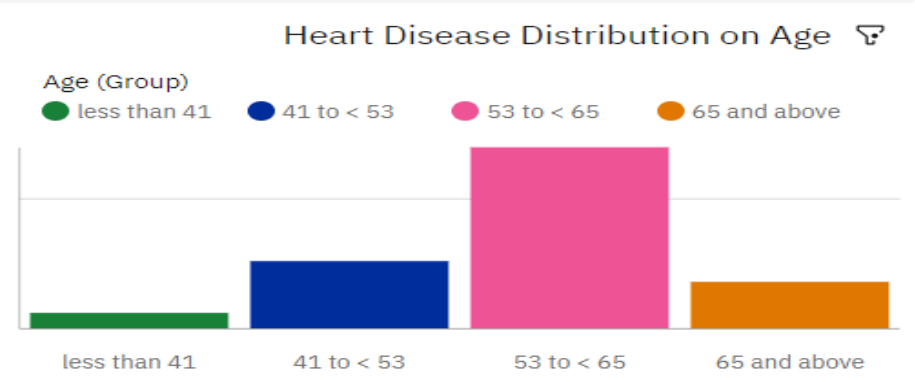
CODING & SOLUTIONING

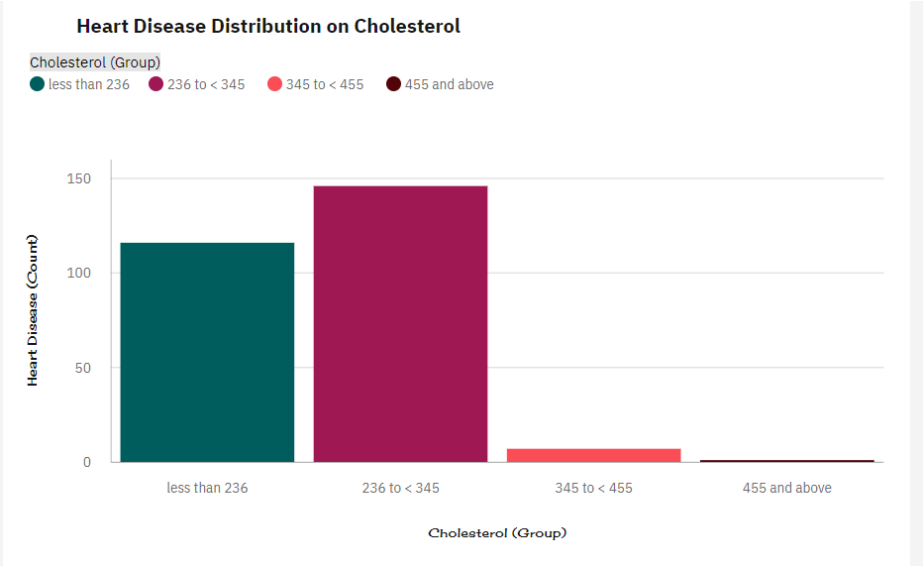
Date	18 November 2022
Team ID	PNT2022TMID52957
Project Name	Visualizing and Predicting Heart Diseases with an Interactive Dashboard
Maximum Marks	10 Marks

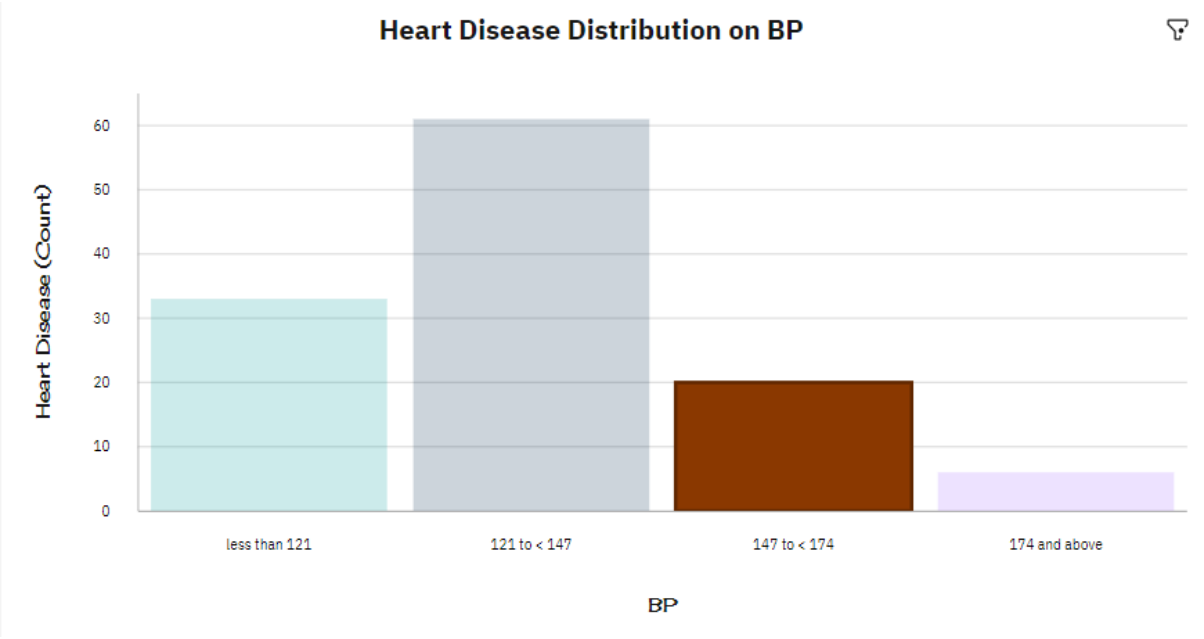
Featured Implemented:

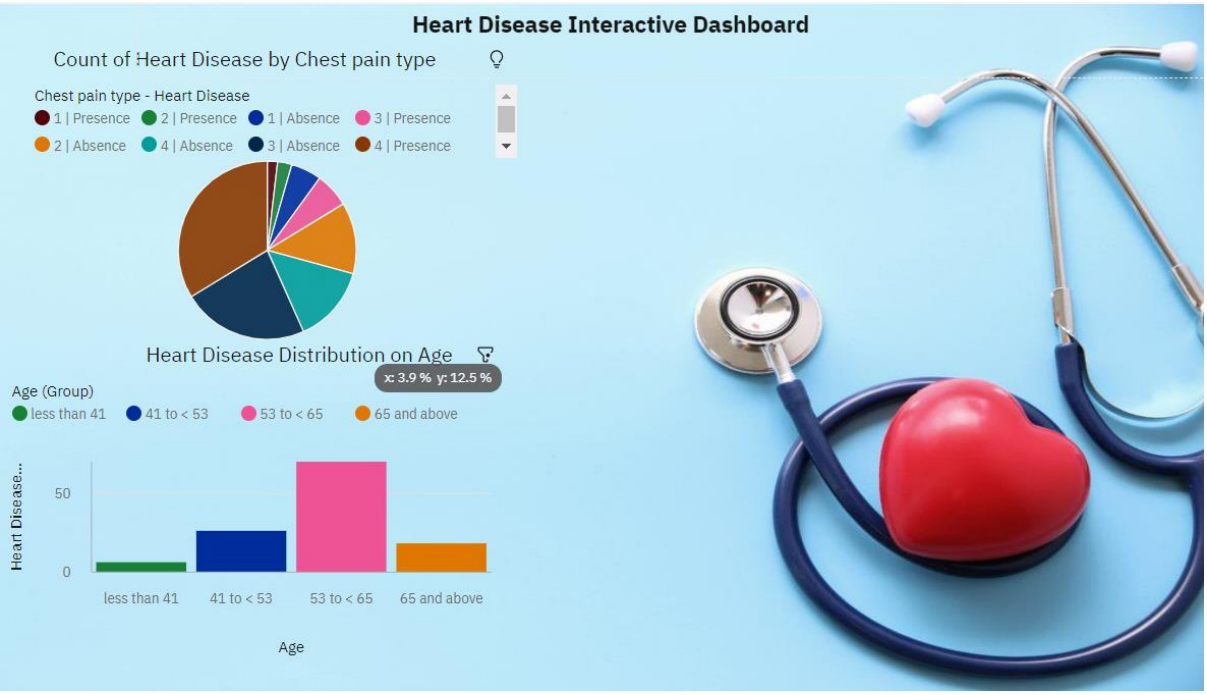
Visualizing Various features of the data
User Interactive Dashboard
Prediction using various Machine learning algorithms
User can predict whether they have heart disease or not using ml model deployed on IBM Cloud.
User can predict whether they have heart disease or not by entering their details in python itself which uses ml model deployed on IBM Cloud.

