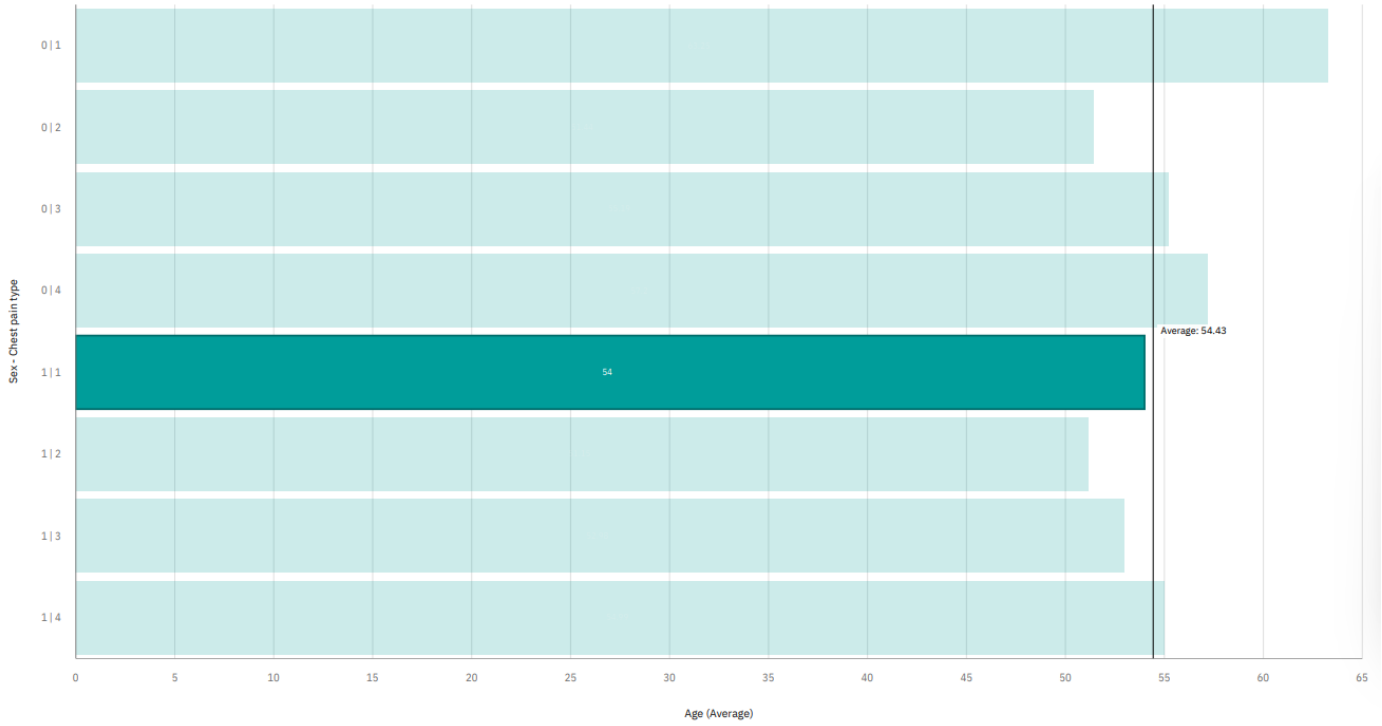
```
Bagging Decision Tree score:  0.8409090909090909 Out of the bag:  0.7790697674418605
```

Dashboard

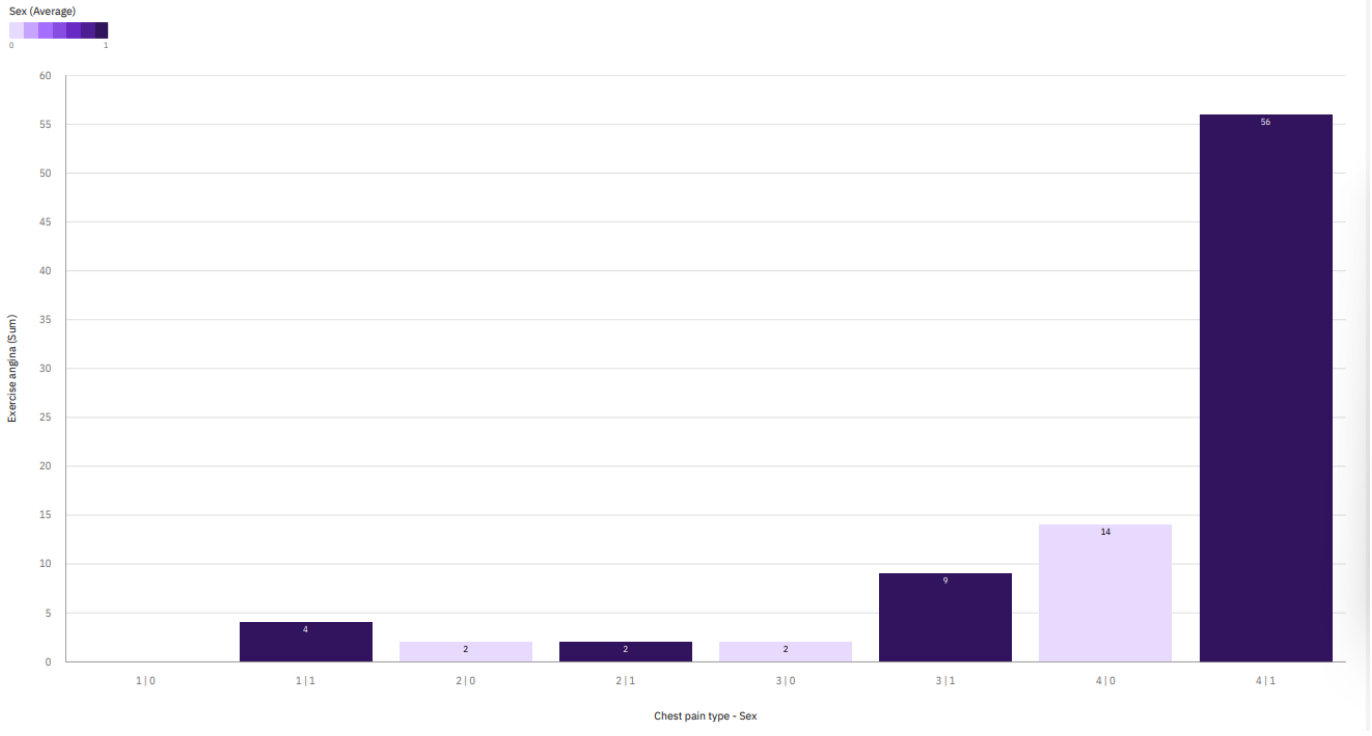
10/16/22, 2:10 PM Heart Disease Dashboard

