Heart Disease Prediction using Machine Learning Algorithms

Import Libraries

In [ ]:
```
import numpy as np
import pandas as pd
import matplotlib.pyplot as plt
from matplotlib import rcParams
from matplotlib.cm import rainbow
%matplotlib inline
import warnings
warnings.filterwarnings('ignore')

from sklearn.model_selection import train_test_split
from sklearn.preprocessing import StandardScaler
from sklearn.metrics import accuracy_score
from sklearn.metrics import classification_report
from sklearn import *

from sklearn.neighbors import KNeighborsClassifier
from sklearn.svm import SVC
from sklearn.tree import DecisionTreeClassifier
```

Read dataset and preprocess the data

In [ ]:
```
heartData = pd.read_csv("./dataset/heart.csv")
```

In [ ]:
```
heartData.info()
```

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 303 entries, 0 to 302
Data columns (total 14 columns):
 #   Column    Non-Null Count  Dtype  
---  ------    --------------  -----  
 0   age       303 non-null    int64  
 1   sex       303 non-null    int64  
 2   cp        303 non-null    int64  
 3   trestbps  303 non-null    int64  
 4   chol      303 non-null    int64  
 5   fbs       303 non-null    int64  
 6   restecg   303 non-null    int64  
 7   thalach   303 non-null    int64  
 8   exang     303 non-null    int64  
 9   oldpeak   303 non-null    float64
 10  slope     303 non-null    int64  
 11  ca        303 non-null    int64  
 12  thal      303 non-null    int64  
 13  target    303 non-null    int64  
dtypes: float64(1), int64(13)
memory usage: 33.3 KB
```

In [ ]:
```
heartData.describe()
```

Out[ ]:

	age	sex	cp	trestbps	chol	fbs
count	303.000000	303.000000	303.000000	303.000000	303.000000	303.000000
mean	54.366337	0.683168	0.966997	131.623762	246.264026	0.148515
std	9.082101	0.466011	1.032052	17.538143	51.830751	0.356198
min	29.000000	0.000000	0.000000	94.000000	126.000000	0.000000
25%	47.500000	0.000000	0.000000	120.000000	211.000000	0.000000
50%	55.000000	1.000000	1.000000	130.000000	240.000000	0.000000
75%	61.000000	1.000000	2.000000	140.000000	274.500000	0.000000
max	77.000000	1.000000	3.000000	200.000000	564.000000	1.000000

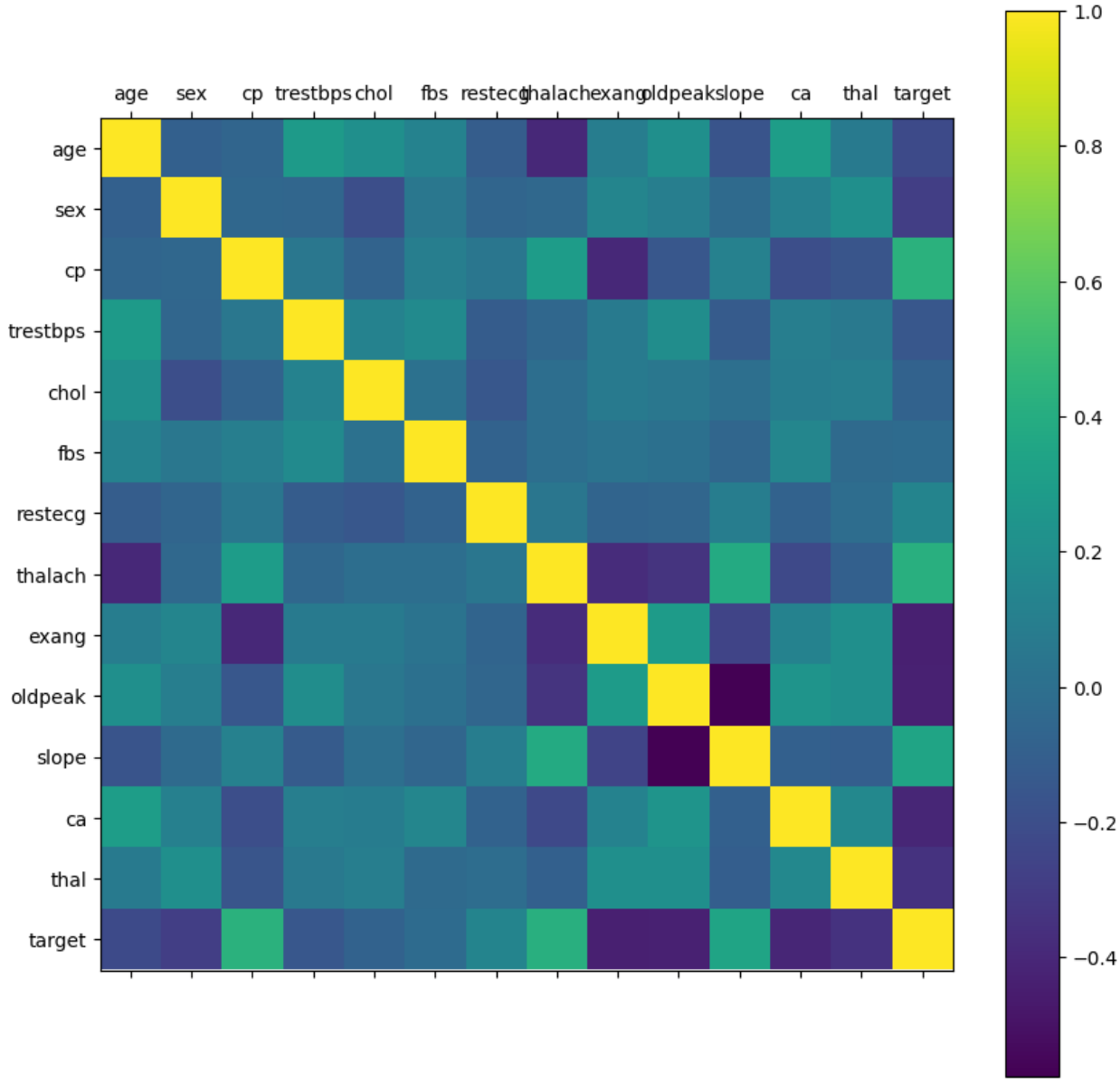
Total missing % of data

In [ ]:
```
missing_data = heartData.isnull().sum()
total_percentage = (missing_data.sum()/heartData.shape[0])*100