1. **Interactive Dashboard:**



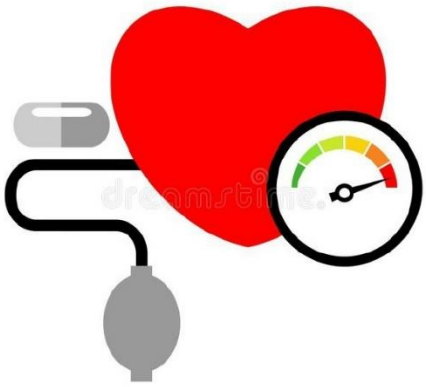


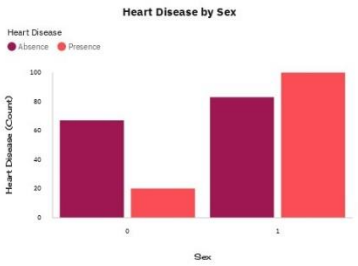

Heart Disease Distribution on BP
Heart Disease (Count)
60
50
40
30
20
10
0
less than 121
121 to < 147
147 to < 174
174 and above
BP

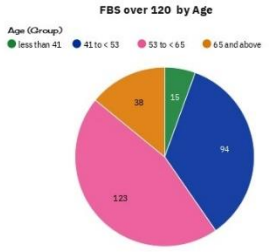

Heart Disease Interactive Dashboard
Count of Heart Disease by Chest pain type
Chest pain type - Heart Disease
1 | Presence
2 | Presence
1 | Absence
3 | Presence
2 | Absence
4 | Absence
3 | Absence
4 | Presence
Heart Disease Distribution on Age
x: 3.9 % y: 12.5 %
Age (Group)
less than 41
41 to < 53
53 to < 65
65 and above
Heart Disease...
50
0
less than 41
41 to < 53
53 to < 65
65 and above
Age

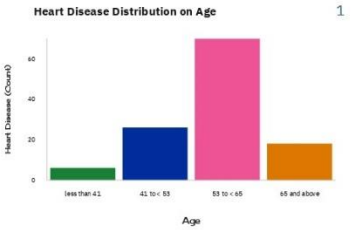
Tab 6

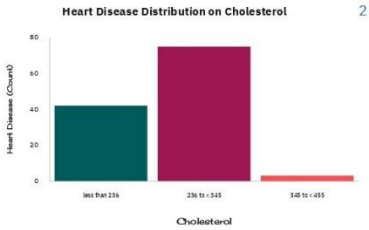
HEART DISEASE -INTERACTIVE DASHBOARD

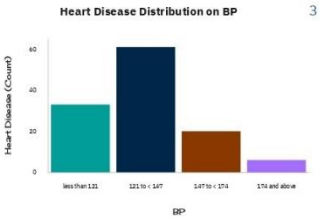


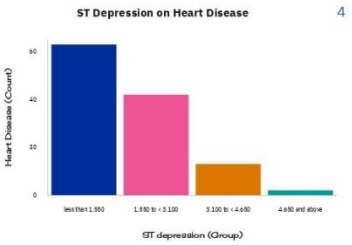


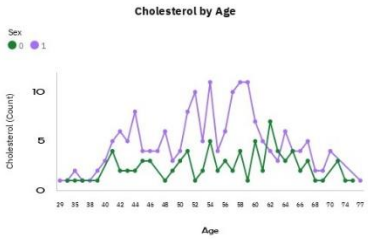


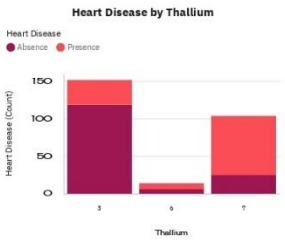


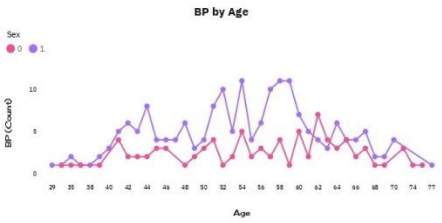






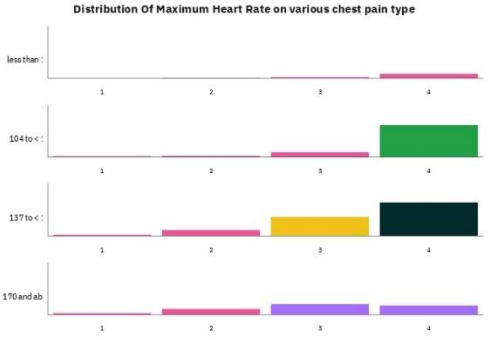


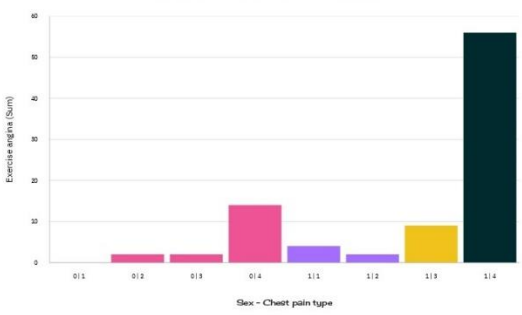




Heart Disease for Chest pain type and Sex

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





2. Different Machine Learning Algorithm Have Been Implemented

1. Import the dataset & libraries into GoogleColab

IMPORTING LIBRARIES

```
[1] import xgboost as xgb
    import pandas as pd
    import numpy as np
    import seaborn as sns
    import matplotlib.pyplot as plt
    import warnings
    warnings.filterwarnings('ignore')
    from sklearn import datasets
    from sklearn.model_selection import train_test_split
    from sklearn.preprocessing import LabelEncoder
    from xgboost import XGBClassifier
    from sklearn.metrics import confusion_matrix
    from sklearn.ensemble import RandomForestClassifier
    from sklearn.metrics import classification_report
    from sklearn.metrics import accuracy_score
    from sklearn.tree import DecisionTreeClassifier
    from sklearn.naive_bayes import GaussianNB
    from sklearn.svm import SVC
```

Loading Train and Test dataset

```
import pandas as pd
from google.colab import drive
drive.mount('/content/drive')
data_set=pd.read_csv('/content/drive/MyDrive/Colab Notebooks/Heart_Disease_Prediction.csv')
```

2. Read the dataset

```
data_set.info()
```

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 270 entries, 0 to 269
Data columns (total 14 columns):
 #   Column                  Non-Null Count  Dtype
---  ------                  --------------  -----
 0   Age                     270 non-null    int64
 1   Sex                     270 non-null    int64
 2   Chest pain type         270 non-null    int64
 3   BP                      270 non-null    int64
 4   Cholesterol             270 non-null    int64
 5   FBS over 120            270 non-null    int64
 6   EKG results             270 non-null    int64
 7   Max HR                  270 non-null    int64
 8   Exercise angina         270 non-null    int64
 9   ST depression           270 non-null    float64
 10  Slope of ST             270 non-null    int64
 11  Number of vessels fluro 270 non-null    int64
 12  Thallium                270 non-null    int64
 13  Heart Disease           270 non-null    object
dtypes: float64(1), int64(12), object(1)
memory usage: 29.7+ KB
```

3. Display first five data details from our dataset

Exploratory Data Analysis(EDA)

```
data_set.head()
```

	Age	Sex	Chest pain type	BP	Cholesterol	FBS over 120	EKG results	Max HR	Exercise angina	ST depression	Slope of ST	Number of vessels fluro	Thallium	Heart Disease
0	70	1	4	130	322	0	2	109	0	2.4	2	3	3	Presence
1	67	0	3	115	564	0	2	160	0	1.6	2	0	7	Absence
2	57	1	2	124	261	0	0	141	0	0.3	1	0	7	Presence
3	64	1	4	128	263	0	0	105	1	0.2	2	1	7	Absence
4	74	0	2	120	269	0	2	121	1	0.2	1	1	3	Absence

4. Check duplicates in the dataset

```
[6] data_set.isnull().sum()
```

```
Age                       0
Sex                       0
Chest pain type           0
BP                        0
Cholesterol               0
FBS over 120              0
EKG results               0
Max HR                    0
Exercise angina           0
ST depression             0
Slope of ST               0
Number of vessels fluro   0
Thallium                  0
Heart Disease             0
dtype: int64
```

5. Describe the some specific data from dataset

