# Wine Quality Prediction

In [1]:
```
# Libraries
import pandas as pd
import seaborn as sns
import matplotlib.pyplot as plt
from sklearn.preprocessing import StandardScaler
from sklearn.model_selection import train_test_split
from sklearn.linear_model import LogisticRegression
from sklearn.metrics import accuracy_score,classification_report
from sklearn.ensemble import RandomForestClassifier
from sklearn.tree import DecisionTreeClassifier
from sklearn.ensemble import AdaBoostClassifier
from sklearn.metrics import f1_score, roc_curve, auc
```

In [2]:
```
# Dataset
wine = pd.read_csv(r'C:\Users\Tanmayee\OneDrive\Documents\Personal\Oth
wine
```

Out[2]:

| | fixed acidity | volatile acidity | citric acid | residual sugar | chlorides | free sulfur dioxide | total sulfur dioxide | density | pH | sulphates |
|---|---|---|---|---|---|---|---|---|---|---|
| **0** | 7.4 | 0.700 | 0.00 | 1.9 | 0.076 | 11.0 | 34.0 | 0.99780 | 3.51 | 0.56 |
| **1** | 7.8 | 0.880 | 0.00 | 2.6 | 0.098 | 25.0 | 67.0 | 0.99680 | 3.20 | 0.68 |
| **2** | 7.8 | 0.760 | 0.04 | 2.3 | 0.092 | 15.0 | 54.0 | 0.99700 | 3.26 | 0.65 |
| **3** | 11.2 | 0.280 | 0.56 | 1.9 | 0.075 | 17.0 | 60.0 | 0.99800 | 3.16 | 0.58 |
| **4** | 7.4 | 0.700 | 0.00 | 1.9 | 0.076 | 11.0 | 34.0 | 0.99780 | 3.51 | 0.56 |
| **...** | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... |
| **1594** | 6.2 | 0.600 | 0.08 | 2.0 | 0.090 | 32.0 | 44.0 | 0.99490 | 3.45 | 0.58 |
| **1595** | 5.9 | 0.550 | 0.10 | 2.2 | 0.062 | 39.0 | 51.0 | 0.99512 | 3.52 | 0.76 |
| **1596** | 6.3 | 0.510 | 0.13 | 2.3 | 0.076 | 29.0 | 40.0 | 0.99574 | 3.42 | 0.75 |
| **1597** | 5.9 | 0.645 | 0.12 | 2.0 | 0.075 | 32.0 | 44.0 | 0.99547 | 3.57 | 0.71 |
| **1598** | 6.0 | 0.310 | 0.47 | 3.6 | 0.067 | 18.0 | 42.0 | 0.99549 | 3.39 | 0.66 |

1599 rows × 12 columns

In [3]:
```
# Information about dataset
wine.info()
```

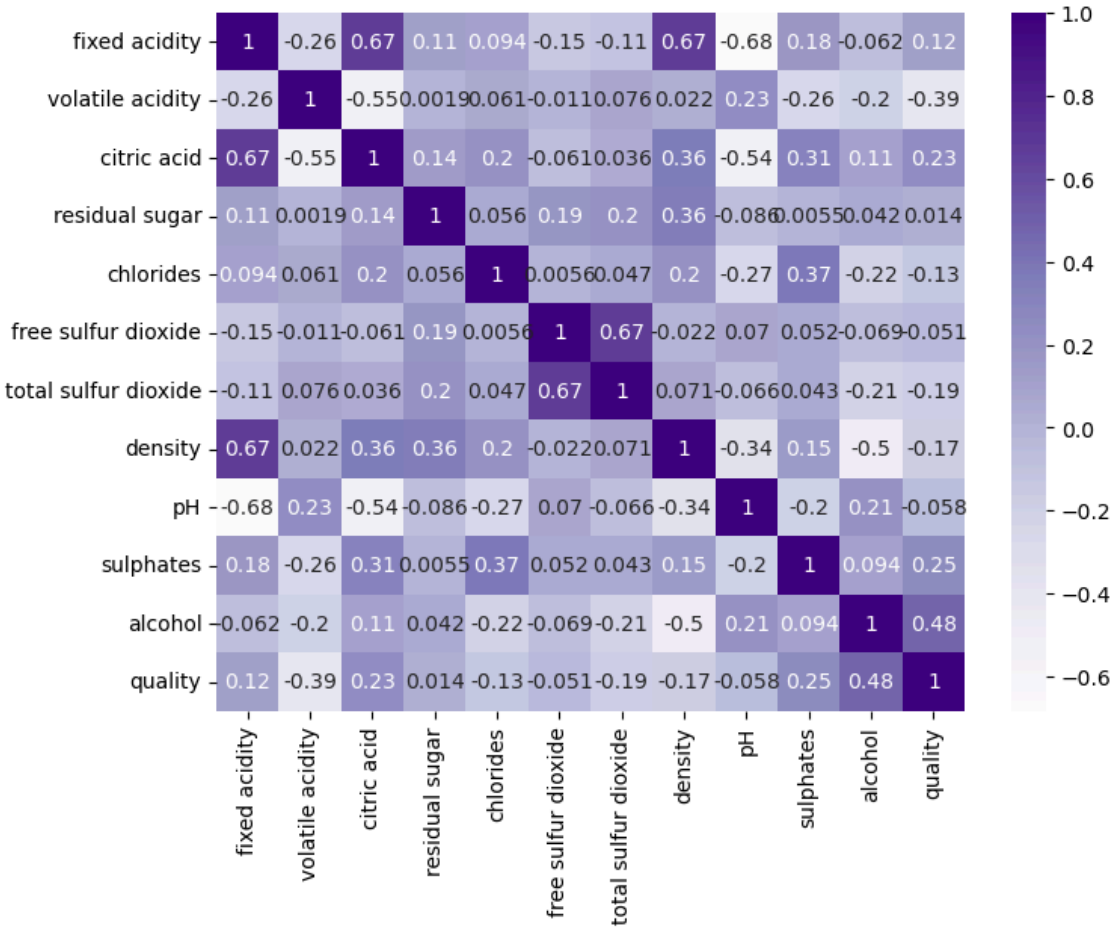
```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 1599 entries, 0 to 1598
Data columns (total 12 columns):
 #   Column                Non-Null Count  Dtype  
---  ------                --------------  -----  
 0   fixed acidity         1599 non-null   float64
 1   volatile acidity      1599 non-null   float64
 2   citric acid           1599 non-null   float64
 3   residual sugar        1599 non-null   float64
 4   chlorides             1599 non-null   float64
 5   free sulfur dioxide   1599 non-null   float64
 6   total sulfur dioxide  1599 non-null   float64
 7   density               1599 non-null   float64
 8   pH                    1599 non-null   float64
 9   sulphates             1599 non-null   float64
 10  alcohol               1599 non-null   float64
 11  quality               1599 non-null   int64  
dtypes: float64(11), int64(1)
memory usage: 150.0 KB
```