print(f"Total percentage of missing data is {round(total_percentage, 2)}%

duplicate = heartData[heartData.duplicated()]
print("Duplicate rows: ")
duplicate

#drop duplicate rows
heartData = heartData.drop_duplicates()
```

```
Total percentage of missing data is 0.0%
Duplicate rows:
```

In [ ]:
```
rcParams['figure.figsize'] = 10, 10

plt.matshow(heartData.corr())
plt.yticks(np.arange(heartData.shape[1]), heartData.columns)
plt.xticks(np.arange(heartData.shape[1]), heartData.columns)
plt.colorbar()
```

Out[ ]:
```
<matplotlib.colorbar.Colorbar at 0x3034f8290>
```



Divide the data into training and testing classes

In [ ]:
```
X = heartData.drop(['target'], axis=1)
y = heartData['target']

X_train, X_test, y_train, y_test  = train_test_split(X, y, test_size = 0.
```

```
print("XTrain: ",X_train.shape[0],"XTest: ",X_test.shape[0])
print("Ytrain: ",y_train.shape[0],"Ytest: ",y_test.shape[0])
```

```
XTrain:  211 XTest:  91
Ytrain:  211 Ytest:  91
```

Model Building

KNN Algorithm

In [ ]:
```
knn_scores = []

for k in range(2, 21):
    knn_classifier = KNeighborsClassifier(n_neighbors = k)
    knn_classifier.fit(X_train.values, y_train.values)
    knn_score = round(knn_classifier.score(X_test.values, y_test.values),
    knn_scores.append(knn_score)


knn_classifier = KNeighborsClassifier(n_neighbors=5)
knn_classifier.fit(X_train, y_train)
knn_score = knn_classifier.predict(X_test)
print(classification_report(y_test, knn_score))
```

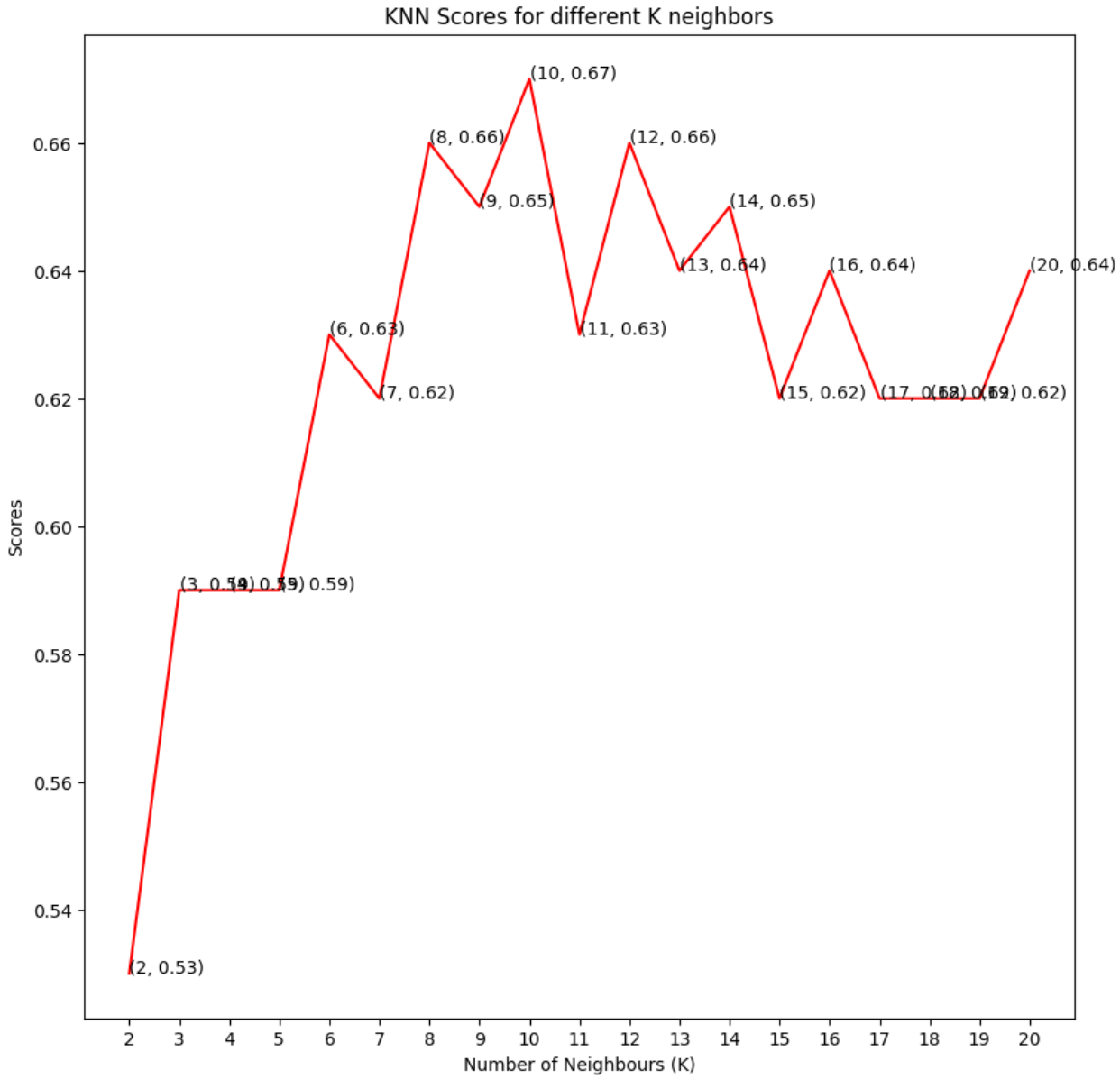
```
              precision    recall  f1-score   support

