ShreyaPatil_MLCaseStudy

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1 Heart Disease Prediction Using Machine Learning

Student Name : Shreya Dipak Patil **Course :** Machine Learning using Python **Project Type :** Capstone Project **Objective :** To build a machine learning model that predicts the presence of heart disease in a patient based on clinical features.

1.0.1 Step 1: Import essential libraries

[34]:
```
import numpy as np
import pandas as pd
import matplotlib.pyplot as plt
import seaborn as sns

# ML model tools
from sklearn.model_selection import train_test_split
from sklearn.preprocessing import StandardScaler
from sklearn.metrics import accuracy_score, confusion_matrix,␣
↪classification_report, roc_curve, roc_auc_score
from sklearn.metrics import ConfusionMatrixDisplay

# ML models
from sklearn.linear_model import LogisticRegression
from sklearn.tree import DecisionTreeClassifier
from sklearn.ensemble import RandomForestClassifier
from sklearn.neighbors import KNeighborsClassifier
from sklearn.svm import SVC
```

1.0.2 Step 2: Load the dataset

[33]:
```
df = pd.read_csv("heart.csv")
```

[4]:
```
# show first 5 rows
df.head()
```

[4]:
```
   Age Sex ChestPainType  RestingBP  Cholesterol  FastingBS RestingECG  MaxHR  \
0   40   M           ATA        140          289          0     Normal    172
1   49   F           NAP        160          180          0     Normal    156
2   37   M           ATA        130          283          0         ST     98
```

```
3   48   F           ASY         138          214          0     Normal     108
4   54   M           NAP         150          195          0     Normal     122

  ExerciseAngina  Oldpeak ST_Slope  HeartDisease
0              N      0.0       Up             0
1              N      1.0     Flat             1
2              N      0.0       Up             0
3              Y      1.5     Flat             1
4              N      0.0       Up             0
```

[5]:
```
# Shape of the dataset
print("Dataset shape : ",df.shape)
```

```
Dataset shape :  (918, 12)
```

[6]:
```
# Column info and data types
df.info()
```

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 918 entries, 0 to 917
Data columns (total 12 columns):
 #   Column          Non-Null Count  Dtype
---  ------          --------------  -----
 0   Age             918 non-null    int64
 1   Sex             918 non-null    object
 2   ChestPainType   918 non-null    object
 3   RestingBP       918 non-null    int64
 4   Cholesterol     918 non-null    int64
 5   FastingBS       918 non-null    int64
 6   RestingECG      918 non-null    object
 7   MaxHR           918 non-null    int64
 8   ExerciseAngina  918 non-null    object
 9   Oldpeak         918 non-null    float64
 10  ST_Slope        918 non-null    object
 11  HeartDisease    918 non-null    int64
dtypes: float64(1), int64(6), object(5)
memory usage: 86.2+ KB
```

[7]:
```
# Summary Statistics
df.describe()
```

[7]:

```
              Age   RestingBP  Cholesterol   FastingBS       MaxHR  \
count  918.000000  918.000000   918.000000  918.000000  918.000000
mean    53.510893  132.396514   198.799564    0.233115  136.809368
std      9.432617   18.514154   109.384145    0.423046   25.460334
min     28.000000    0.000000     0.000000    0.000000   60.000000
25%     47.000000  120.000000   173.250000    0.000000  120.000000
50%     54.000000  130.000000   223.000000    0.000000  138.000000
```

```
75%      60.000000  140.000000   267.000000    0.000000  156.000000
max      77.000000  200.000000   603.000000    1.000000  202.000000

           Oldpeak  HeartDisease
count   918.000000    918.000000
mean      0.887364      0.553377
std       1.066570      0.497414
min      -2.600000      0.000000
25%       0.000000      0.000000
50%       0.600000      1.000000
75%       1.500000      1.000000
max       6.200000      1.000000
```

[8]:

```python
# Check for null values
df.isnull().sum()
```

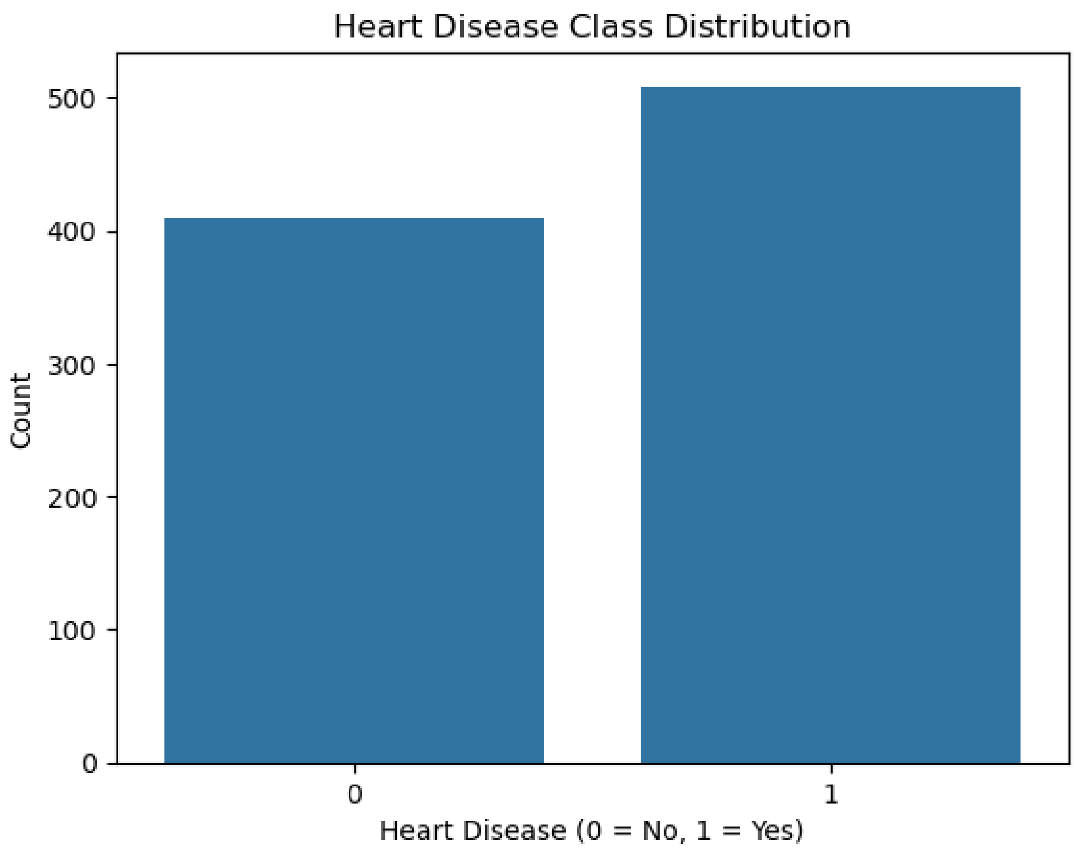
[8]:

```
Age                 0
Sex                 0
ChestPainType       0
RestingBP           0
Cholesterol         0
FastingBS           0
RestingECG          0
MaxHR               0
ExerciseAngina      0
Oldpeak             0
ST_Slope            0
HeartDisease        0
dtype: int64
```

1.0.3 Step 3 : Exploratory Data Analysis (EDA)

[9]:

```python
sns.countplot(x='HeartDisease', data=df)
plt.title("Heart Disease Class Distribution")
plt.xlabel("Heart Disease (0 = No, 1 = Yes)")
plt.ylabel("Count")
plt.show()
```

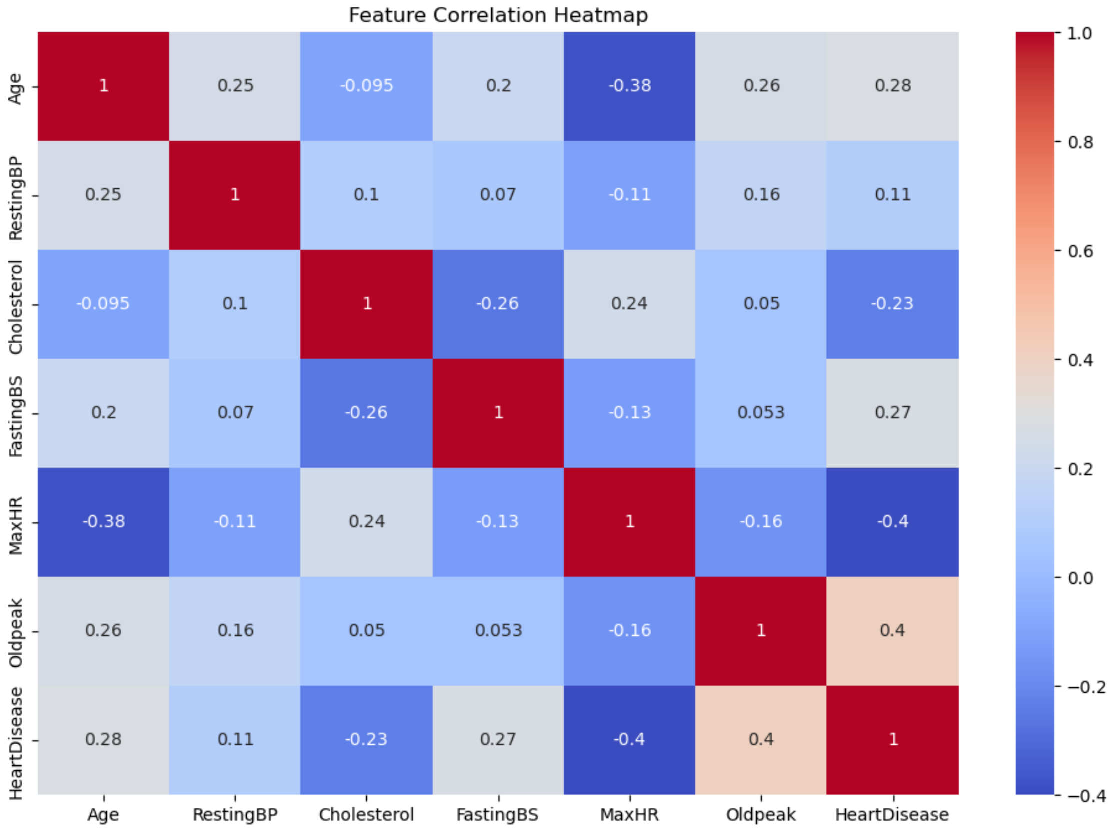


[10]:
```
# Check how many in each class
df['HeartDisease'].value_counts()
```

[10]:
```
HeartDisease
1    508
0    410
Name: count, dtype: int64
```

[13]:
```
# Select only numeric columns
numeric_df = df.select_dtypes(include=['int64', 'float64'])

plt.figure(figsize=(12,8))
sns.heatmap(numeric_df.corr(), annot=True, cmap='coolwarm')
plt.title("Feature Correlation Heatmap")
plt.show()
```



1.0.4 Step 4 : Preprocessing and Feature Engineering

[14]:
```python
# Encode categorical columns using one-hot encoding
df_encoded = pd.get_dummies(df, drop_first=True)
df_encoded.head()
```

[14]:
```
   Age  RestingBP  Cholesterol  FastingBS  MaxHR  Oldpeak  HeartDisease  \
0   40        140          289          0    172      0.0             0
1   49        160          180          0    156      1.0             1
2   37        130          283          0     98      0.0             0
3   48        138          214          0    108      1.5             1
4   54        150          195          0    122      0.0             0

   Sex_M  ChestPainType_ATA  ChestPainType_NAP  ChestPainType_TA  \
0   True               True              False             False
1  False              False               True             False
2   True               True              False             False
3  False              False              False             False
4   True              False               True             False
```

```
   RestingECG_Normal  RestingECG_ST  ExerciseAngina_Y  ST_Slope_Flat  \
0               True          False             False          False
1               True          False             False           True
2              False           True             False          False
3               True          False              True           True
4               True          False             False          False