In [4]:
```
# Counting the different qualities of wines
wine['quality'].value_counts()
```

Out[4]:
```
5    681
6    638
7    199
4     53
8     18
3     10
Name: quality, dtype: int64
```

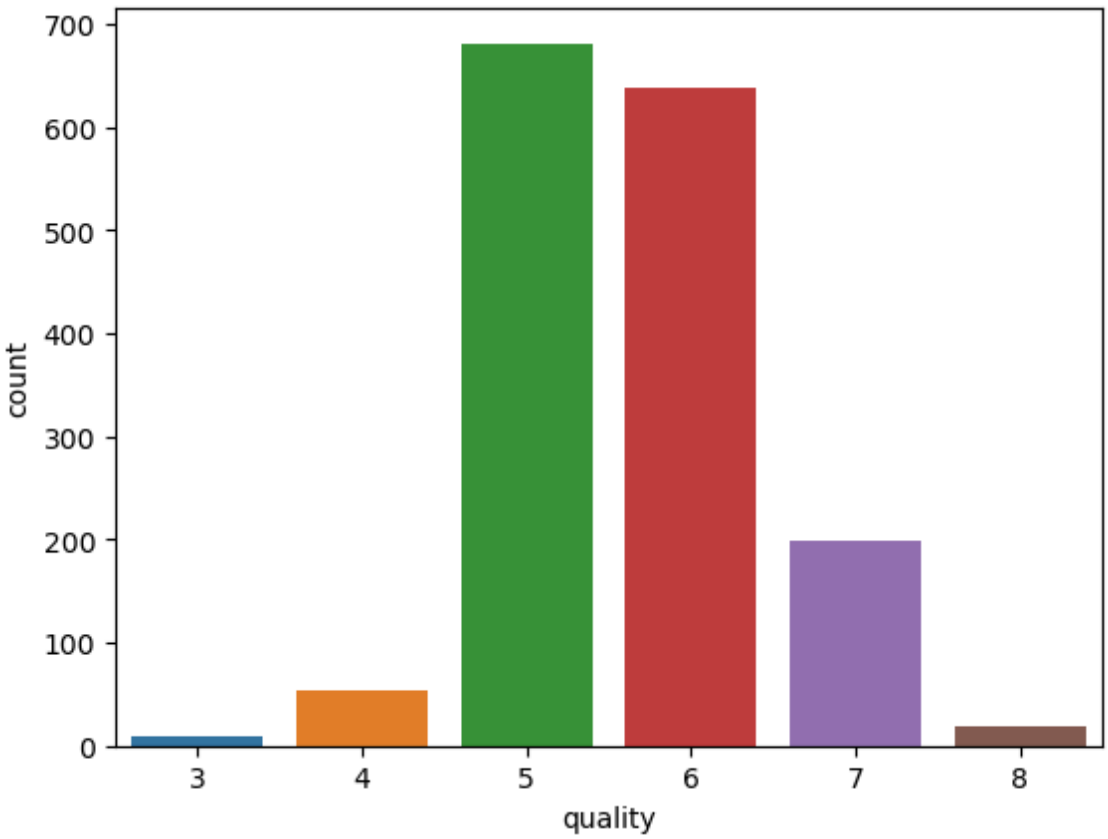
In [5]:
```
# Creating the heatmap for datset
plt.figure(figsize=(8,6))
sns.heatmap(data=wine.corr(),cmap='Purples',annot=True)
```