           0       0.61      0.49      0.54        45
           1       0.58      0.70      0.63        46

    accuracy                           0.59        91
   macro avg       0.60      0.59      0.59        91
weighted avg       0.60      0.59      0.59        91
```

In [ ]:
```
score_knn = round(accuracy_score(knn_score, y_test)*100,2)
print(f"The accuracy score achieved using KNN is {score_knn}")
```

```
The accuracy score achieved using KNN is 59.34
```

In [ ]:
```
plt.plot([k for k in range(2, 21)], knn_scores, color='red')

for i in range(2,21):
    plt.text(i, knn_scores[i-2], (i, knn_scores[i-2]))

plt.xticks([i for i in range(2,21)])
plt.xlabel("Number of Neighbours (K)")
plt.ylabel('Scores')
plt.title('KNN Scores for different K neighbors')
```

Out[ ]:
```
Text(0.5, 1.0, 'KNN Scores for different K neighbors')
```



Support Vector Machine

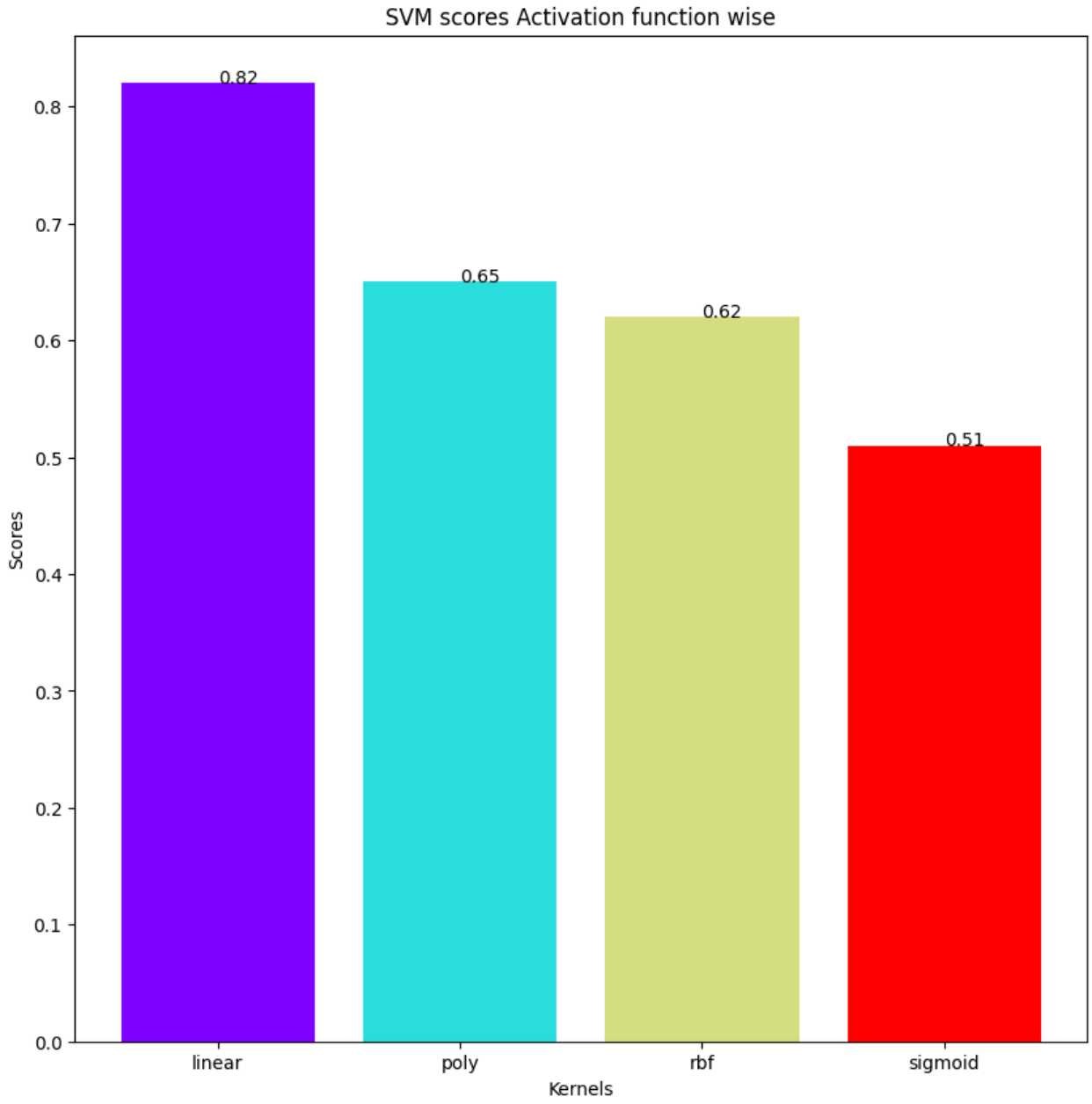
In [ ]:
```
from sklearn.metrics import accuracy_score