Tab 1

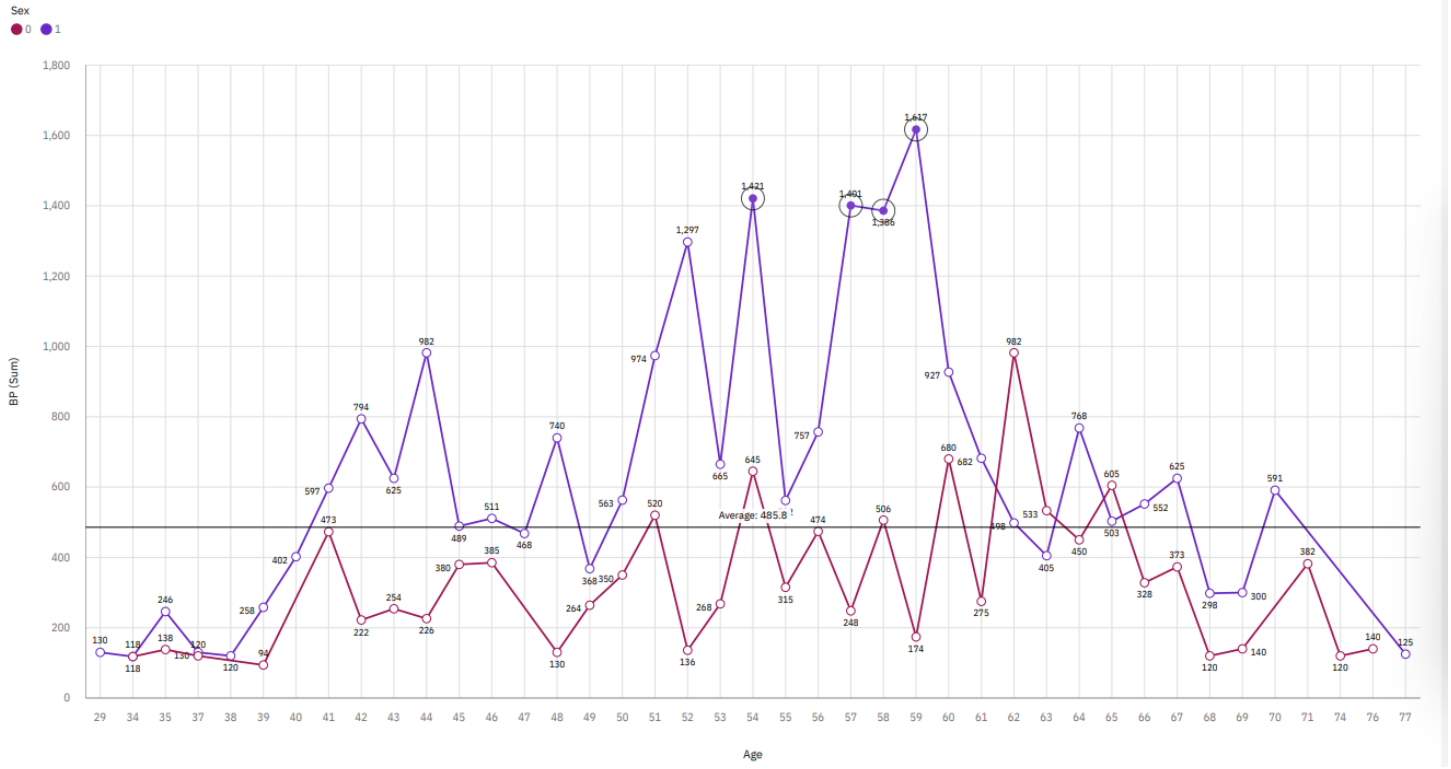
AVERAGE AGE FOR DIFFERENT TYPES OF CHEST PAIN FOR MALE AND FEMALE



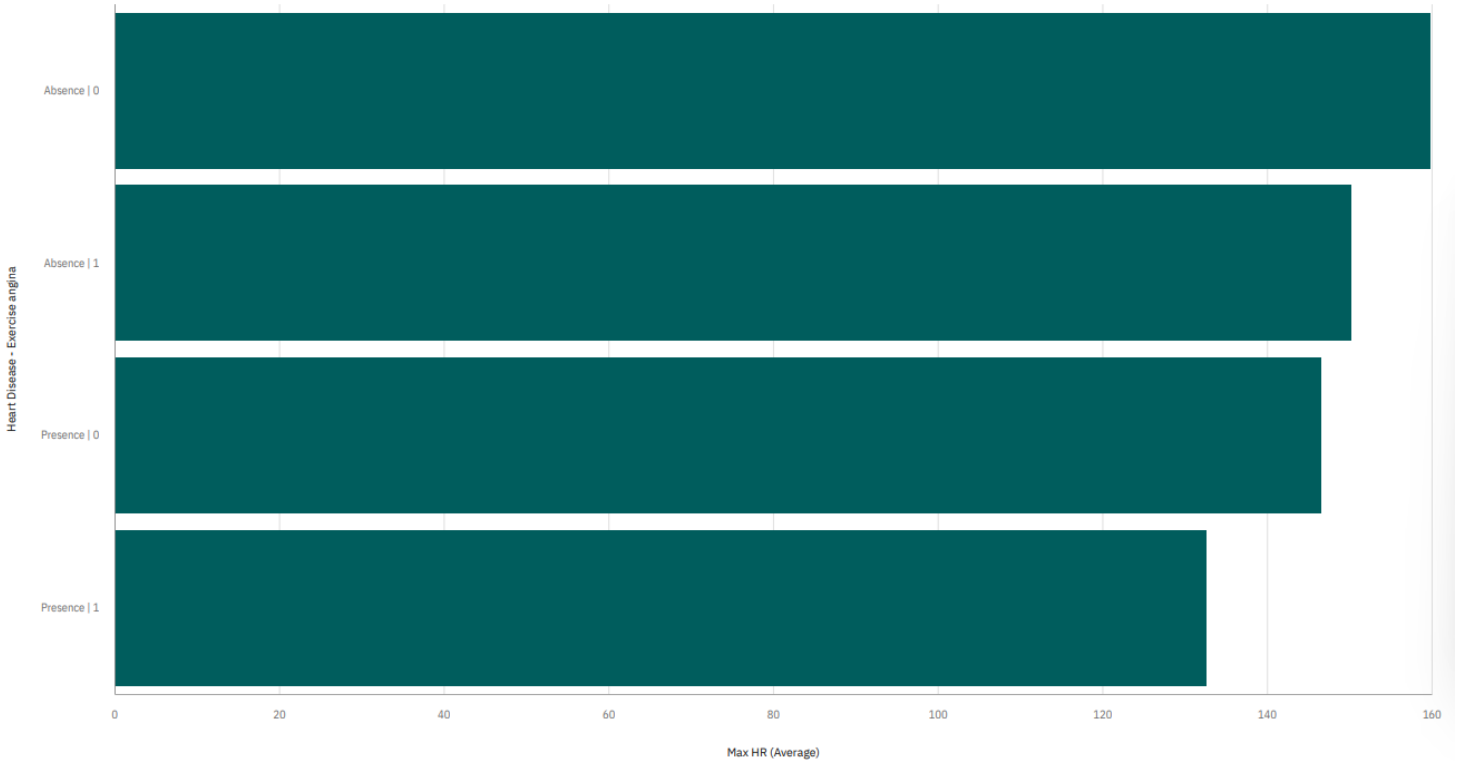
EXERCISE ANGINA BY CHEST PAIN TYPE AND GENDER



BP VARIATION WITH RESPECT TO AGE



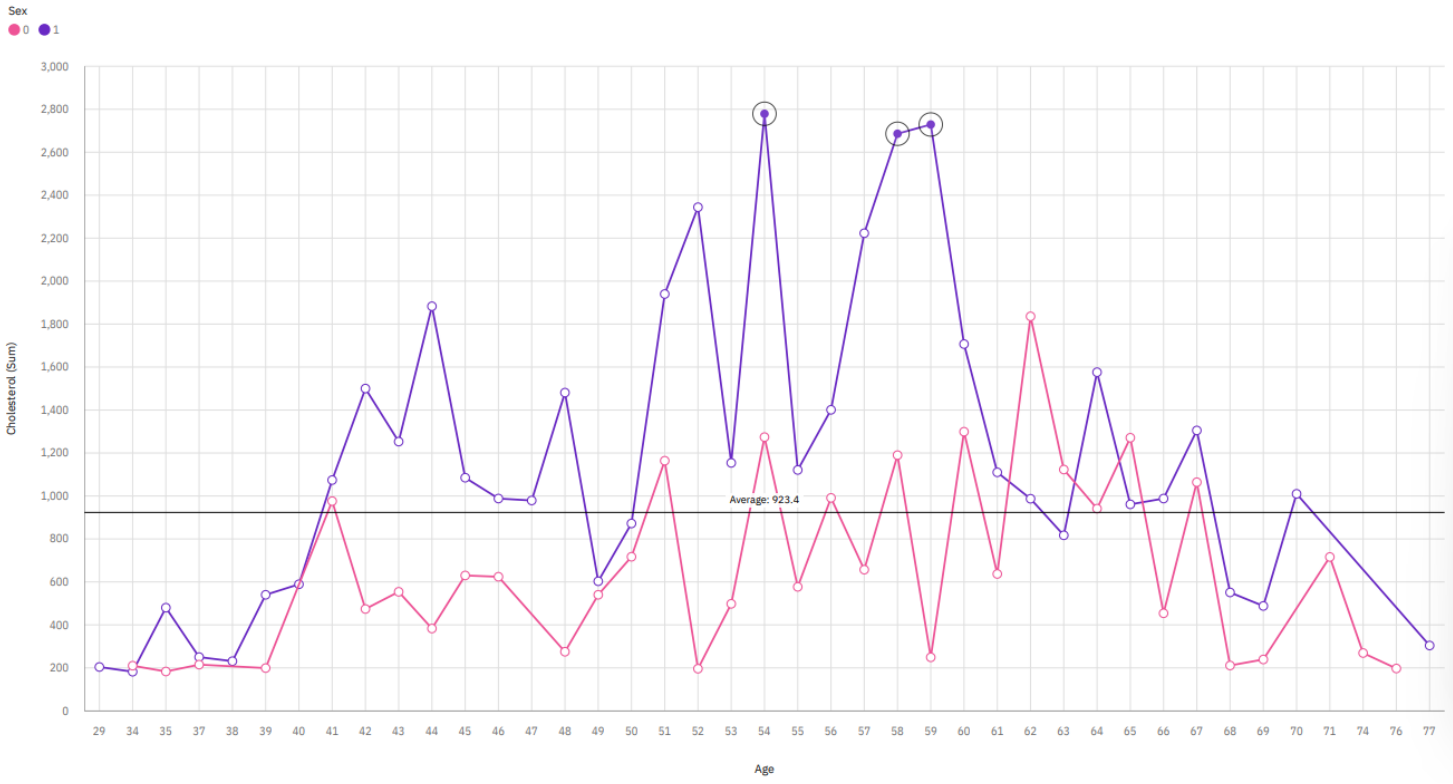
MAX HR BY HEART DISEASE AND EXERCISE ANGINA

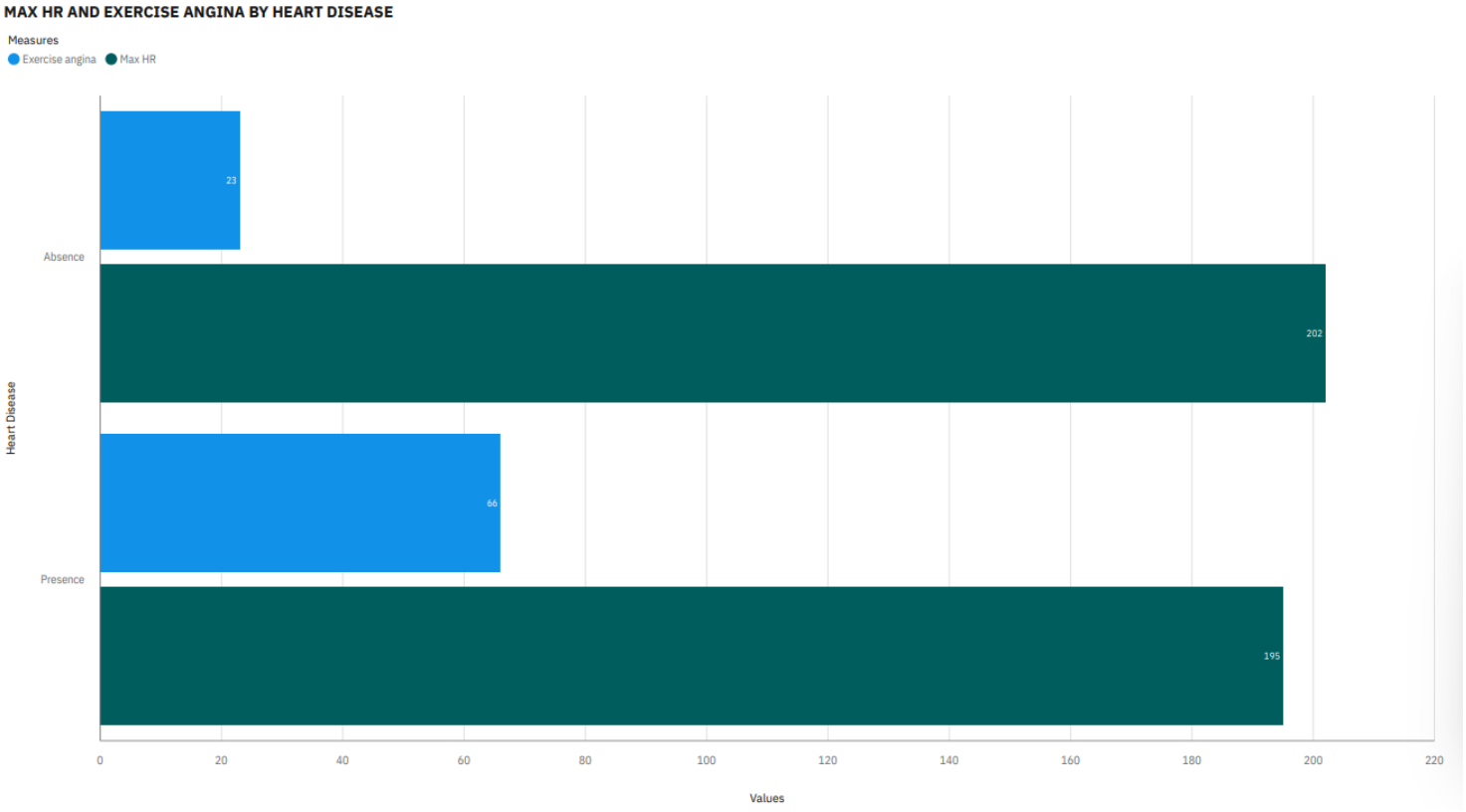


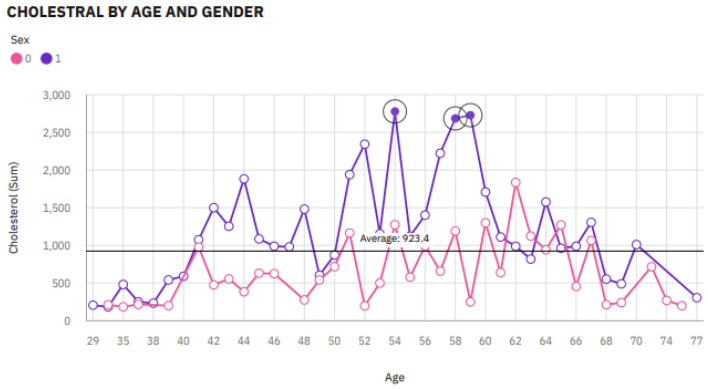