Out[5]: <AxesSubplot:>



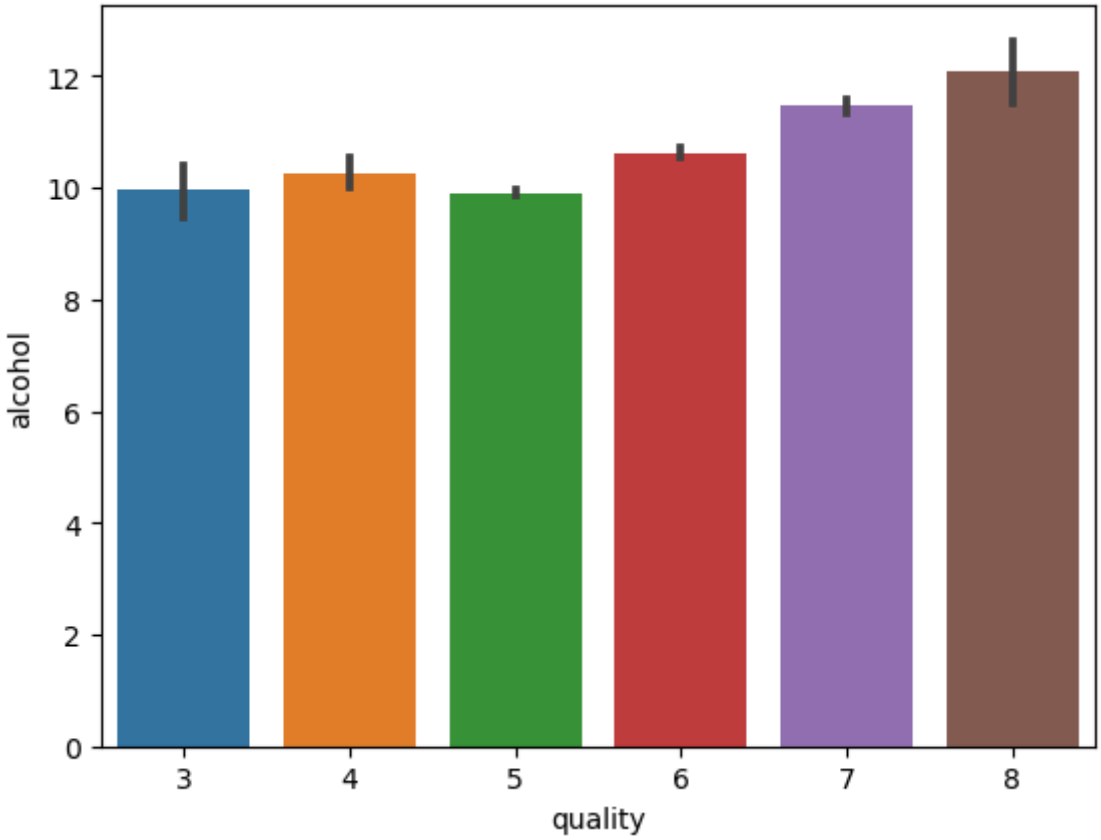
In [6]:
```
# The available qualities of the wines are plotted using the seaborn l
sns.countplot(x='quality',data=wine)
```

Out[6]: <AxesSubplot:xlabel='quality', ylabel='count'>



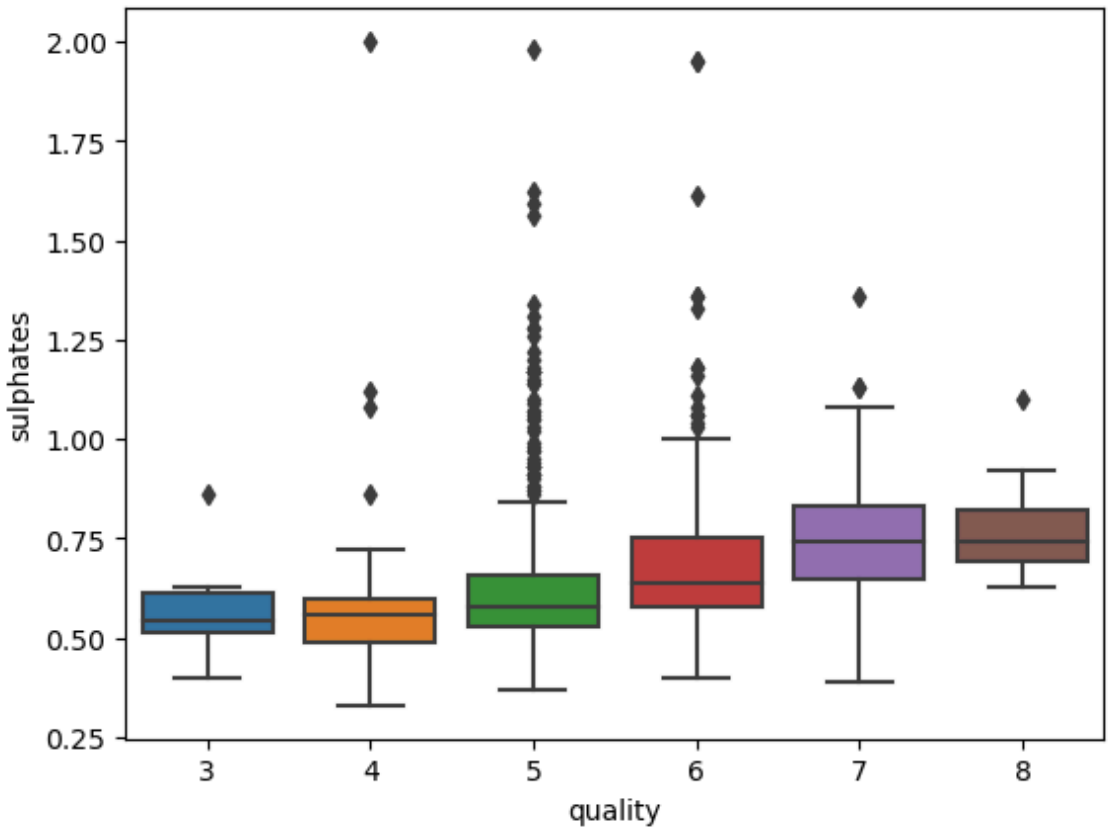
In [7]:
```
# X axis represents the quality of wine and y represents the % of aloc
sns.barplot(data=wine,y='alcohol',x='quality')
```

Out[7]: <AxesSubplot:xlabel='quality', ylabel='alcohol'>



In [8]:
```
# Quality of wine and contents of sulphur in it are displayed
sns.boxplot(data=wine,y='sulphates',x='quality')
```

Out[8]: <AxesSubplot:xlabel='quality', ylabel='sulphates'>




In [9]:
```
# Dropping the two columns quality and volatile acidity to divide the
w_x=wine.drop(columns=['quality','volatile acidity'],axis=1)
w_x
```