```
[4] data_set.describe()
```

	Age	Sex	Chest pain type	BP	Cholesterol	FBS over 120	EKG results	Max HR	Exercise angina	ST depression	Slope of ST	Number of vessels fluro	Thallium
count	270.000000	270.000000	270.000000	270.000000	270.000000	270.000000	270.000000	270.000000	270.000000	270.00000	270.000000	270.000000	270.000000
mean	54.433333	0.677778	3.174074	131.344444	249.659259	0.148148	1.022222	149.677778	0.329630	1.05000	1.585185	0.670370	4.696296
std	9.109067	0.468195	0.950090	17.861608	51.686237	0.355906	0.997891	23.165717	0.470952	1.14521	0.614390	0.943896	1.940659
min	29.000000	0.000000	1.000000	94.000000	126.000000	0.000000	0.000000	71.000000	0.000000	0.00000	1.000000	0.000000	3.000000
25%	48.000000	0.000000	3.000000	120.000000	213.000000	0.000000	0.000000	133.000000	0.000000	0.00000	1.000000	0.000000	3.000000
50%	55.000000	1.000000	3.000000	130.000000	245.000000	0.000000	2.000000	153.500000	0.000000	0.80000	2.000000	0.000000	3.000000
75%	61.000000	1.000000	4.000000	140.000000	280.000000	0.000000	2.000000	166.000000	1.000000	1.60000	2.000000	1.000000	7.000000
max	77.000000	1.000000	4.000000	200.000000	564.000000	1.000000	2.000000	202.000000	1.000000	6.20000	3.000000	3.000000	7.000000

6. Calculates the relationship between each column in your data set

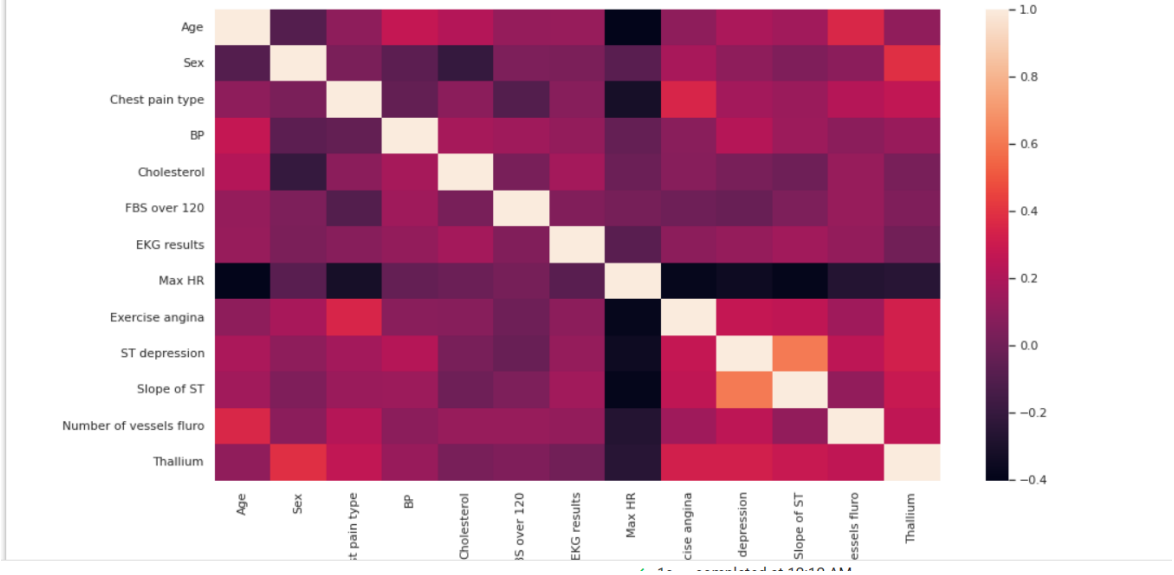
```
data_set.corr()
```

	Age	Sex	Chest pain type	BP	Cholesterol	FBS over 120	EKG results	Max HR	Exercise angina	ST depression	Slope of ST	Number of vessels fluro	Thallium
Age	1.000000	-0.094401	0.096920	0.273053	0.220056	0.123458	0.128171	-0.402215	0.098297	0.194234	0.159774	0.356081	0.106100
Sex	-0.094401	1.000000	0.034636	-0.062693	-0.201647	0.042140	0.039253	-0.076101	0.180022	0.097412	0.050545	0.086830	0.391046
Chest pain type	0.096920	0.034636	1.000000	-0.043196	0.090465	-0.098537	0.074325	-0.317682	0.353160	0.167244	0.136900	0.225890	0.262659
BP	0.273053	-0.062693	-0.043196	1.000000	0.173019	0.155681	0.116157	-0.039136	0.082793	0.222800	0.142472	0.085697	0.132045
Cholesterol	0.220056	-0.201647	0.090465	0.173019	1.000000	0.025186	0.167652	-0.018739	0.078243	0.027709	-0.005755	0.126541	0.028836
FBS over 120	0.123458	0.042140	-0.098537	0.155681	0.025186	1.000000	0.053499	0.022494	-0.004107	-0.025538	0.044076	0.123774	0.049237
EKG results	0.128171	0.039253	0.074325	0.116157	0.167652	0.053499	1.000000	-0.074628	0.095098	0.120034	0.160614	0.114368	0.007337
Max HR	-0.402215	-0.076101	-0.317682	-0.039136	-0.018739	0.022494	-0.074628	1.000000	-0.380719	-0.349045	-0.386847	-0.265333	-0.253397
Exercise angina	0.098297	0.180022	0.353160	0.082793	0.078243	-0.004107	0.095098	-0.380719	1.000000	0.274672	0.255908	0.153347	0.321449
ST depression	0.194234	0.097412	0.167244	0.222800	0.027709	-0.025538	0.120034	-0.349045	0.274672	1.000000	0.609712	0.255005	0.324333
Slope of ST	0.159774	0.050545	0.136900	0.142472	-0.005755	0.044076	0.160614	-0.386847	0.255908	0.609712	1.000000	0.109498	0.283678
Number of vessels fluro	0.356081	0.086830	0.225890	0.085697	0.126541	0.123774	0.114368	-0.265333	0.153347	0.255005	0.109498	1.000000	0.255648
Thallium	0.106100	0.391046	0.262659	0.132045	0.028836	0.049237	0.007337	-0.253397	0.321449	0.324333	0.283678	0.255648	1.000000

7. Display the Heatmap of Dataset

```
sns.heatmap(data_set.corr())
```

```
<matplotlib.axes._subplots.AxesSubplot at 0x7f408fbc13d0>
```



8.Spint dataset into Train and Test

Train test and split

```
[14] X = data_set.iloc[:,:-1]
     y = data_set.iloc[:,-1]
```

9.Display the different types of models

(i) Using xgboost algorithm

XgBoost stands for Extreme Gradient Boosting.It is a library written in C++ which optimizes the training for Gradient Boosting.

XGBOOST ALGORITHM

```
# XGBoost :
X_train, X_test, y_train, y_test = train_test_split(X, y, test_size=0.5, random_state=0)
lc = LabelEncoder()
lc = lc.fit(y)
lc_y = lc.transform(y)

model = XGBClassifier()
model.fit(X_train, y_train)

y_pred = model.predict(X_test)
predictions = [round(value) for value in y_pred]

cm= confusion_matrix(y_test, y_pred)
print(cm)

accuracy1 = accuracy_score(y_test, predictions)
print("Accuracy1: %.2f%%" % (accuracy1 * 100.0))
```

```
[[63 15]
 [ 9 48]]
Accuracy1: 82.22%
```

(ii) Using Logistic Regression

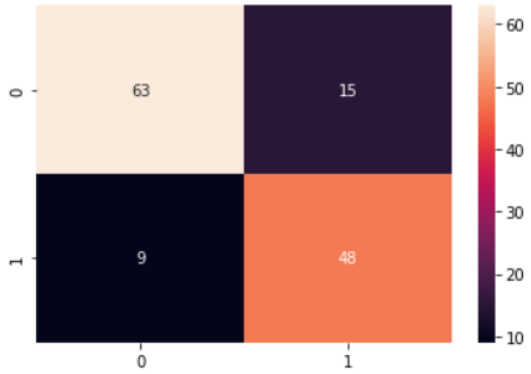
Logistic regression is an example of supervised learning. It is used to calculate or predict the probability of a binary (yes/no) event occurring.