svc_scores = []
kernels = ['linear', 'poly', 'rbf', 'sigmoid']

for i in range(len(kernels)):
    svc_classifier = SVC(kernel=kernels[i])
    svc_classifier.fit(X_train.values, y_train.values)
    svc_scores.append(round(svc_classifier.score(X_test.values, y_test.va

svc_classifier = SVC(kernel = kernels[0])
svc_classifier.fit(X_train.values, y_train.values)
svc_prediction_result = svc_classifier.predict(X_test.values)

# print(svc_prediction_result)
```

```
print("Accuracy Score: ", accuracy_score(y_test.values, svc_prediction_re
```

```
Accuracy Score:  0.8241758241758241
```

In [ ]:
```
colors = rainbow(np.linspace(0, 1, len(kernels)))

plt.bar(kernels, svc_scores, color=colors)

for i in range(len(kernels)):
    plt.text(i, svc_scores[i], svc_scores[i])
plt.xlabel('Kernels')
plt.ylabel('Scores')
plt.title('SVM scores Activation function wise')
```

Out[ ]:
```
Text(0.5, 1.0, 'SVM scores Activation function wise')
```



In [ ]:
```
score_svm = round(accuracy_score(svc_prediction_result,y_test)*100,2)
print(f"The accuracy score achieved using Linear SVM is {score_svm}")
```

```
The accuracy score achieved using Linear SVM is 82.42
```

Decision Tree

In [ ]:
```
dt_scores = []

for i in range(1, len(X.columns)+1):
    dt_classifier = DecisionTreeClassifier(max_features = i, random_state
    dt_classifier.fit(X_train.values, y_train.values)
    dt_scores.append(round(dt_classifier.score(X_test.values, y_test.valu