Out[9]:

| | fixed acidity | citric acid | residual sugar | chlorides | free sulfur dioxide | total sulfur dioxide | density | pH | sulphates | alcohol |
|---|---|---|---|---|---|---|---|---|---|---|
| **0** | 7.4 | 0.00 | 1.9 | 0.076 | 11.0 | 34.0 | 0.99780 | 3.51 | 0.56 | 9.4 |
| **1** | 7.8 | 0.00 | 2.6 | 0.098 | 25.0 | 67.0 | 0.99680 | 3.20 | 0.68 | 9.8 |
| **2** | 7.8 | 0.04 | 2.3 | 0.092 | 15.0 | 54.0 | 0.99700 | 3.26 | 0.65 | 9.8 |
| **3** | 11.2 | 0.56 | 1.9 | 0.075 | 17.0 | 60.0 | 0.99800 | 3.16 | 0.58 | 9.8 |
| **4** | 7.4 | 0.00 | 1.9 | 0.076 | 11.0 | 34.0 | 0.99780 | 3.51 | 0.56 | 9.4 |
| **...** | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... |
| **1594** | 6.2 | 0.08 | 2.0 | 0.090 | 32.0 | 44.0 | 0.99490 | 3.45 | 0.58 | 10.5 |
| **1595** | 5.9 | 0.10 | 2.2 | 0.062 | 39.0 | 51.0 | 0.99512 | 3.52 | 0.76 | 11.2 |
| **1596** | 6.3 | 0.13 | 2.3 | 0.076 | 29.0 | 40.0 | 0.99574 | 3.42 | 0.75 | 11.0 |
| **1597** | 5.9 | 0.12 | 2.0 | 0.075 | 32.0 | 44.0 | 0.99547 | 3.57 | 0.71 | 10.2 |
| **1598** | 6.0 | 0.47 | 3.6 | 0.067 | 18.0 | 42.0 | 0.99549 | 3.39 | 0.66 | 11.0 |

1599 rows × 10 columns

In [10]:
```
# Pre-processing function to standardize the given data
ss=StandardScaler()
```

In [11]:
```
# below code fits the StandardScaler() object to the data w_x and then
w_x=ss.fit_transform(w_x)
w_x
```

Out[11]:
```
array([[-0.52835961, -1.39147228, -0.45321841, ...,  1.28864292,
        -0.57920652, -0.96024611],
       [-0.29854743, -1.39147228,  0.04341614, ..., -0.7199333 ,
         0.1289504 , -0.58477711],
       [-0.29854743, -1.18607043, -0.16942723, ..., -0.33117661,
        -0.04808883, -0.58477711],
       ...,
       [-1.1603431 , -0.72391627, -0.16942723, ...,  0.70550789,
         0.54204194,  0.54162988],
       [-1.39015528, -0.77526673, -0.38227061, ...,  1.6773996 ,
         0.30598963, -0.20930812],
       [-1.33270223,  1.02199944,  0.75289408, ...,  0.51112954,
         0.01092425,  0.54162988]])
```

In [12]:
```
# Creating a new variable to store the quality of wine
w_y=wine['quality'].apply(lambda w_y:1 if w_y>=7 else 0)
w_y
```

Out[12]:
```
0       0
1       0
2       0
3       0
4       0
       ..
1594    0
1595    0
1596    0
1597    0
1598    0
Name: quality, Length: 1599, dtype: int64
```

In [13]:
```
# Train and Test
wx_train,wx_test,wy_train,wy_test=train_test_split(w_x,w_y,test_size=0
```

## Logistic Regression Algorithm

In [14]:
```
# Logistic Regression
lr=LogisticRegression()

# Making the model of Logistic Regression Ready
model1=lr.fit(wx_train,wy_train)

# Predicting the quality of wine
wy1_pred=lr.predict(wx_test)

# Finding the accuracy of trained model
acc1 = accuracy_score(wy_test,wy1_pred)
print("Accuracy Score of Logistic Regression",acc1)
```

```
Accuracy Score of Logistic Regression 0.89375
```

## Finding the F1 score for Logistic Regression Model

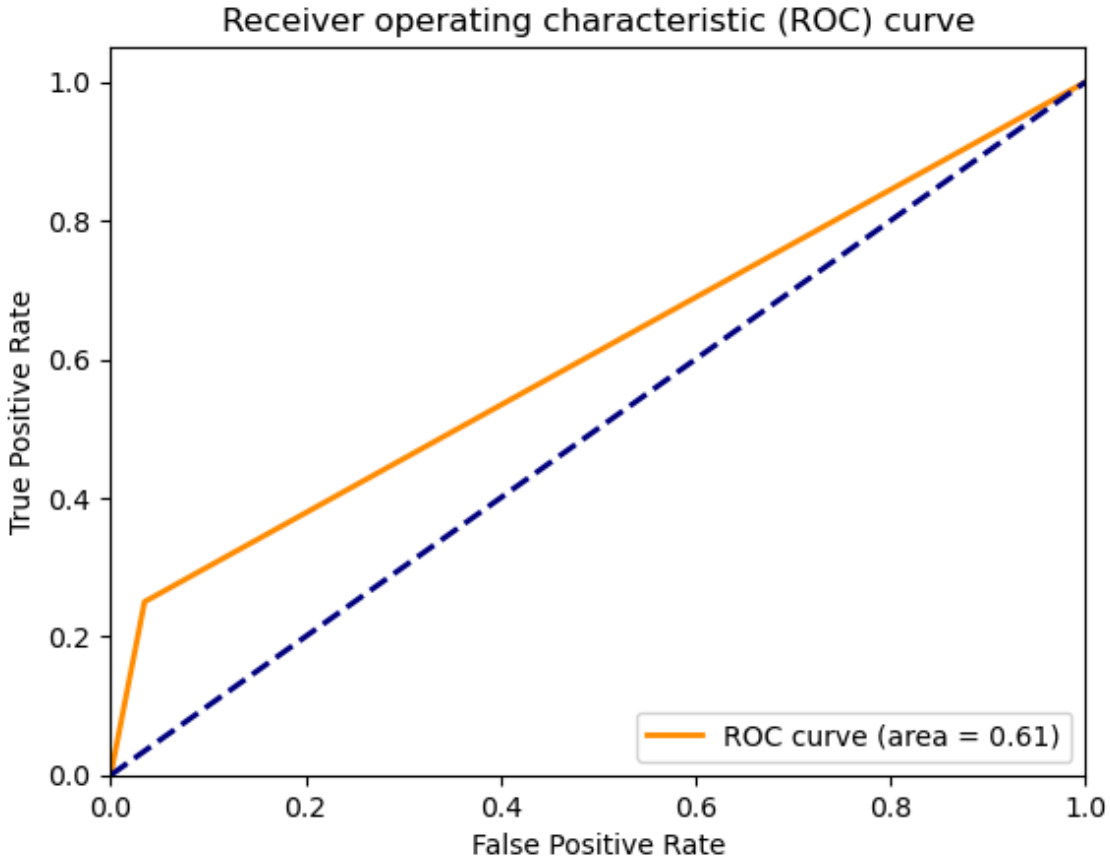
In [15]:
```
f1_lr = f1_score(wy_test, wy1_pred)
print("F1 score:", f1_lr)
```

```
F1 score: 0.32
```