HEART DISEASE CHEST PAIN TYPE BY GENDER

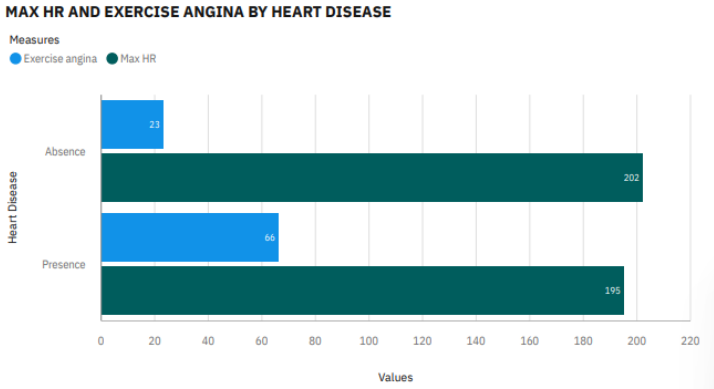
Heart Disease	1	2	3	4	Summary
0	4	16	32	35	**87**
1	16	26	47	94	**183**
Summary	**20**	**42**	**79**	**129**	**270**

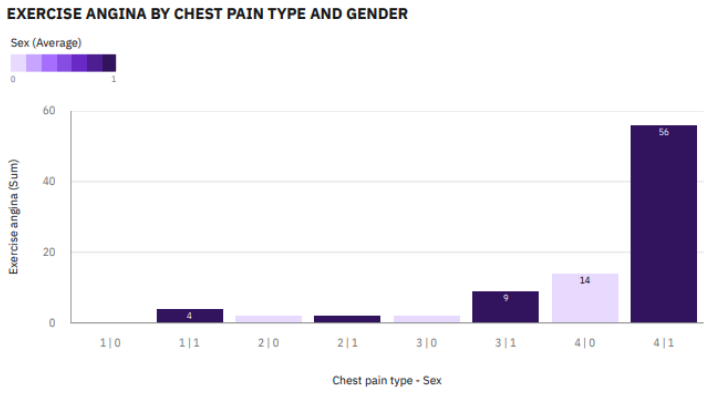
CHOLESTRAL BY AGE AND GENDER

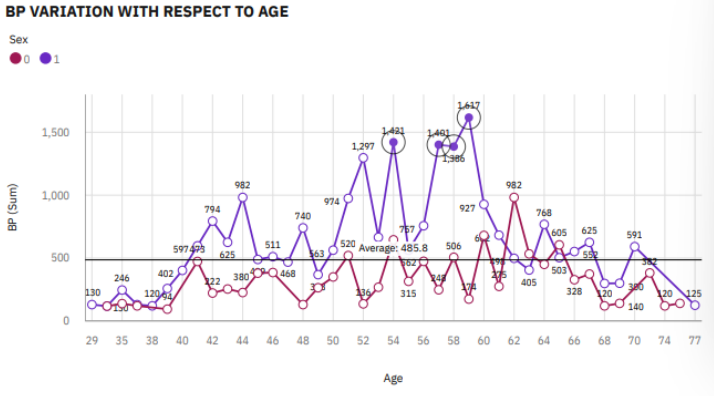



MAX HR AND EXERCISE ANGINA BY HEART DISEASE
Measures
Exercise angina
Max HR
Heart Disease
Absence
Presence
23