print("Dt_scores: ", dt_scores)
```

```
Dt_scores:  [0.67, 0.7, 0.79, 0.78, 0.79, 0.76, 0.76, 0.84, 0.73, 0.77, 0.
76, 0.73, 0.74]
```

In [ ]:
```
score_dt = round(max(dt_scores)*100, 2)
print(f"The accuracy score achieved using Decision Tree is {score_dt}%")
```

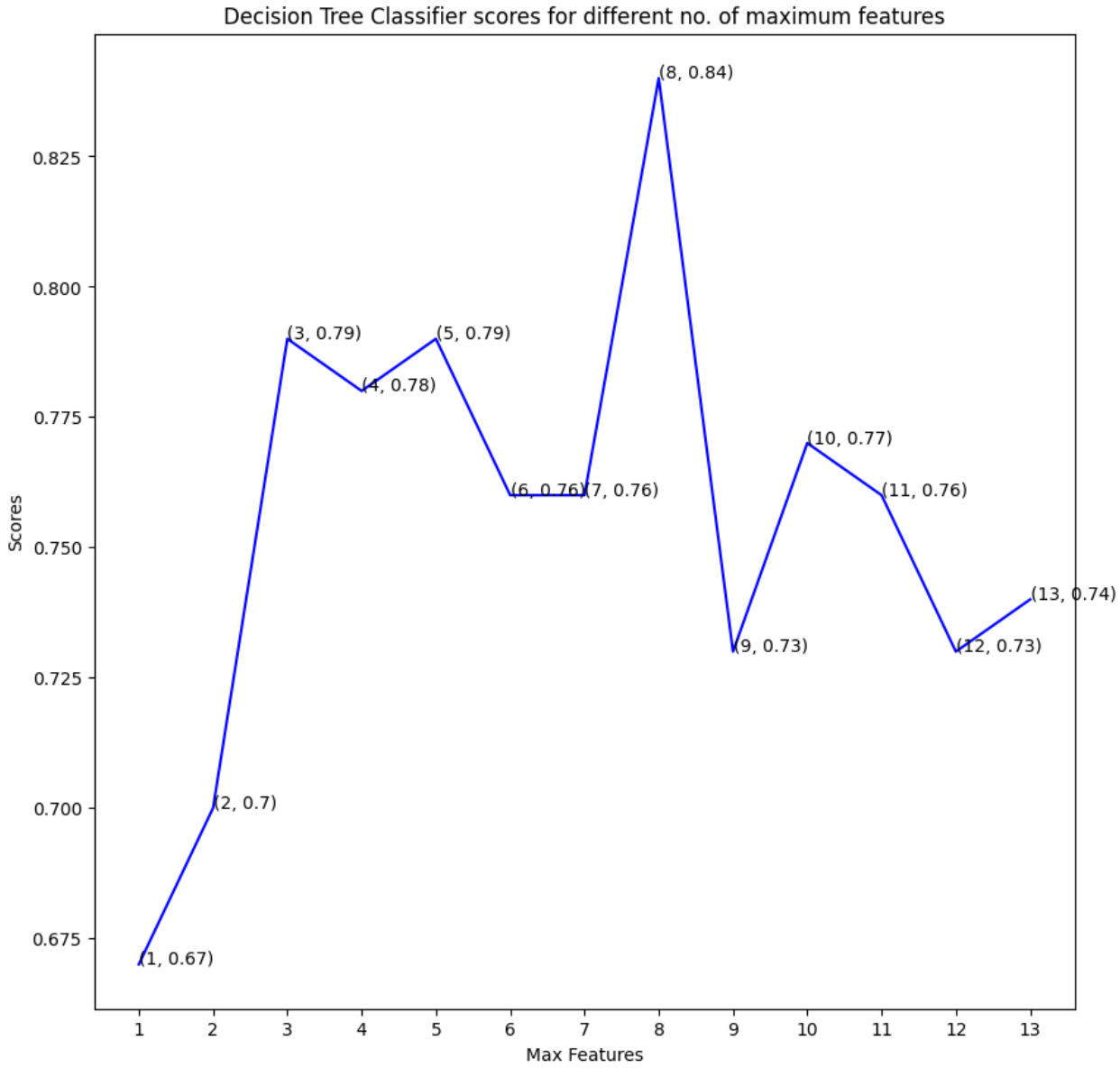
```
The accuracy score achieved using Decision Tree is 84.0%
```

In [ ]:
```
dt_classifier = DecisionTreeClassifier(max_features=13, random_state=0)
dt_classifier.fit(X_train.values, y_train.values)
```

Out[ ]:
```
DecisionTreeClassifier(max_features=13, random_state=0)
```

In [ ]:
```
plt.plot([i for i in range(1, len(X.columns)+1)], dt_scores, color='blue'

for i in range(1, len(X.columns)+1):
    plt.text(i, dt_scores[i-1], (i, dt_scores[i-1]))