   ST_Slope_Up
0         True
1        False
2         True
3        False
4         True
```

[15]:
```
# Features and Target
X = df_encoded.drop('HeartDisease', axis=1)
y = df_encoded['HeartDisease']
```

[16]:
```
# Split : 80% train, 20% test
X_train, X_test, y_train, y_test = train_test_split(X, y, test_size=0.2,␣
 ↪random_state=42)
```

[17]:
```
scaler = StandardScaler()
X_train = scaler.fit_transform(X_train)
X_test = scaler.transform(X_test)
```

1.0.5 Step 5 : Model Building and Evaluation

I will train and evaluate multiple classification models: - Logistic Regression - Decision Tree - Random Forest - Support Vector Machine (SVM) - K-Nearest Neighbors (KNN)

[19]:
```
# Logistic Regression

log_model = LogisticRegression()
log_model.fit(X_train, y_train)
y_pred_log = log_model.predict(X_test)

print("Logistic Regression Results : ")
print("Accuracy : ",accuracy_score(y_test, y_pred_log))
print("Classification Report : \n", classification_report(y_test, y_pred_log))
```

```
Logistic Regression Results :
Accuracy :  0.8532608695652174
Classification Report :
               precision    recall  f1-score   support

           0       0.80      0.87      0.83        77
           1       0.90      0.84      0.87       107
```

```
    accuracy                           0.85       184
   macro avg       0.85      0.86      0.85       184
weighted avg       0.86      0.85      0.85       184
```

[21]:

```
# Decision Tree

dt_model = DecisionTreeClassifier()
dt_model.fit(X_train, y_train)
y_pred_dt = dt_model.predict(X_test)

print("Decision Tree Results : ")
print("Accuracy : ",accuracy_score(y_test, y_pred_dt))
print("Classification Report : \n", classification_report(y_test, y_pred_dt))
```

```
Decision Tree Results :
Accuracy :  0.8478260869565217
Classification Report :
               precision    recall  f1-score   support

           0       0.83      0.81      0.82        77
           1       0.86      0.88      0.87       107

    accuracy                           0.85       184
   macro avg       0.84      0.84      0.84       184
weighted avg       0.85      0.85      0.85       184
```

[22]:

```
# Random Forest

rf_model = RandomForestClassifier()
rf_model.fit(X_train, y_train)
y_pred_rf = rf_model.predict(X_test)

print("Random Forest Results : ")
print("Accuracy : ",accuracy_score(y_test, y_pred_rf))
print("Classification Report : \n", classification_report(y_test, y_pred_rf))
```

```
Random Forest Results :
Accuracy :  0.8641304347826086
Classification Report :
               precision    recall  f1-score   support

           0       0.83      0.84      0.84        77
           1       0.89      0.88      0.88       107

    accuracy                           0.86       184
   macro avg       0.86      0.86      0.86       184
```

```
weighted avg       0.86      0.86      0.86       184
```

[23]:
```python
# Support Vector Machine (SVM)

svm_model = SVC()
svm_model.fit(X_train, y_train)
y_pred_svm = svm_model.predict(X_test)

print("SVM Results : ")
print("Accuracy : ",accuracy_score(y_test, y_pred_svm))
print("Classification Report : \n", classification_report(y_test, y_pred_svm))
```

```
SVM Results :
Accuracy :  0.875
Classification Report :
               precision    recall  f1-score   support

           0       0.84      0.87      0.85        77
           1       0.90      0.88      0.89       107

    accuracy                           0.88       184
   macro avg       0.87      0.87      0.87       184
weighted avg       0.88      0.88      0.88       184
```

[24]:
```python
# K-Nearest Neighbors (KNN)

knn_model = KNeighborsClassifier()
knn_model.fit(X_train, y_train)
y_pred_knn = knn_model.predict(X_test)

print("KNN Results : ")
print("Accuracy : ",accuracy_score(y_test, y_pred_knn))
print("Classification Report : \n", classification_report(y_test, y_pred_knn))
```