```
[17] # Logistic Regression:
     from sklearn.linear_model import LogisticRegression
     from sklearn.metrics import accuracy_score
     #logreg = LogisticRegression()
     #logreg.fit(X_train,y_train)
     #y_pred = logreg.predict(X_train)
     #print('Train accuracy score:',(accuracy_score(y_train,y_pred)*100,2),"%")
     #print('Test accuracy score:', (accuracy_score(y_test,logreg.predict(X_test))*100,2),"%")
     logreg = LogisticRegression()
     logreg.fit(X_train, y_train)
     y_pred_lr = logreg.predict(X_test)
     score_lr = round(accuracy_score(y_pred_lr,y_test)*100,2)
     print("The accuracy score achieved using Logistic Regression is: "+str(score_lr)+" %")
```

```
The accuracy score achieved using Logistic Regression is: 82.96 %
```

```
print(classification_report(y_test, y_pred))


matrix= confusion_matrix(y_test, y_pred)
sns.heatmap(matrix,annot = True, fmt = "d")
```

```
              precision    recall  f1-score   support

           0       0.88      0.81      0.84        78
           1       0.76      0.84      0.80        57

    accuracy                           0.82       135
   macro avg       0.82      0.82      0.82       135
weighted avg       0.83      0.82      0.82       135

<matplotlib.axes._subplots.AxesSubplot at 0x7f4092a99c90>
```



(iii) Using Random Forest algorithm

Random forest is a supervised machine learning algorithm that is used widely in classification and regression problems. It builds a decision tree on different samples and takes their majority vote for classification and average in case of regression.

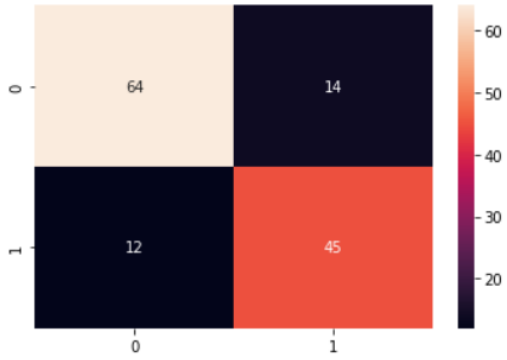
RANDOM FOREST

```
[23] randfor = RandomForestClassifier(n_estimators=100, random_state=0)

     randfor.fit(X_train, y_train)

     y_pred_rf = randfor.predict(X_test)

     score_rf = round(accuracy_score(y_pred_rf,y_test)*100,2)

     print("The accuracy score achieved using Random Forest is: "+str(score_rf)+" %")
```

```
The accuracy score achieved using Random Forest is: 80.74 %
```

```
print(classification_report(y_test, y_pred_rf))

matrix= confusion_matrix(y_test, y_pred_rf)
sns.heatmap(matrix,annot = True, fmt = "d")
```

```
              precision    recall  f1-score   support

           0       0.84      0.82      0.83        78
           1       0.76      0.79      0.78        57

    accuracy                           0.81       135
   macro avg       0.80      0.80      0.80       135
weighted avg       0.81      0.81      0.81       135

<matplotlib.axes._subplots.AxesSubplot at 0x7f40902512d0>
```



(iv)Decision Tree

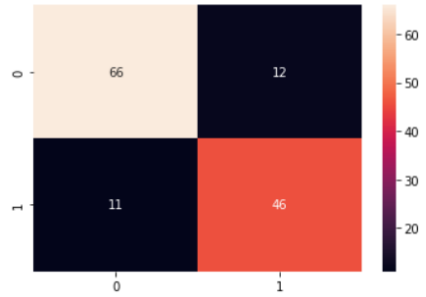
Decision Tree is a Supervised learning technique that can be used for both classification and Regression problems, but mostly it is preferred for solving Classification problems and it is a tree-structured classifier

```
[25] dt = DecisionTreeClassifier(max_depth=3, random_state=0)

     dt.fit(X_train, y_train)

     y_pred_dt = dt.predict(X_test)

     score_dt = round(accuracy_score(y_pred_dt,y_test)*100,2)

     print("The accuracy score achieved using Decision Tree is: "+str(score_dt)+" %")
```

```
The accuracy score achieved using Decision Tree is: 75.56 %
```

```
print(classification_report(y_test, y_pred_lr))


matrix= confusion_matrix(y_test, y_pred_lr)
sns.heatmap(matrix,annot = True, fmt = "d")
```

```
              precision    recall  f1-score   support

           0       0.86      0.85      0.85        78
           1       0.79      0.81      0.80        57

    accuracy                           0.83       135
   macro avg       0.83      0.83      0.83       135
weighted avg       0.83      0.83      0.83       135

<matplotlib.axes._subplots.AxesSubplot at 0x7f4092c77710>
```



(v)Naïve Bayes

Naïve Bayes algorithm is a supervised learning algorithm, which is based on Bayes theorem and used for solving classification problems.

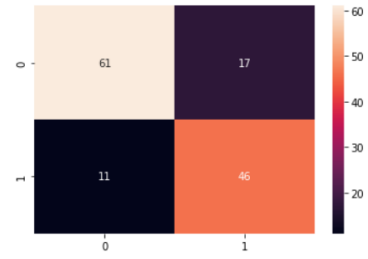
Naive Bayes

```
[29] gnb = GaussianNB()
     y_pred_nb = gnb.fit(X_train, y_train).predict(X_test)

     score_nb = round(accuracy_score(y_pred_nb,y_test)*100,2)

     print("The accuracy score achieved using Naive Bayes is: "+str(score_nb)+" %")
```

```
The accuracy score achieved using Naive Bayes is: 79.26 %
```

```
print(classification_report(y_test, y_pred_nb))

matrix= confusion_matrix(y_test, y_pred_nb)
sns.heatmap(matrix,annot = True, fmt = "d")
```

```
              precision    recall  f1-score   support

           0       0.85      0.78      0.81        78
           1       0.73      0.81      0.77        57

    accuracy                           0.79       135
   macro avg       0.79      0.79      0.79       135
weighted avg       0.80      0.79      0.79       135

<matplotlib.axes._subplots.AxesSubplot at 0x7f4092e4f0d0>
```



(vi) Using Support vector machine algorithm

SVM algorithm is to create the best line or decision boundary that can segregate n-dimensional space into classes so that we can easily put the new data point in the correct category in the future.

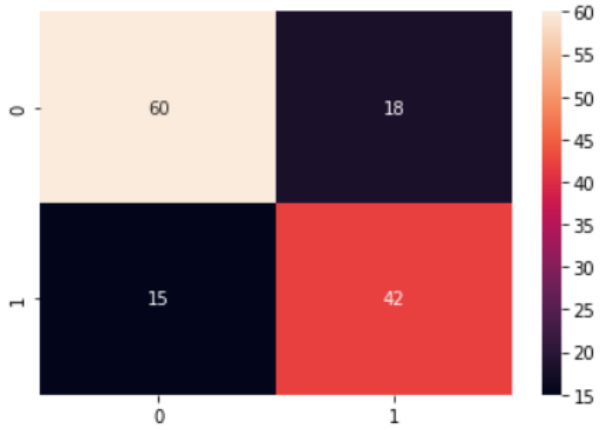
Support Vector Machine

```
classifier = SVC(kernel = 'rbf', random_state = 0)
classifier.fit(X_train, y_train)
y_pred_svm = dt.predict(X_test)

score_svm = round(accuracy_score(y_pred_svm,y_test)*100,2)

print("The accuracy score achieved using SVM is: "+str(score_svm)+" %")
```

```
The accuracy score achieved using SVM is: 75.56 %
```

```
print(classification_report(y_test, y_pred_svm))

matrix= confusion_matrix(y_test, y_pred_svm)
sns.heatmap(matrix,annot = True, fmt = "d")
```

```
              precision    recall  f1-score   support

           0       0.80      0.77      0.78        78
           1       0.70      0.74      0.72        57

    accuracy                           0.76       135
   macro avg       0.75      0.75      0.75       135
weighted avg       0.76      0.76      0.76       135

<matplotlib.axes._subplots.AxesSubplot at 0x7f4095521910>
```



10.Comparison of All Algorithms Accuracy

```
[33] accuracy = []

     classifiers = ['Decision Trees', 'Logistic Regression', 'Naive Bayes', 'Random Forests','Support Vector Machine','XGBOOST ALGORITHM']

     models = [DecisionTreeClassifier(max_depth=3, random_state=0), LogisticRegression(),
             GaussianNB(), RandomForestClassifier(n_estimators=100, random_state=0), SVC(kernel = 'rbf', random_state = 0),XGBClassifier() ]

     for i in models:
         model = i
         model.fit(X_train, y_train)
         score = model.score(X_test, y_test)
         accuracy.append(score)
```