## ROC for Logistic Regression Model

In [16]:

```
f1, t1, thresholds = roc_curve(wy_test, wy1_pred)
roc_auc1 = auc(f1, t1)

plt.figure()
plt.plot(f1, t1, color='darkorange', lw=2, label='ROC curve (area = %0
plt.plot([0, 1], [0, 1], color='navy', lw=2, linestyle='--')
plt.xlim([0.0, 1.0])
plt.ylim([0.0, 1.05])
plt.xlabel('False Positive Rate')
plt.ylabel('True Positive Rate')
plt.title('Receiver operating characteristic (ROC) curve')
plt.legend(loc="lower right")
plt.show()
```



## AdaBoost Classifier

In [17]:
```
# Training the model
abc=AdaBoostClassifier()

# Fitting the chosen model on given data
abc.fit(wx_train,wy_train)

# Predicting the quality using AdaBoost Classifier
wy2_pred=abc.predict(wx_test)

# Accuracy Score
acc2 = accuracy_score(wy_test,wy2_pred)
print("Accuracy of AdaBoost Classifier",acc2)
```

```
Accuracy of AdaBoost Classifier 0.86875
```

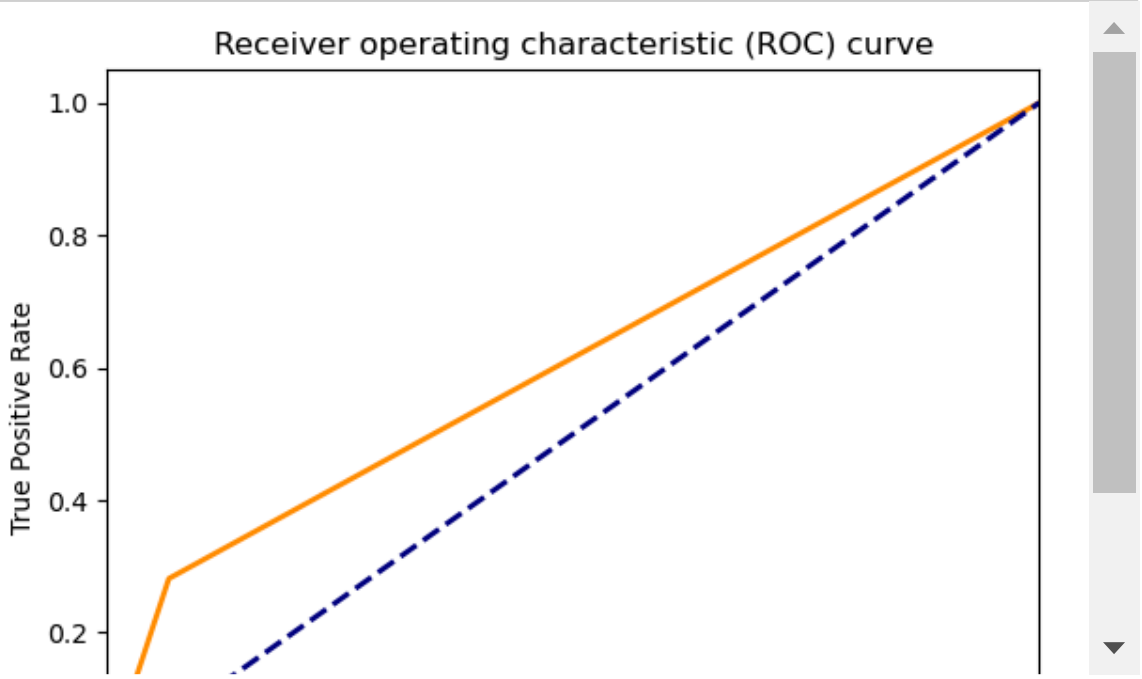
## F1 Score of AdaBoost

In [18]:
```
f1_abc = f1_score(wy_test, wy2_pred)
print("F1 score:", f1_abc)
```

```
F1 score: 0.30000000000000004
```

## Roc Curve of AdaBoost

In [19]:
```
f2, t2, thresholds = roc_curve(wy_test, wy2_pred)
roc_auc2 = auc(f2, t2)

plt.figure()
plt.plot(f2, t2, color='darkorange', lw=2, label='ROC curve (area = %0
plt.plot([0, 1], [0, 1], color='navy', lw=2, linestyle='--')
plt.xlim([0.0, 1.0])
plt.ylim([0.0, 1.05])
plt.xlabel('False Positive Rate')
plt.ylabel('True Positive Rate')
plt.title('Receiver operating characteristic (ROC) curve')
plt.legend(loc="lower right")
plt.show()
```