plt.xticks([i for i in range(1, len(X.columns)+1)])
plt.xlabel('Max Features')
plt.ylabel('Scores')
plt.title('Decision Tree Classifier scores for different no. of maximum f
```

Out[ ]:
```
Text(0.5, 1.0, 'Decision Tree Classifier scores for different no. of max
imum features')
```



Random Forest

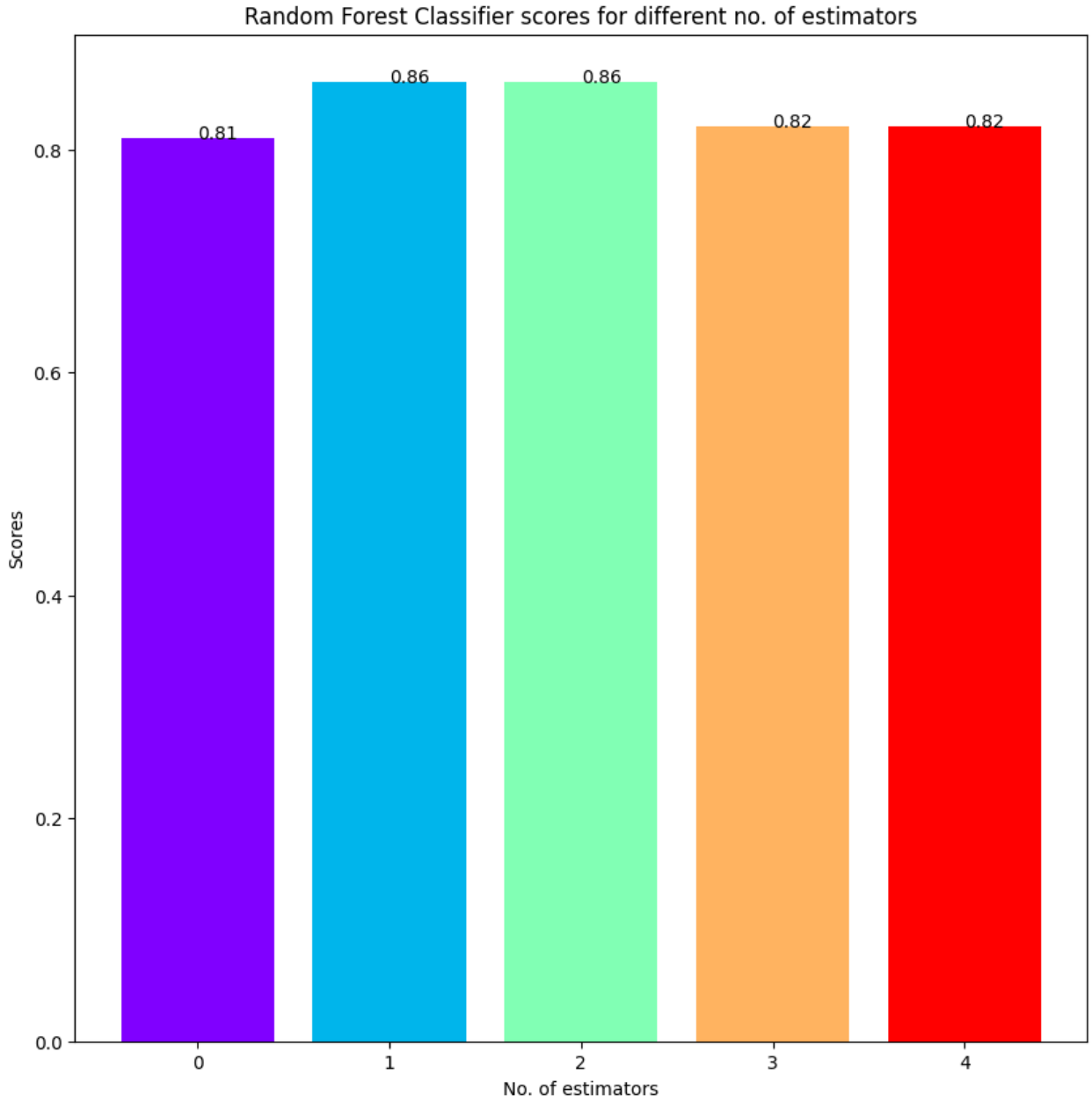
In [ ]:
```
from sklearn.ensemble import RandomForestClassifier
```

In [ ]:
```
rf_scores = []