```
KNN Results :
Accuracy :  0.8532608695652174
Classification Report :
               precision    recall  f1-score   support

           0       0.80      0.87      0.83        77
           1       0.90      0.84      0.87       107

    accuracy                           0.85       184
   macro avg       0.85      0.86      0.85       184
weighted avg       0.86      0.85      0.85       184
```

1.0.6 Step 6: Result Comparison and Visualization

I compare accuracy of all trained models and visualize the confusion matrix of the best-performing one.

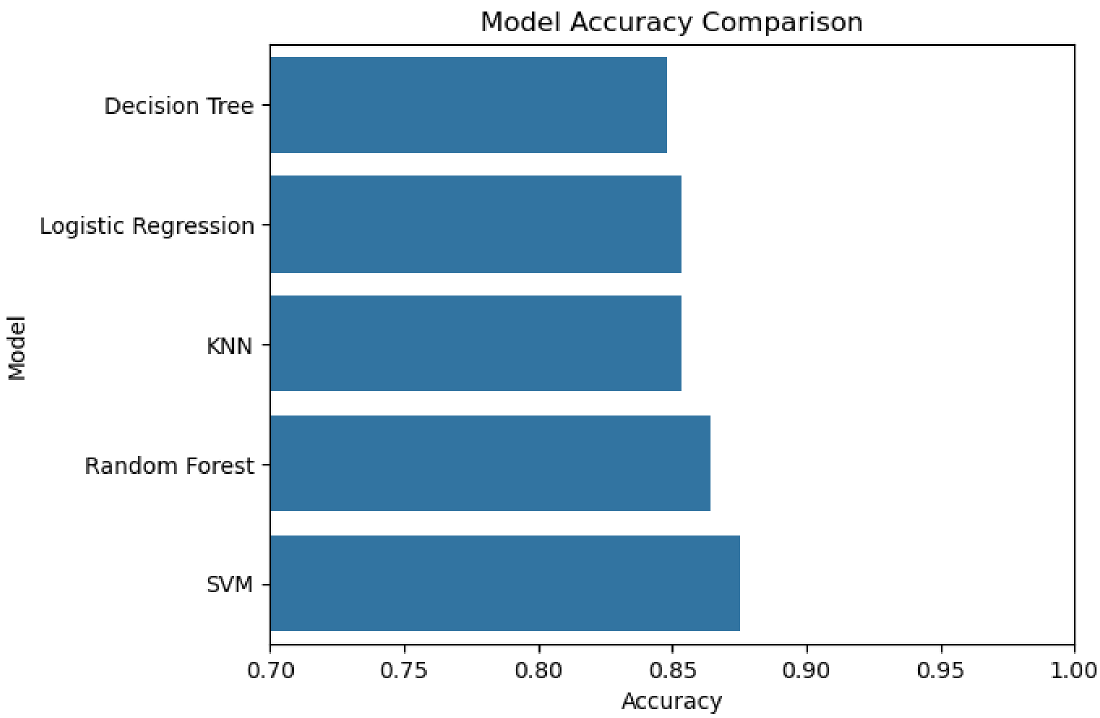
[27]:
```
# Compare Accuracy Scores
model_scores = {
    'Logistic Regression' : accuracy_score(y_test, y_pred_log),
    'Decision Tree' : accuracy_score(y_test, y_pred_dt),
    'Random Forest' : accuracy_score(y_test, y_pred_rf),
    'SVM' : accuracy_score(y_test, y_pred_svm),
    'KNN' : accuracy_score(y_test, y_pred_knn)
}