202
66
195
0
20
40
60
80
100
120
140
160
180
200
220
Values


CHOLESTRAL BY AGE AND GENDER
Sex
0
1
Cholesterol (Sum)
3,000
2,500
2,000
1,500
1,000
500
0
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

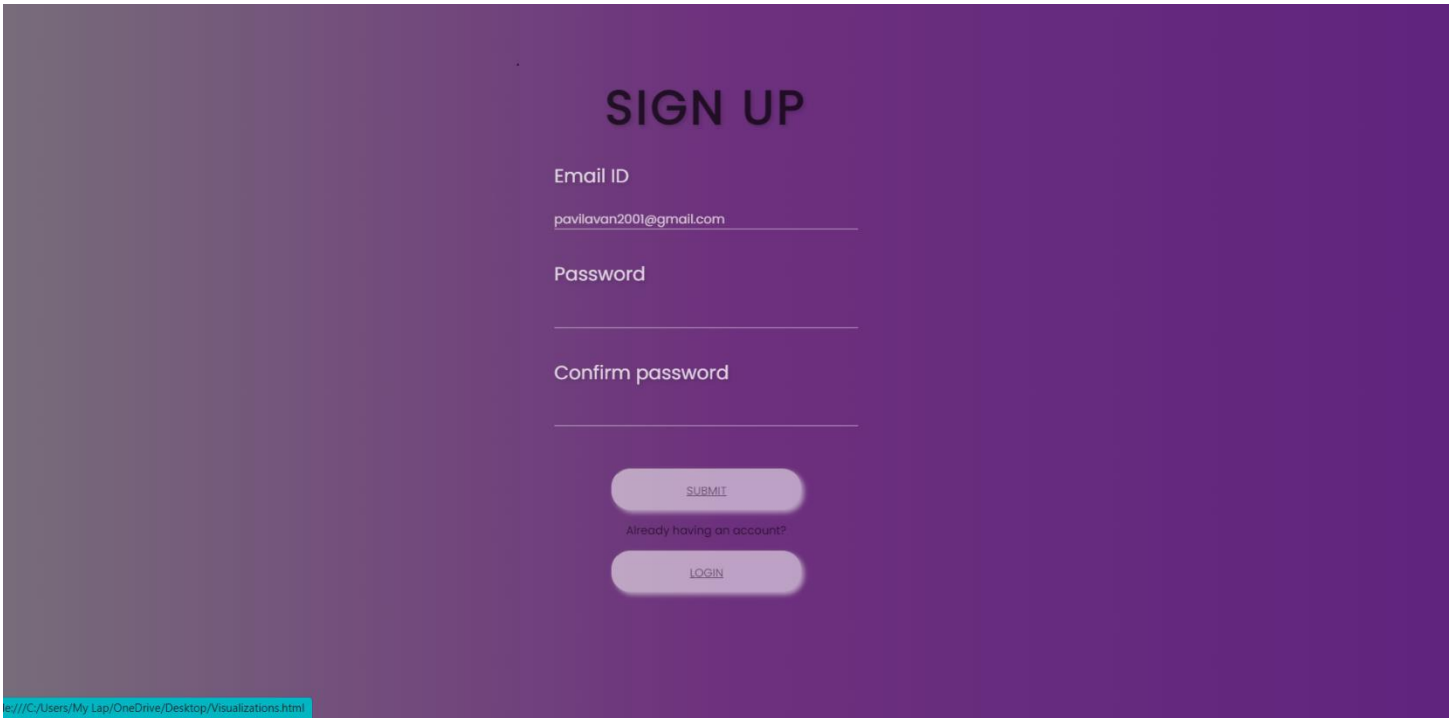

MAX HR AND EXERCISE ANGINA BY HEART DISEASE
Measures
Exercise angina
Max HR
Heart Disease
Absence
Presence
23
202
66
195
0
20
40
60
80
100
120
140
160
180
200
220
Values