```
summary = pd.DataFrame({'Accuracy':accuracy}, index=classifiers)
summary
```

	Accuracy
Decision Trees	0.755556
Logistic Regression	0.829630
Naive Bayes	0.792593
Random Forests	0.807407
Support Vector Machine	0.711111
XGBOOST ALGORITHM	0.822222

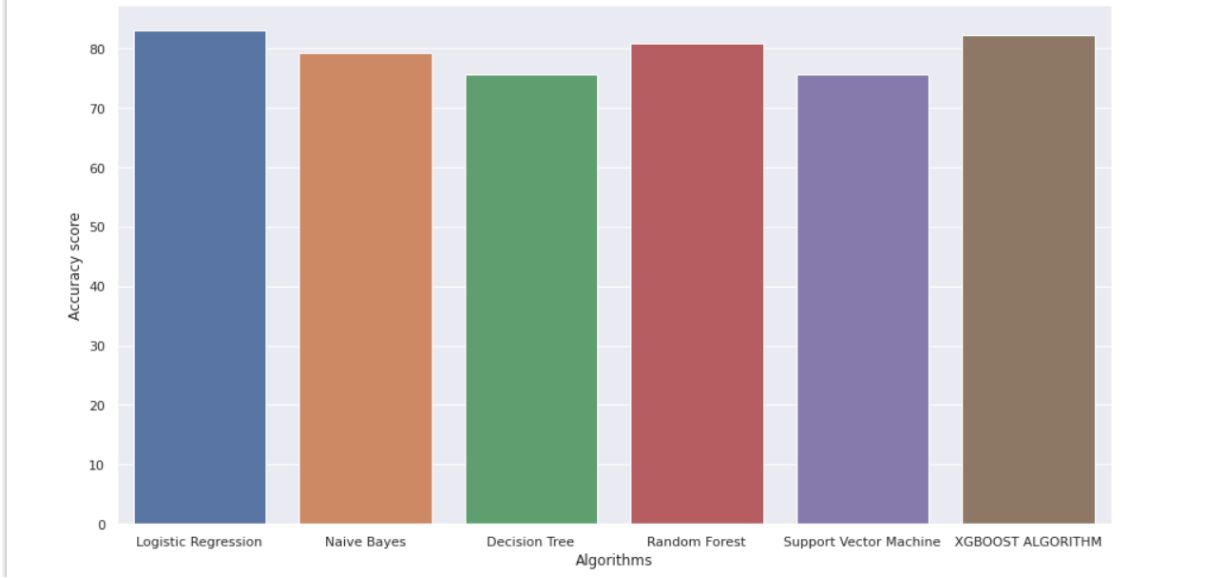
11.Accuracy Comparison Chart

```
scores = [score_lr,score_nb,score_dt,score_rf,score_svm,accuracy1*100]
algorithms = ["Logistic Regression","Naive Bayes","Decision Tree","Random Forest","Support Vector Machine",'XGBOOST ALGORITHM']
sns.set(rc={'figure.figsize':(15,8)})
plt.xlabel("Algorithms")
plt.ylabel("Accuracy score")

sns.barplot(algorithms,scores)
```

```
<matplotlib.axes._subplots.AxesSubplot at 0x7f408fef9290>
```

```
sns.barplot(algorithms,scores)
```

```
<matplotlib.axes._subplots.AxesSubplot at 0x7f408fef9290>
```



12. The Dataset is tested with all above models of which logistic regression given the good accuracy.

1. Import the logistic regression package

```
log_reg= LogisticRegression()
log_reg.fit(X_train,Y_train)
Y_pred=log_reg.predict(X_test)
```

2. Create the data for testing

```
heart_Disease={'Age':[50],
               'Sex':[1],
               'Chest pain type':[3],
               'BP':[120],'Cholesterol':
               [170],'FBS over 120':[0],
               'EKG results':[0],
               'Max HR':[130],
               'Exercise angina':[0],
               'ST depression':[0.2],
               'Slope of ST':[1],
               'Number of vessels fluro':[0],
               'Thallium':[7]}
```

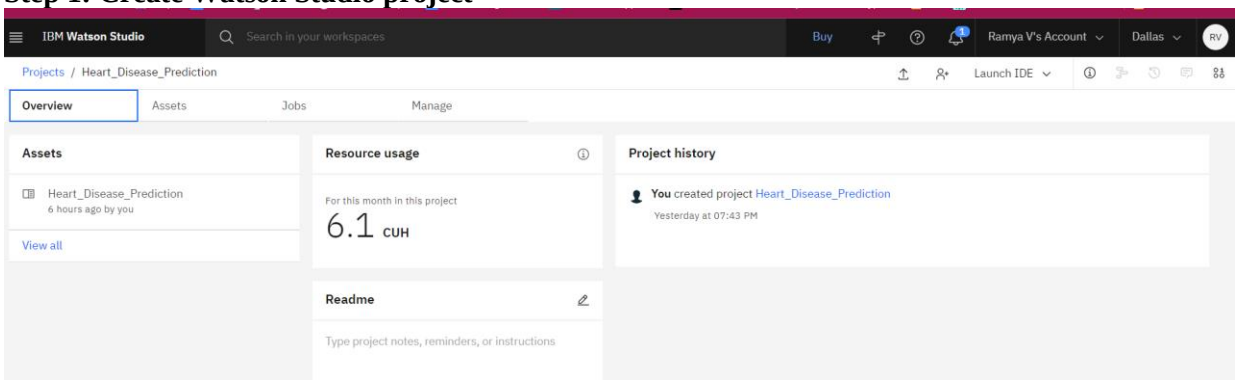
3. The above data is tested to check the existence of the disease