## Random Forest Classifier

In [20]:
```
# Training the Random Forest Classifier Model
rf=RandomForestClassifier(max_depth=10,criterion='entropy',n_estimator

# Fitting the model
model3=rf.fit(wx_train,wy_train)

# Predicting the values using Random Forest Classifier
wy3_pred=rf.predict(wx_test)

# Finding the accuracy
acc3 = accuracy_score(wy3_pred,wy_test)
print("Accuracy of Random Forest", acc3)
```

```
Accuracy of Random Forest 0.915625
```

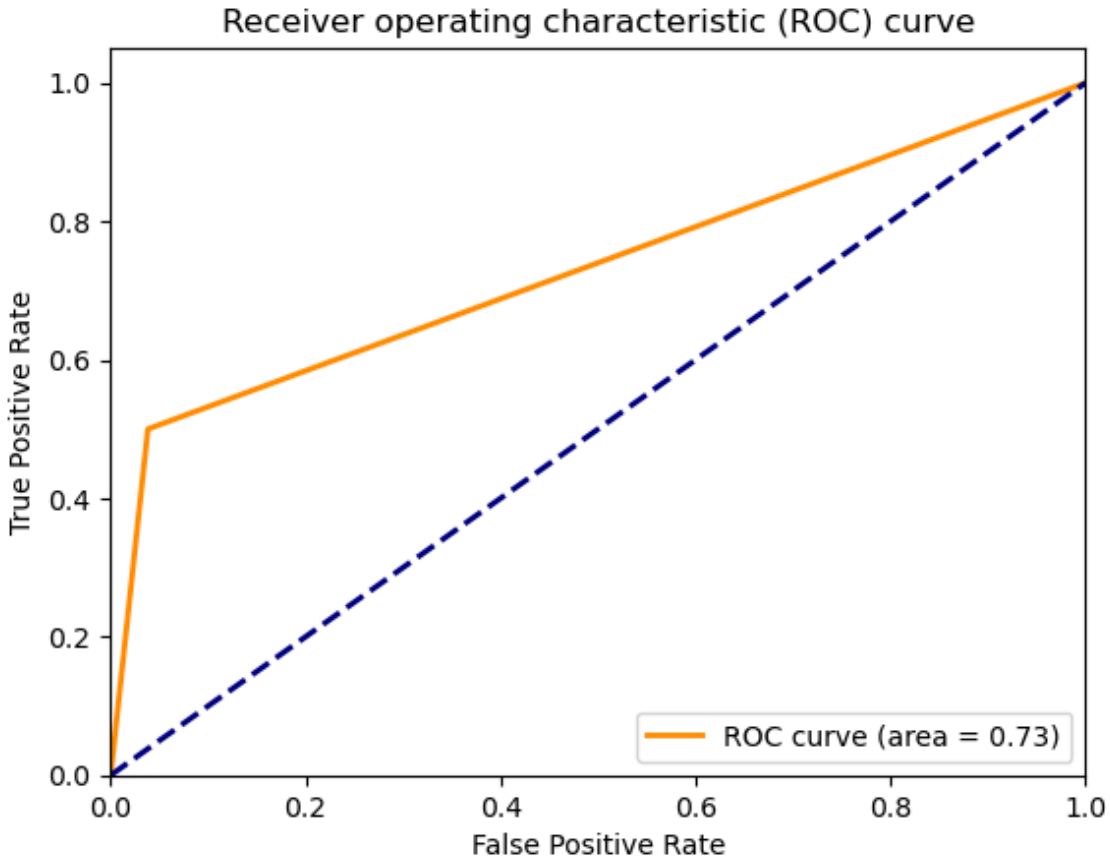
## F1 Score of Random Forest

In [21]:
```
f1_rf = f1_score(wy_test, wy3_pred)
print("F1 score:", f1_rf)
```

```
F1 score: 0.5423728813559322
```

## Plotting the graph of ROC Curve for Random Forest

In [22]:
```
f3, t3, thresholds = roc_curve(wy_test, wy3_pred)
roc_auc3 = auc(f3, t3)

plt.figure()
plt.plot(f3, t3, color='darkorange', lw=2, label='ROC curve (area = %0
plt.plot([0, 1], [0, 1], color='navy', lw=2, linestyle='--')
plt.xlim([0.0, 1.0])
plt.ylim([0.0, 1.05])
plt.xlabel('False Positive Rate')
plt.ylabel('True Positive Rate')
plt.title('Receiver operating characteristic (ROC) curve')
plt.legend(loc="lower right")
plt.show()
```



## Decision Tree Classifier

In [23]:
```
# Training the Model
decision=DecisionTreeClassifier(random_state = 8)

# Fitting the model
mo4 = decision.fit(wx_train,wy_train)

# Predicting the values
wy4_pred = mo4.predict(wx_test)

# Finding the accuracy
acc4=accuracy_score(wy4_pred,wy_test)
print("Accuracy of Decision Tree Classifier",acc4)
```

```
Accuracy of Decision Tree Classifier 0.921875
```