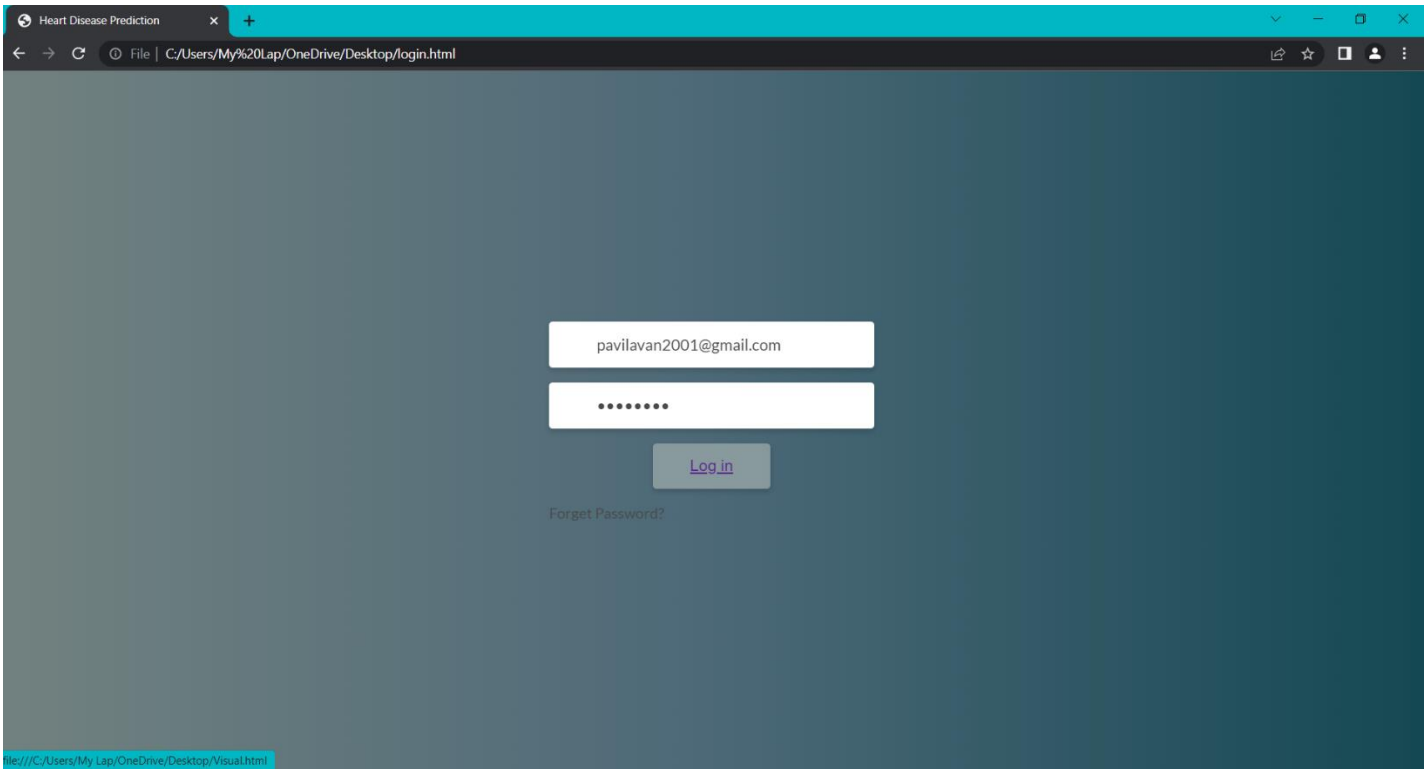

EXERCISE ANGINA BY CHEST PAIN TYPE AND GENDER
Sex (Average)
0
1
Exercise angina (Sum)
60
40
20
0
4
9
14
56
1 | 0
1 | 1
2 | 0
2 | 1
3 | 0
3 | 1
4 | 0
4 | 1
Chest pain type - Sex