```
df2 = p.DataFrame(heart_Disease,columns= ['Age','Sex','Chest pain type','BP','Cholesterol','FBS over 120','EKG results','Max HR',
                                          'Exercise angina','ST depression','Slope of ST','Number of vessels fluro',
       'Thallium'])
Y_pred=log_reg.predict(df2)
print (Y_pred)
```

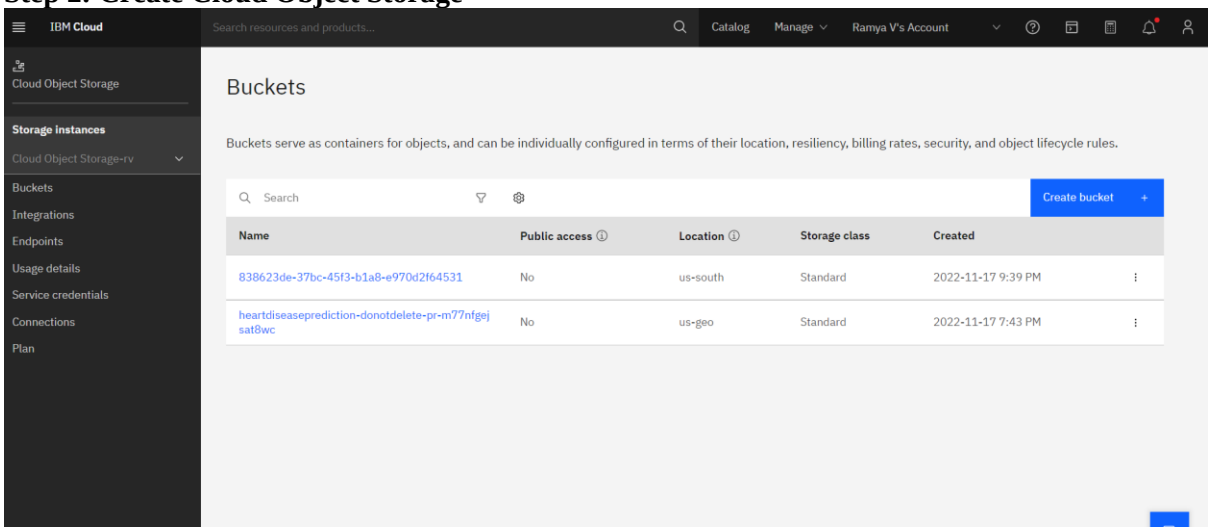
```
['Absence']
```

3. Deployment of Selected ML Model on IBM Cloud

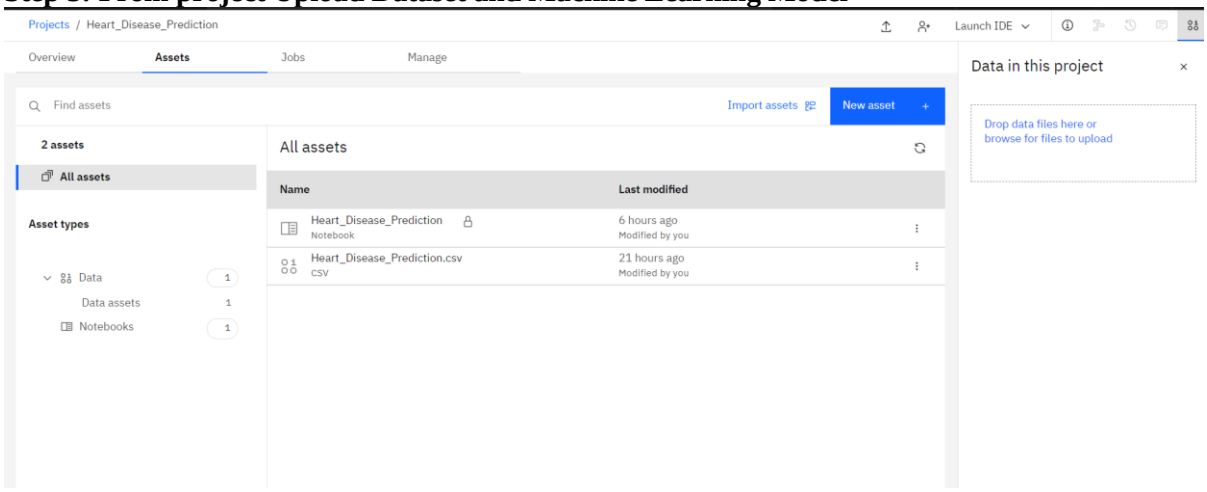
Step 1: Create Watson Studio project



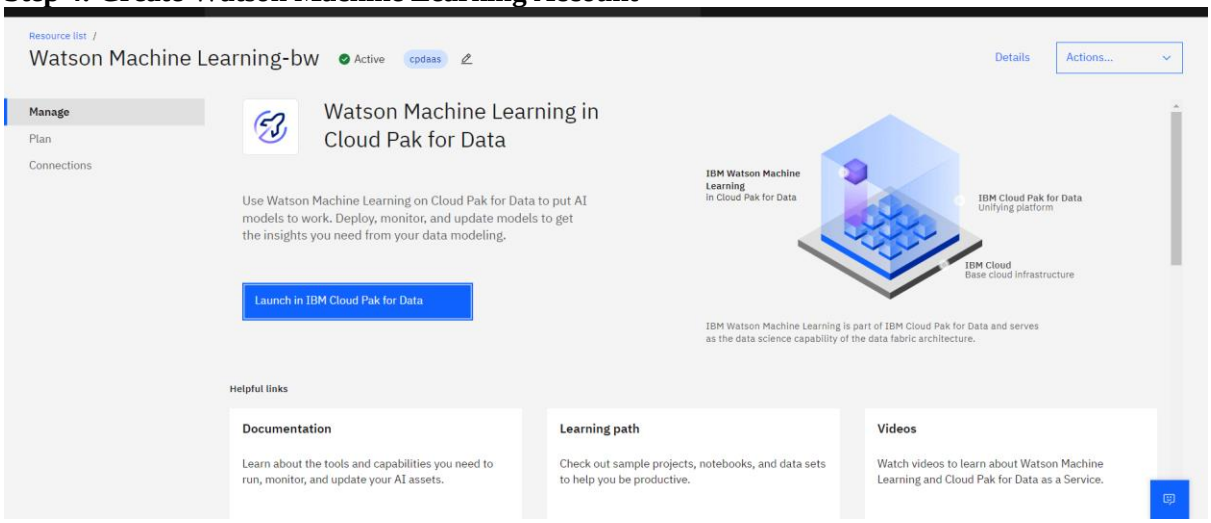
Step 2: Create Cloud Object Storage



Step 3: From project Upload Dataset and Machine Learning Model

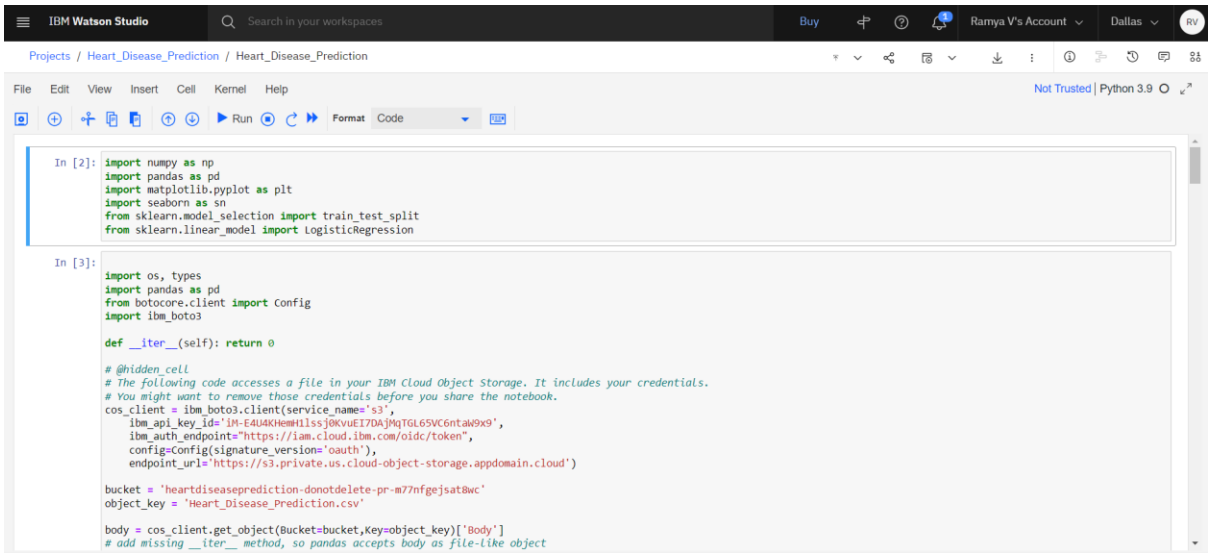


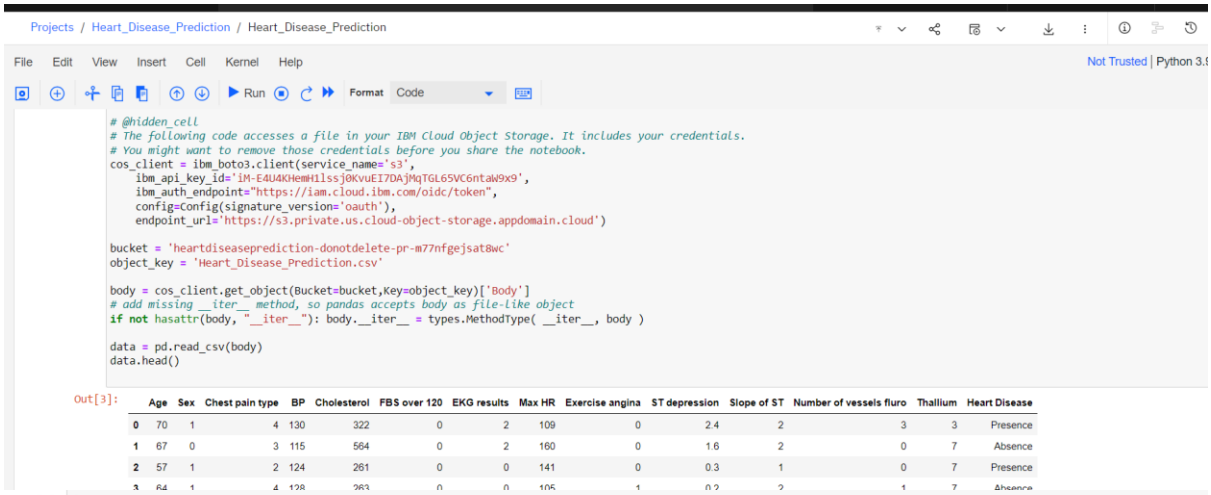
Step 4: Create Watson Machine Learning Account



Step 5: Train ML Model in IBM Cloud

Step 1: Import Libraries and Upload data in IBM Watson Studio And Connect it to ML Model





In [4]:
```
data
```

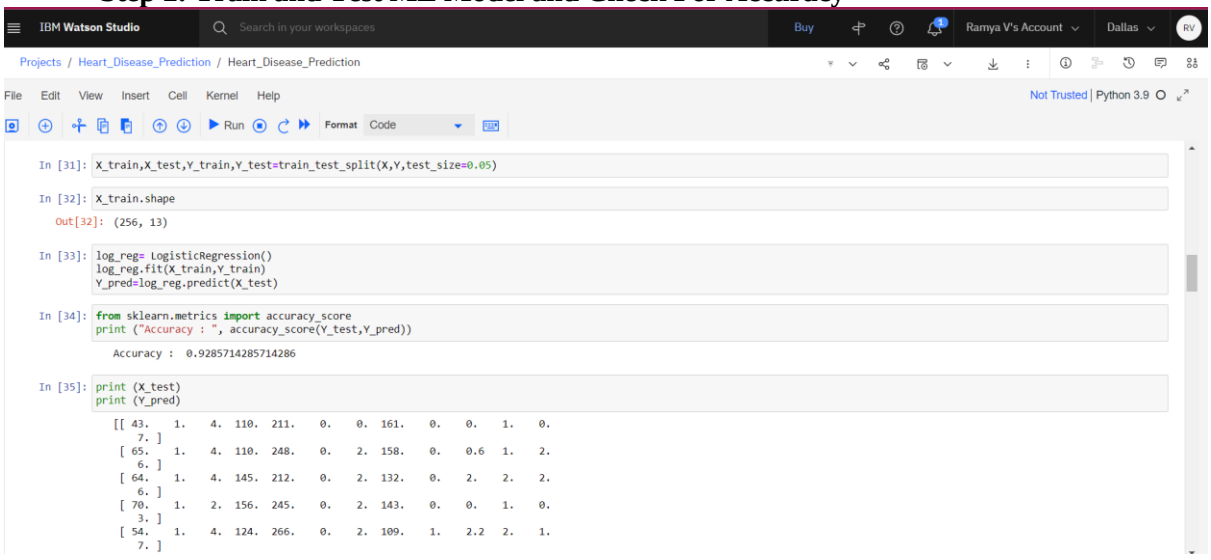
Out[4]:

	Age	Sex	Chest pain type	BP	Cholesterol	FBS over 120	EKG results	Max HR	Exercise angina	ST depression	Slope of ST	Number of vessels fluro	Thallium	Heart Disease
0	70	1	4	130	322	0	2	109	0	2.4	2	3	3	Presence
1	67	0	3	115	564	0	2	160	0	1.6	2	0	7	Absence
2	57	1	2	124	261	0	0	141	0	0.3	1	0	7	Presence
3	64	1	4	128	263	0	0	105	1	0.2	2	1	7	Absence
4	74	0	2	120	269	0	2	121	1	0.2	1	1	3	Absence
...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
265	52	1	3	172	199	1	0	162	0	0.5	1	0	7	Absence
266	44	1	2	120	263	0	0	173	0	0.0	1	0	7	Absence
267	56	0	2	140	294	0	2	153	0	1.3	2	0	3	Absence
268	57	1	4	140	192	0	0	148	0	0.4	2	0	6	Absence
269	67	1	4	160	286	0	2	108	1	1.5	2	3	3	Presence

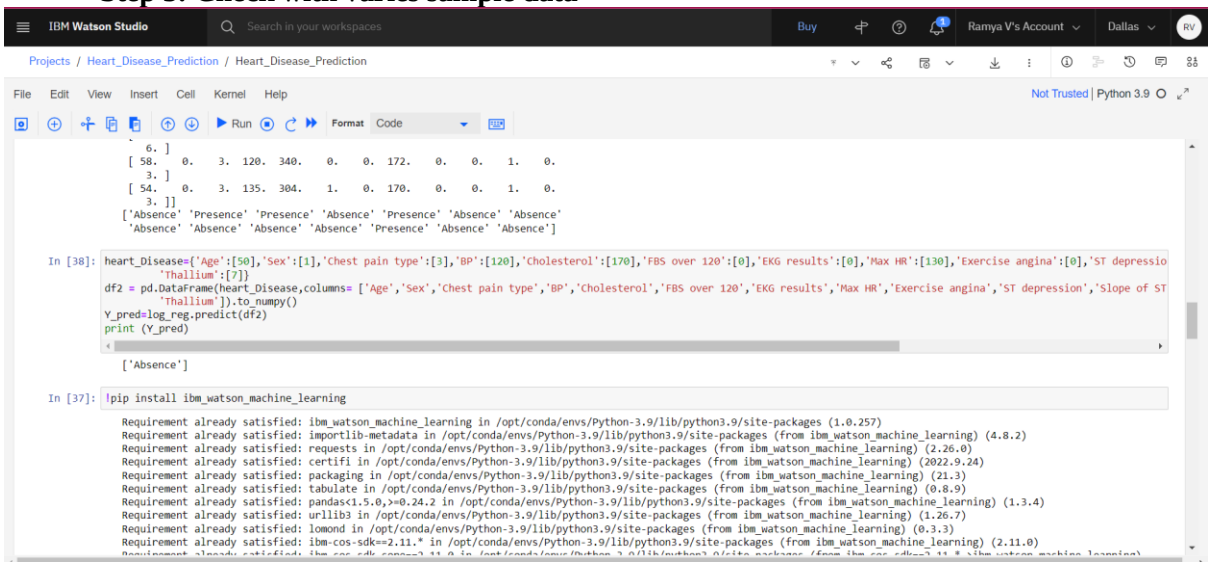
270 rows × 14 columns

In [29]:
```
X= data[['Age','Sex','Chest pain type','BP','Cholesterol','FBS over 120','EKG results','Max HR','Exercise angina','ST depression','Slope of ST','Number of vessels fluro',
         'Thallium']].to_numpy()
Y= data['Heart Disease'].to_numpy()
```

Step 2: Train and Test ML Model and Check For Accuracy



Step 3: Check with varies sample data



Step 6: Connecting a Machine Learning Service as an API Client

Step 1: Create API Key in IBM Cloud