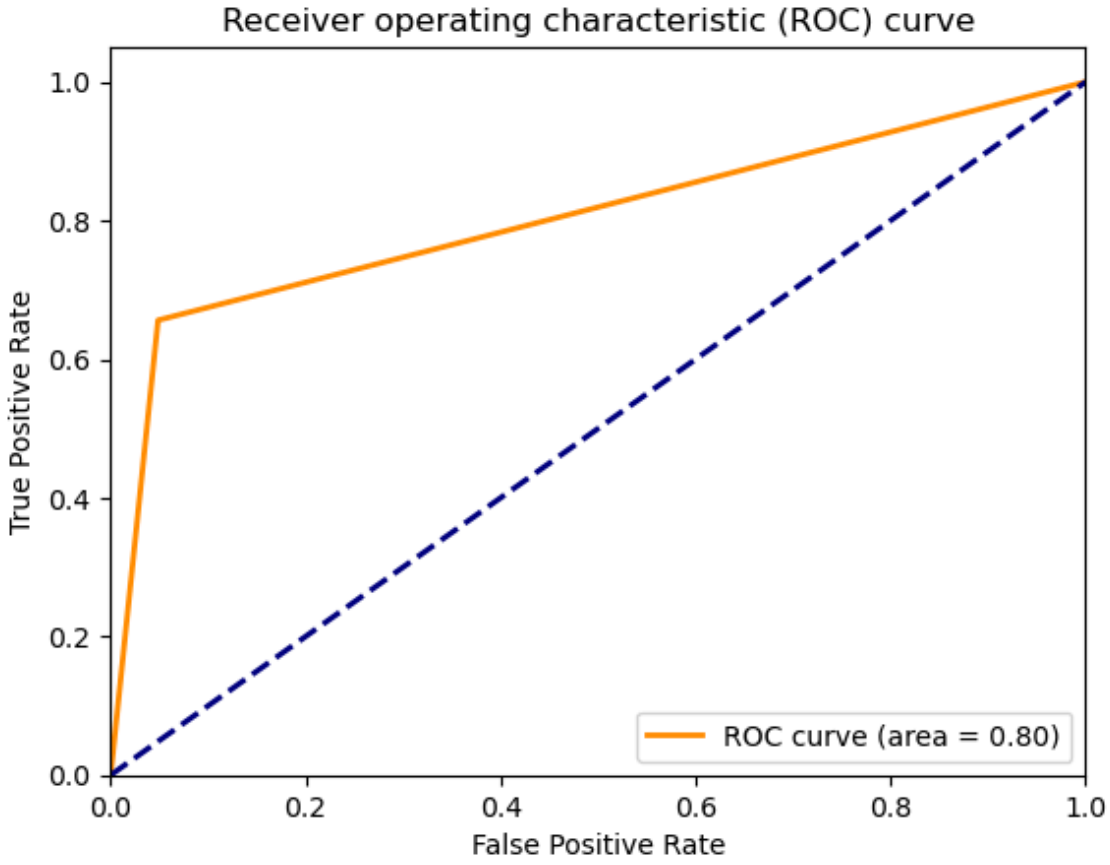
## Calculating F1 Score

In [24]:
```
f1_dt = f1_score(wy_test, wy4_pred)
print("F1 score:", f1_dt)
```

```
F1 score: 0.626865671641791
```

## Plotting the ROC Curve

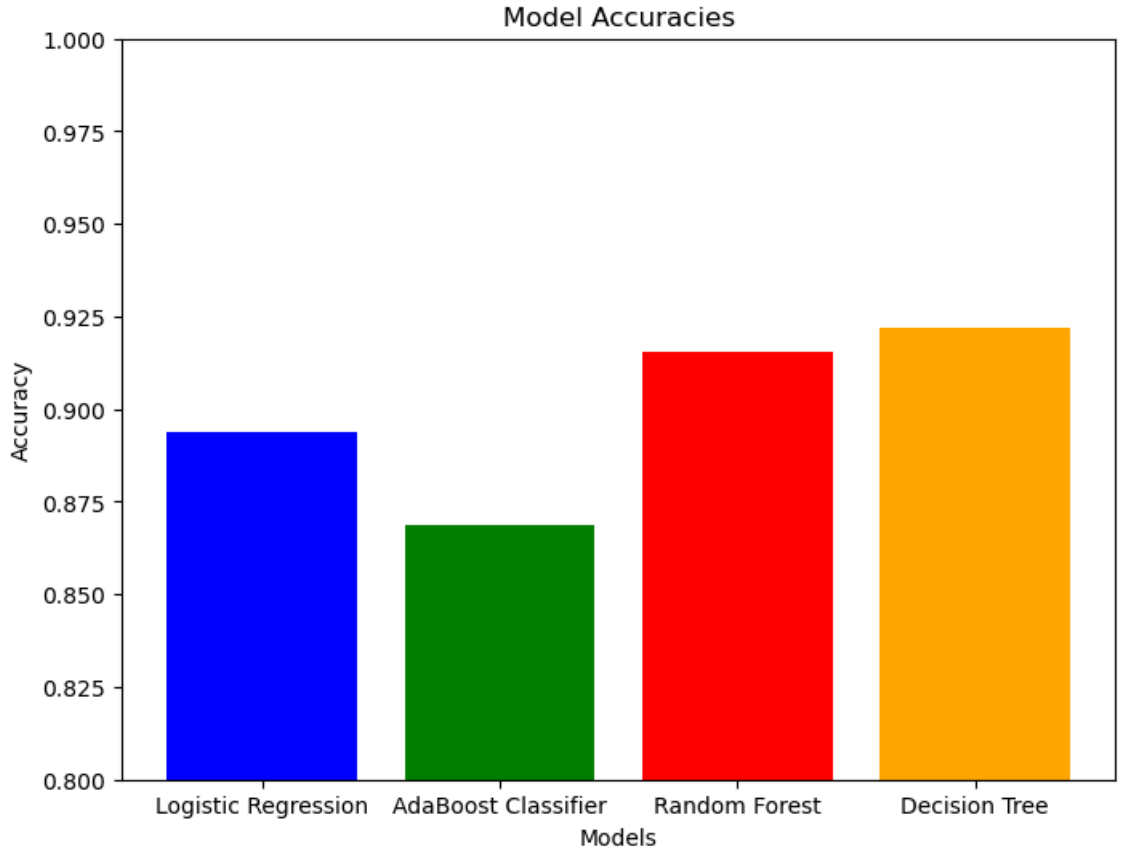
In [25]:
```
f4, t4, thresholds = roc_curve(wy_test, wy4_pred)
roc_auc4 = auc(f4, t4)

plt.figure()
plt.plot(f4, t4, color='darkorange', lw=2, label='ROC curve (area = %0
plt.plot([0, 1], [0, 1], color='navy', lw=2, linestyle='--')
plt.xlim([0.0, 1.0])
plt.ylim([0.0, 1.05])
plt.xlabel('False Positive Rate')
plt.ylabel('True Positive Rate')
plt.title('Receiver operating characteristic (ROC) curve')
plt.legend(loc="lower right")
plt.show()
```