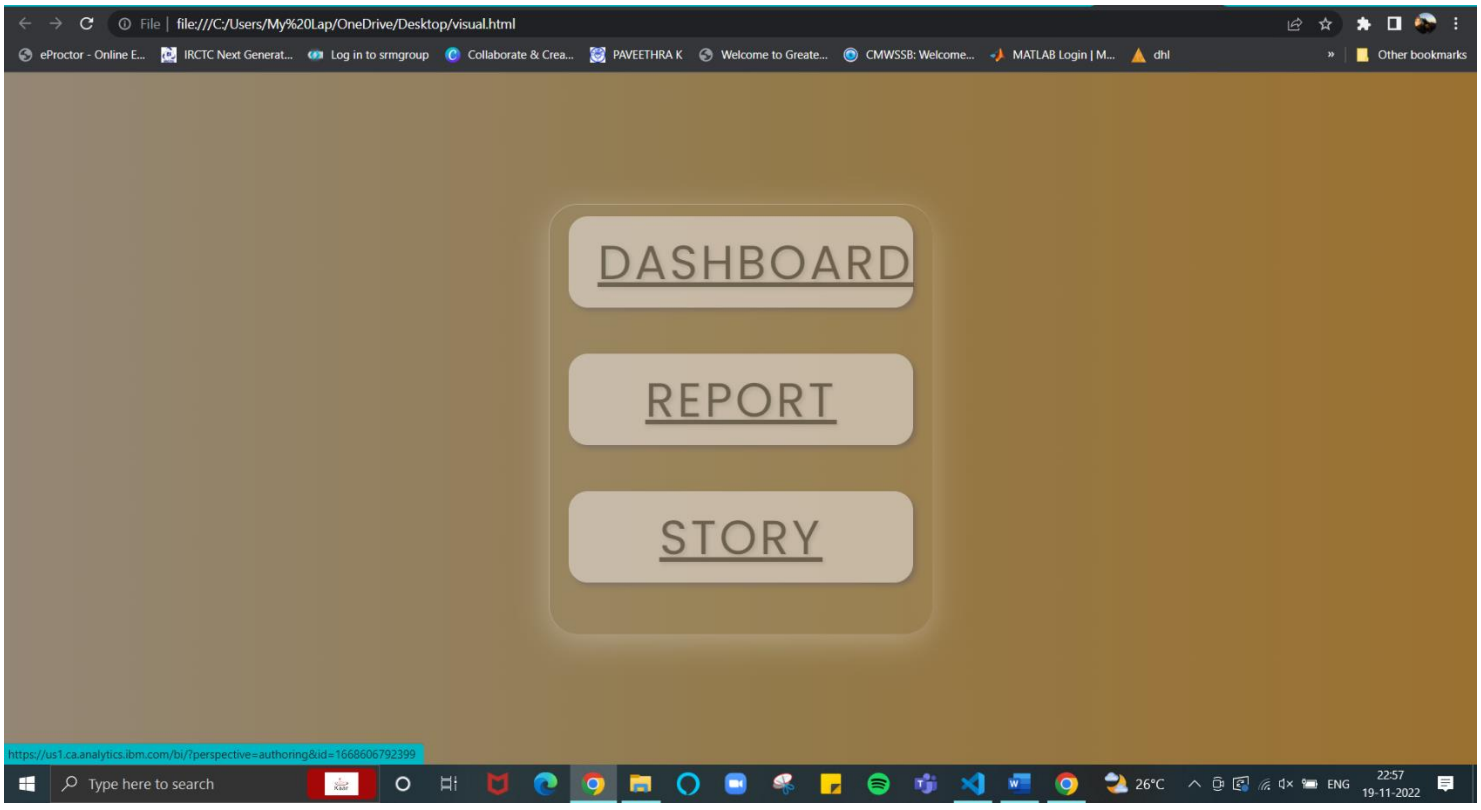

BP VARIATION WITH RESPECT TO AGE
Sex
0
1
BP (Sum)
1,500
1,000
500
0
Average: 485.8
29
35
38
40
42
44
46
48
50
52
54
56
58
60
62
64
66
68
70
74
77
Age