```
Requirement already satisfied: pyparsing!=3.0.5,>=2.0.2 in /opt/conda/envs/Python-3.9/lib/python3.9/site-packages (from packaging->ibm_watson_machine_learning) (3.0.4)
```

In [39]:
```
from ibm_watson_machine_learning import APIClient
wml_credentials={
    "url":"https://us-south.ml.cloud.ibm.com",
    "apikey":"YgTKlJaXJfw0Buhk6_FCGdcAAtzUwBNBznleRI9fJ-KB"
}
client=APIClient(wml_credentials)
```

In [40]:
```
def guid_from_space_name(client,space_name):
    space=client.spaces.get_details()
    return(next(item for item in space['resources'] if item['entity']['name']==space_name)['metadata']['id'])
```

In [41]:
```
space_uid=guid_from_space_name(client,'Heart Diseases Prediction Model')
print("Space UID="+space_uid)
```

```
Space UID=d18c6095-1931-4722-9c35-d10688009ffa
```

In [42]:
```
client.set.default_space(space_uid)
```

Out[42]: 'SUCCESS'

In [43]:
```
client.software_specifications.list()
```

```
------------------------------  ------------------------------------  ----
```

Step 2: Deploy Model

```
Requirement already satisfied: pyparsing!=3.0.5,>=2.0.2 in /opt/conda/envs/Python-3.9/lib/python3.9/site-packages (from packaging->ibm_watson_machine_learning) (3.0.4)
```

In [39]:
```
from ibm_watson_machine_learning import APIClient
wml_credentials={
    "url":"https://us-south.ml.cloud.ibm.com",
    "apikey":"YgTKlJaXJfw0Buhk6_FCGdcAAtzUwBNBznleRI9fJ-KB"
}
client=APIClient(wml_credentials)
```

In [40]:
```
def guid_from_space_name(client,space_name):
    space=client.spaces.get_details()
    return(next(item for item in space['resources'] if item['entity']['name']==space_name)['metadata']['id'])
```

In [41]:
```
space_uid=guid_from_space_name(client,'Heart Diseases Prediction Model')
print("Space UID="+space_uid)
```