In [26]:
```
# creating list of model names and their corresponding accuracies
models = ['Logistic Regression', 'AdaBoost Classifier', 'Random Forest
accuracies = [acc1, acc2, acc3, acc4]
```

## Plotting the Graph of accuracy

In [27]:
```
# plot the accuracies as a bar chart
plt.figure(figsize=(8, 6))
plt.bar(models, accuracies, color=['blue', 'green', 'red', 'orange'])
plt.ylim(0.8, 1.0)
plt.title('Model Accuracies')
plt.xlabel('Models')
plt.ylabel('Accuracy')
plt.show()
```

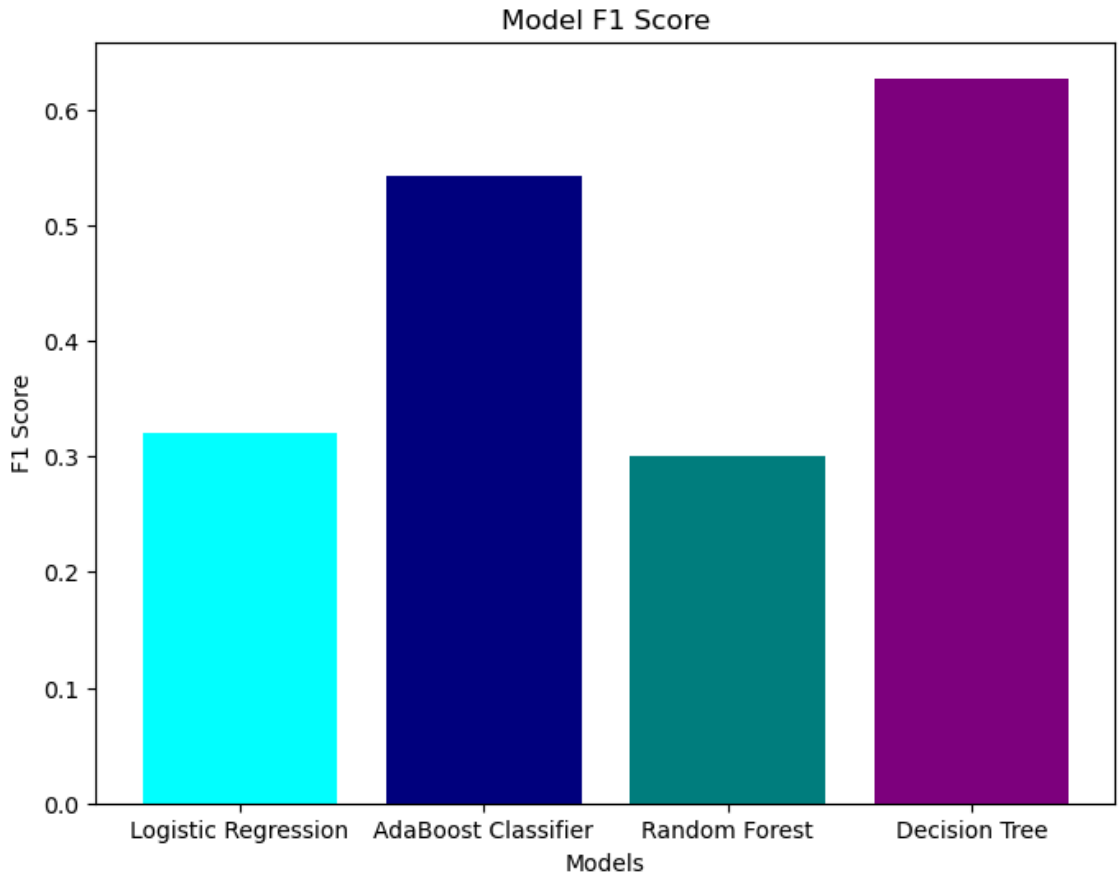



In [28]:
```
models = ['Logistic Regression','AdaBoost Classifier', 'Random Forest'
f1_score = [f1_lr, f1_rf, f1_abc, f1_dt]
f1_score
```

Out[28]:
```
[0.32, 0.5423728813559322, 0.30000000000000004, 0.626865671641791]
```

## Plotting Accuracies

In [29]:
```
# plot the accuracies as a bar chart
plt.figure(figsize=(8, 6))
plt.bar(models, f1_score, color=['aqua', 'navy', 'teal', 'purple'])
plt.title('Model F1 Score')
plt.xlabel('Models')
plt.ylabel('F1 Score')
plt.show()
```



## Plotting ROC Curve

In [30]:

```
# plot the ROC curves for each model on the same graph
plt.figure(figsize=(8, 6))
plt.plot(f1, t1, color='blue', lw=2, label='Model 1 (AUC = %0.2f)' % r
plt.plot(f2, t2, color='green', lw=2, label='Model 2 (AUC = %0.2f)' %
plt.plot(f3, t3, color='red', lw=2, label='Model 3 (AUC = %0.2f)' % ro
plt.plot(f4, t4, color='orange', lw=2, label='Model 4 (AUC = %0.2f)' %
plt.plot([0, 1], [0, 1], color='black', lw=2, linestyle='--')
plt.xlim([0.0, 1.0])
plt.ylim([0.0, 1.05])
plt.title('ROC Curves for Four Models')
plt.xlabel('False Positive Rate')
plt.ylabel('True Positive Rate')
plt.legend(loc="lower right")
plt.show()
```