b

User acceptance Testing




Heart Disease Prediction
File | C:/Users/My%20Lap/OneDrive/Desktop/login.html
pavilavan2001@gmail.com
Log in
Forget Password?
file:///C:/Users/My Lap/OneDrive/Desktop/Visual.html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ePROCTOR - Online E...
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Log in to srmgroup
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DASHBOARD
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Type here to search
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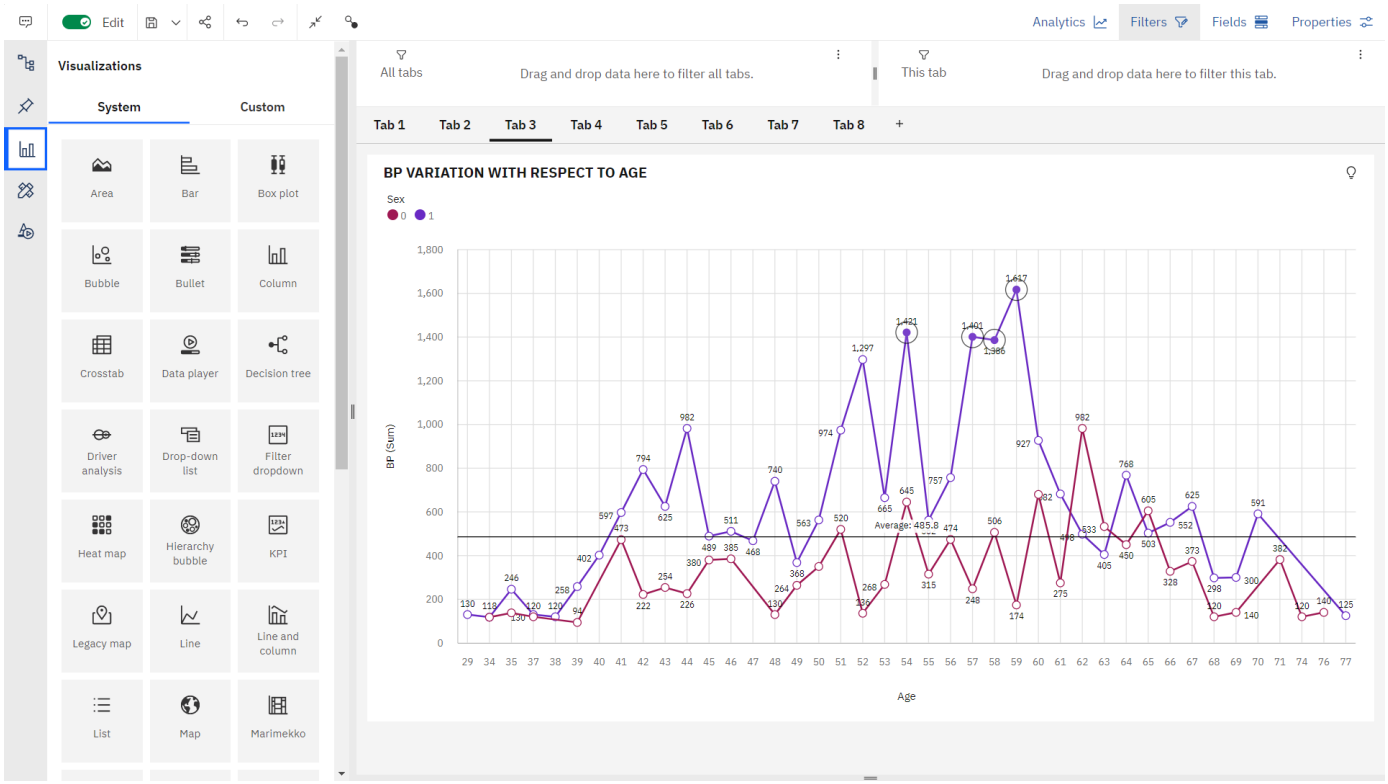
Edit
Analytics
Filters
Fields
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Visualizations
System
Custom
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Box plot
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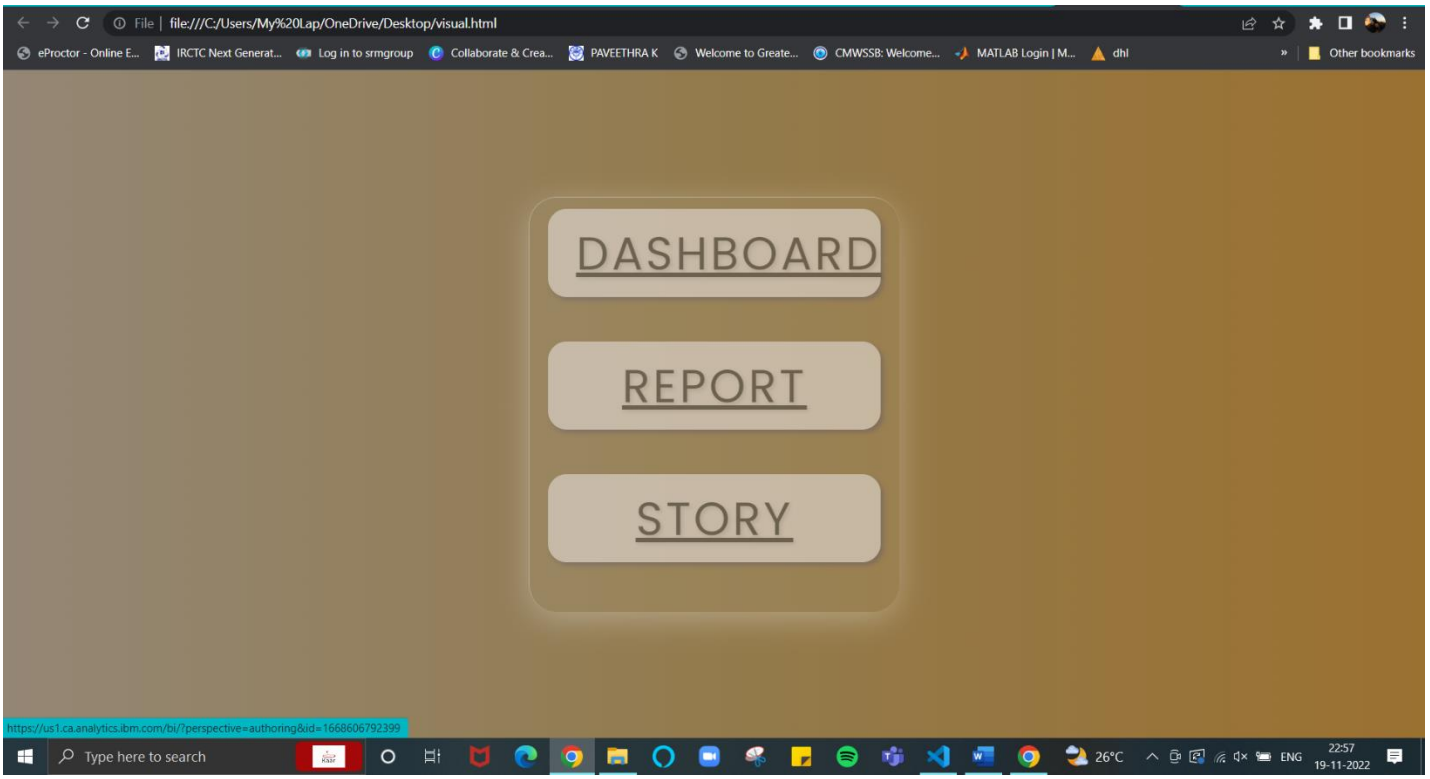
Data player
Decision tree
Driver analysis
Drop-down list
Filter dropdown
Heat map
Hierarchy bubble
KPI
Legacy map
Line
Line and column
List
Map
Marimekko
All tabs
Drag and drop data here to filter all tabs.
This tab
Drag and drop data here to filter this tab.
Tab 1
Tab 2
Tab 3
Tab 4
Tab 5
Tab 6
Tab 7
Tab 8
BP VARIATION WITH RESPECT TO AGE
Sex
0
1
BP (Sum)
Age
Average: 485.8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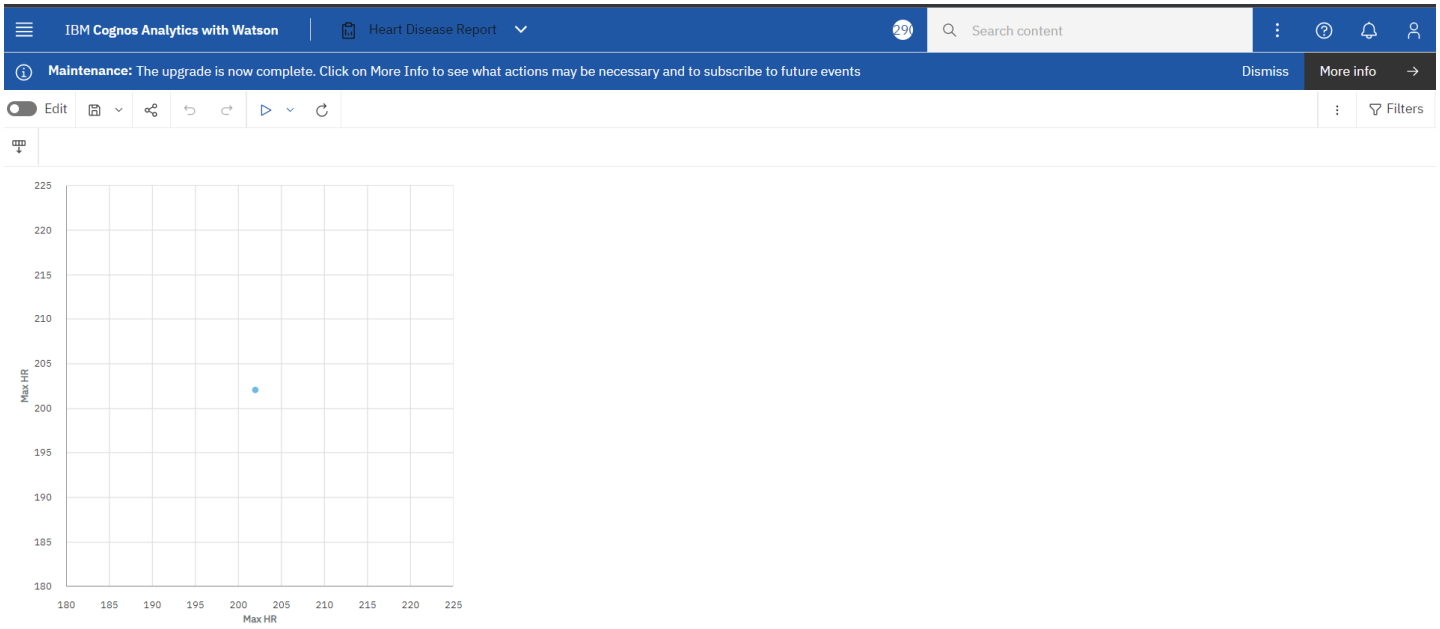
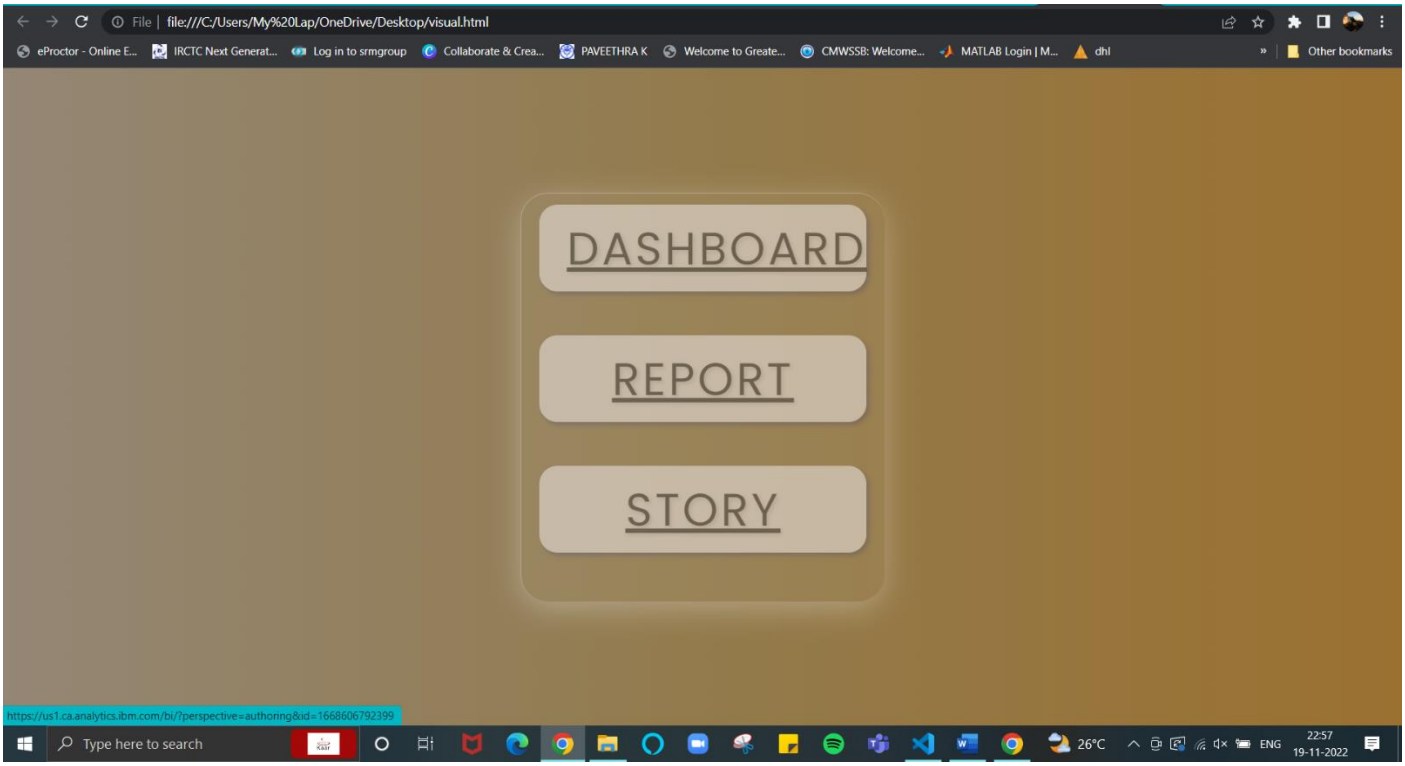