# Show as DataFrame
import pandas as pd
results_df = pd.DataFrame(model_scores.items(), columns=['Model', 'Accuracy'])
results_df.sort_values(by='Accuracy', ascending=False)
```

[27]:

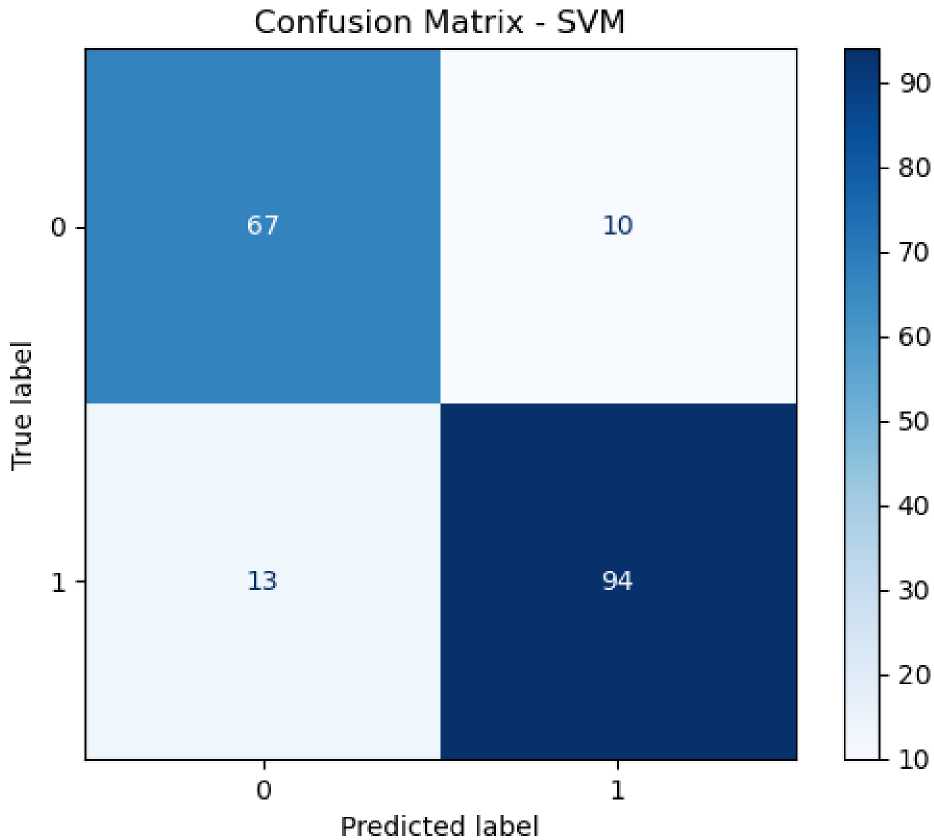
	Model	Accuracy
3	SVM	0.875000
2	Random Forest	0.864130
0	Logistic Regression	0.853261
4	KNN	0.853261
1	Decision Tree	0.847826

[28]:
```
# Plot a Bar Chart
sns.barplot(x='Accuracy', y='Model', data=results_df.sort_values(by='Accuracy',␣
↪ascending=True))
plt.title('Model Accuracy Comparison')
plt.xlim(0.7, 1)
plt.show()
```



[31]:
```python
# Confusion Matrix for the best model

cm = confusion_matrix(y_test, y_pred_svm)
disp = ConfusionMatrixDisplay(confusion_matrix=cm)
disp.plot(cmap='Blues')
plt.title("Confusion Matrix - SVM")
plt.show()
```



Summary of Results

- Among all trained models, **Support Vector Machine (SVM)** gave the highest accuracy.
- **SVM Accuracy:** 87.5%
- The confusion matrix shows that the SVM model correctly classified most positive and negative heart disease cases.
- This makes SVM the best-performing model for this dataset.

1.0.7 Step 7: Conclusion

In this project, I built a machine learning model to predict the presence of heart disease based on patient clinical data. We compared five classification algorithms:

- Logistic Regression
- Decision Tree
- Random Forest
- K-Nearest Neighbors

- Support Vector Machine (SVM)

After evaluating all models, **Support Vector Machine (SVM)** performed best with the highest accuracy.
We visualized the confusion matrix of SVM and confirmed its strength in classifying both heart disease and non-disease cases.

1.0.8 Recommendations:

- More features (like ECG data, lifestyle factors) could improve prediction.
- This model could be deployed in hospitals as a screening tool.