```
Space UID=d18c6095-1931-4722-9c35-d10688009ffa
```

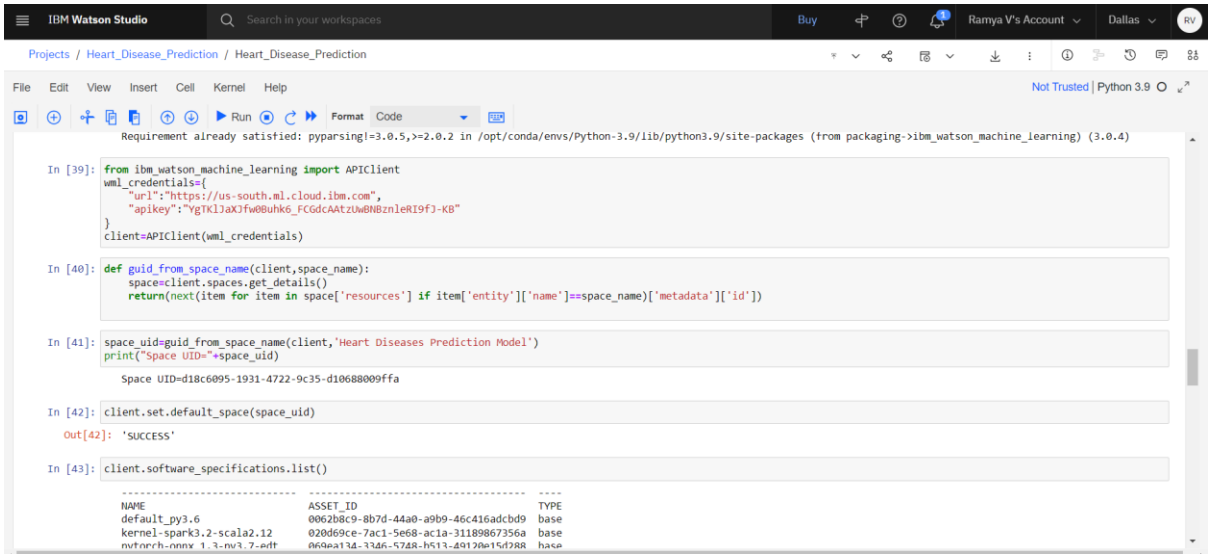
In [42]:
```
client.set.default_space(space_uid)
```

Out[42]: 'SUCCESS'

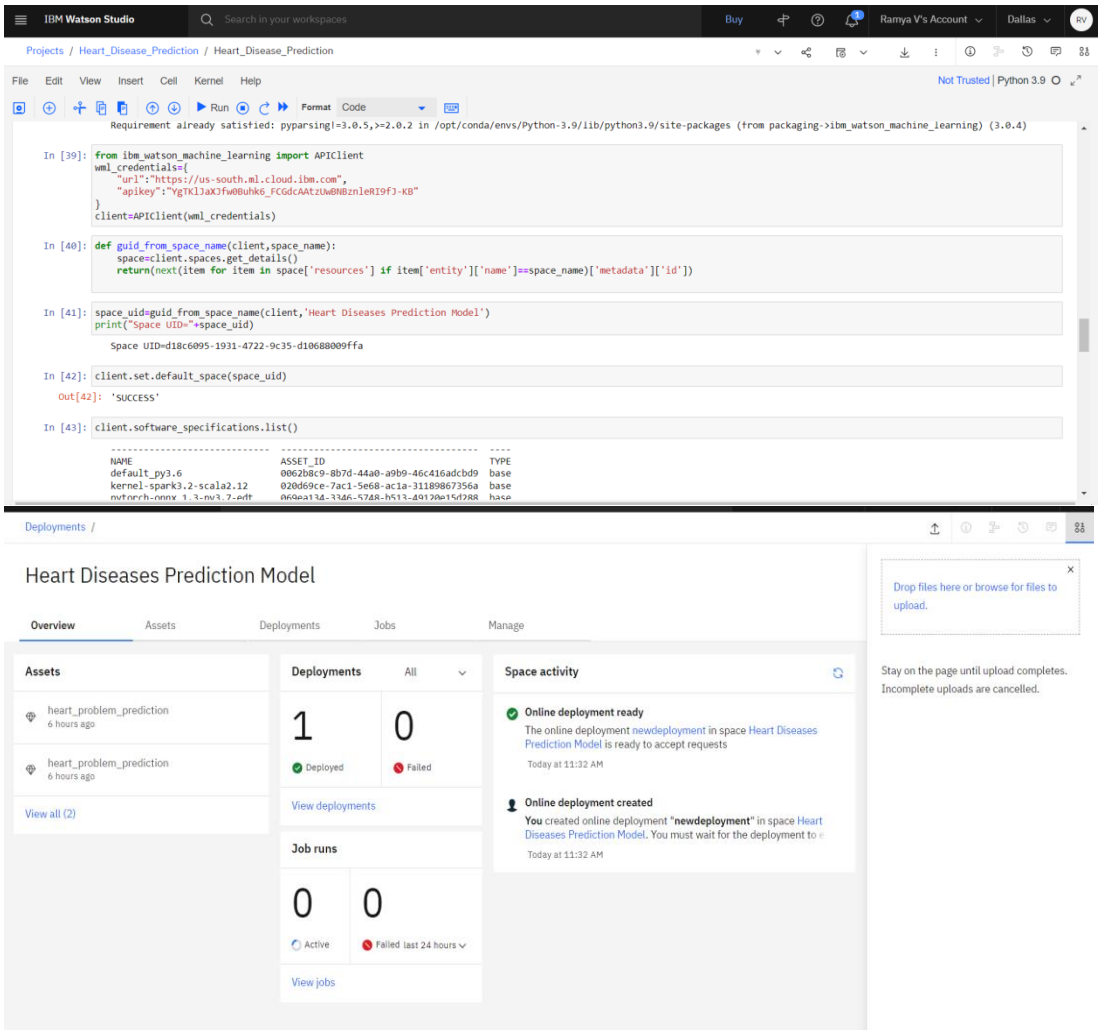
In [43]:
```
client.software_specifications.list()
```

```
------------------------------  ------------------------------------  ----
```

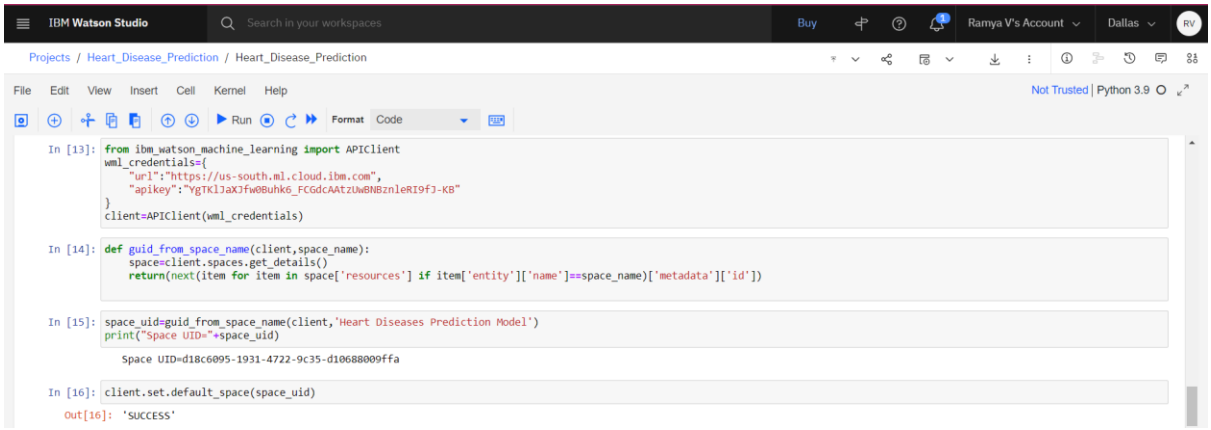
Step 7: Create Deployment Space Where Model will be deployed



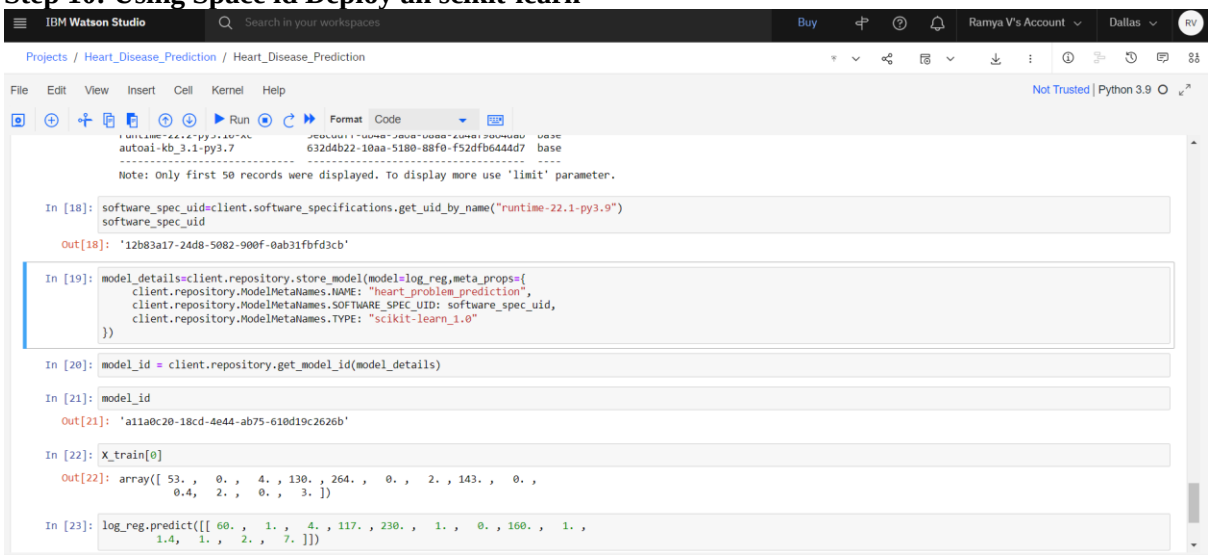
Step 8: Create Deployment Space as Heart Diseases Prediction Model



Step 9: Make the Space id as default one



Step 10: Using Space id Deploy an scikit-learn



Step 11: Test And predict the Model