IBM Cognos Analytics with Watson
Heart Disease Report
Search content
Maintenance: The upgrade is now complete. Click on More Info to see what actions may be necessary and to subscribe to future events
Dismiss
More info
Edit
Filters
Max HR
225
220
215
210
205
200
195
190
185
180
180 185 190 195 200 205 210 215 220 225
Max HR


File | file:///C:/Users/My%20Lap/OneDrive/Desktop/visual.html
eProctor - Online E...
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https://us1.ca.analytics.ibm.com/bi/?perspective=authoring&id=1668606792399
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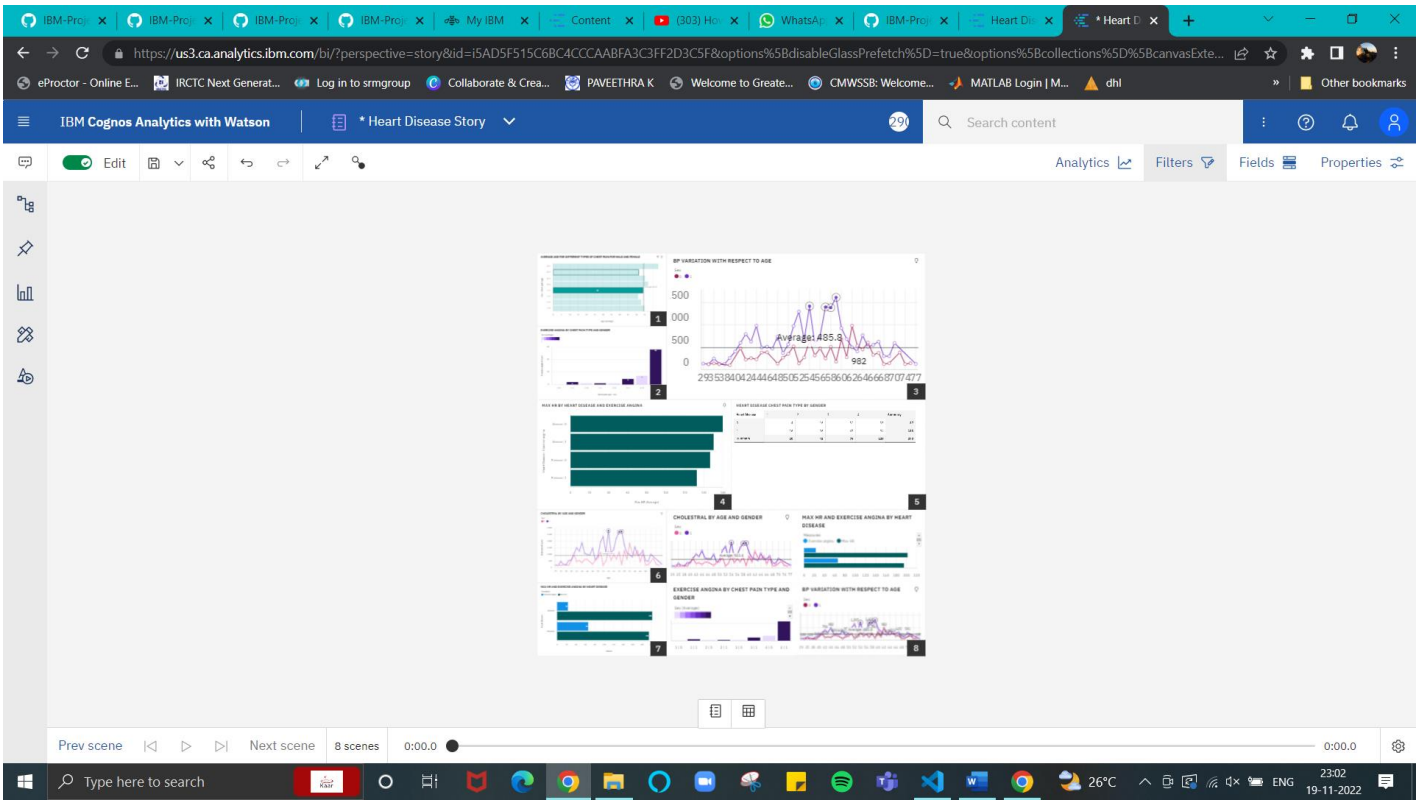
19-11-2022


IBM Cognos Analytics with Watson
* Heart Disease Story
Search content
Edit
Analytics
Filters
Fields
Properties
Prev scene
Next scene
8 scenes
0:00.0
0:00.0
Type here to search
26°C
ENG
23:02
19-11-2022

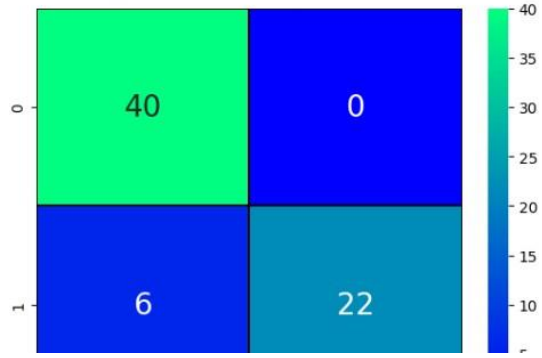
9. Result

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 Code:
https://github.com/IBM-EPBL/IBM-Project-42183-1660654909/tree/main/FINAL%20DELIVERABLES

Demo video link:
https://drive.google.com/file/d/19mVC30zJlTTTHW6JVvTPNhrC7GpgxCjU/view