estimators = [10, 20, 100, 200, 500]

for i in estimators:
    rf_classifier = RandomForestClassifier(n_estimators = i, random_state
    rf_classifier.fit(X_train.values, y_train.values)
    rf_scores.append(round(rf_classifier.score(X_test.values, y_test.valu
```

In [ ]:
```
colors = rainbow(np.linspace(0, 1, len(estimators)))

plt.bar([i for i in range(len(estimators))], rf_scores, color = colors, w

for i in range(len(estimators)):
```

```
    plt.text(i, rf_scores[i], rf_scores[i])

plt.xlabel('No. of estimators')
plt.ylabel('Scores')
plt.title('Random Forest Classifier scores for different no. of estimator
```

Out[ ]:
```
Text(0.5, 1.0, 'Random Forest Classifier scores for different no. of est
imators')
```



In [ ]:
```
score_rf = round(max(rf_scores)*100,2)
print(f"The accuracy score achieved using Random Forest is {score_rf}")
```

```
The accuracy score achieved using Random Forest is 86.0
```

Logistic Regression

In [ ]:
```
from sklearn.linear_model import LogisticRegression
```

In [ ]:
```
logistic_model = LogisticRegression()
logistic_model.fit(X_train.values, y_train.values)
logistic_model_prediction = logistic_model.predict(X_test.values)

print("Accuracy score: ", accuracy_score(y_test.values, logistic_model_pr
print(classification_report(y_test.values, logistic_model_prediction))
```

```
Accuracy score:  0.8131868131868132
              precision    recall  f1-score   support

           0       0.87      0.73      0.80        45
           1       0.77      0.89      0.83        46

    accuracy                           0.81        91
   macro avg       0.82      0.81      0.81        91
weighted avg       0.82      0.81      0.81        91
```

In [ ]:
```
score_lr = round(accuracy_score(logistic_model_prediction, y_test)*100,2)
print(f"The accuracy scored achieved using Logistic Regression is {score_
```

```
The accuracy scored achieved using Logistic Regression is 81.32
```

Naive Bayes

In [ ]:
```
from sklearn.naive_bayes import GaussianNB
```

In [ ]:
```
nb = GaussianNB()
nb.fit(X_train, y_train)

Y_pred_nb = nb.predict(X_test)
```

In [ ]:
```
score_nb = round(accuracy_score(Y_pred_nb, y_test)*100,2)
print(f"The accuracy score achieved using naive bayes is: {score_nb}%")
```

```
The accuracy score achieved using naive bayes is: 82.42%
```

Output Final Score

In [ ]:
```
scores = [score_lr, score_svm, score_knn, score_dt, score_rf, score_nb]
algorithms = ["Logistic Regression", "Support Vector Machine", "K-Nearest

for i in range(len(algorithms)):
    print(f"{algorithms[i]} Accuracy: {scores[i]}%")
```

```
Logistic Regression Accuracy: 81.32%
Support Vector Machine Accuracy: 82.42%
K-Nearest Neighbors Accuracy: 59.34%
Decision Tree Accuracy: 84.0%
Random Forest Accuracy: 86.0%
Naive Bayes Accuracy: 82.42%
```

Save Trained Models

In [ ]:
```
import pickle
```

Saving the logistic regression model

In [ ]:
```
pickle.dump(logistic_model, open('logistic_regression.model', 'wb'))
```

Saving the SVM Model

In [ ]:
```
pickle.dump(svc_classifier, open('svm.model', 'wb'))
```

Saving Decision Tree Classifier

In [ ]:
```
pickle.dump(dt_classifier, open('dt.model', 'wb'))
```

Saving Naive Bayes Classifier

In [ ]:
```
pickle.dump(nb, open('naive_bayes.model', 'wb'))
```

Saving the KNN Model

In [ ]:
```
pickle.dump(knn_classifier, open('knn.model', 'wb'))
```