Import Libraries

INFO 5502- PRINCIPLES AND TECHNIQUES OF DATA SCIENCE

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Group 6

WINE QUALITY PREDICTION

In [1]:

```
import pandas as pd
import numpy as np
import sklearn
import seaborn as sns
import matplotlib.pyplot as plt
from sklearn.model_selection import train_test_split
from sklearn.preprocessing import StandardScaler
from sklearn.linear_model import LogisticRegression
from sklearn.metrics import confusion_matrix, accuracy_score
```

Load Dataset

In [2]:

```
data = pd.read_csv("winequality-red.csv")
data.head()
```

Out[2]:

	fixed acidity	volatile acidity	citric acid	residual sugar	chlorides	free sulfur dioxide	total sulfur dioxide	density	pH	sulphates	alcohol	quali
0	7.4	0.70	0.00	1.9	0.076	11.0	34.0	0.9978	3.51	0.56	9.4	
1	7.8	0.88	0.00	2.6	0.098	25.0	67.0	0.9968	3.20	0.68	9.8	
2	7.8	0.76	0.04	2.3	0.092	15.0	54.0	0.9970	3.26	0.65	9.8	
3	11.2	0.28	0.56	1.9	0.075	17.0	60.0	0.9980	3.16	0.58	9.8	
4	7.4	0.70	0.00	1.9	0.076	11.0	34.0	0.9978	3.51	0.56	9.4	

Check the correlation for each of the fields

In [3]:

```
data.corr
```

Out[3]:

```
<bound method DataFrame.corr of       fixed acidity  volatile acidity  citric acid  resi
dual sugar  chlorides  \
0               7.4             0.700         0.00             1.9      0.076
1               7.8             0.880         0.00             2.6      0.098
2               7.8             0.760         0.04             2.3      0.092
3              11.2             0.280         0.56             1.9      0.075
4               7.4             0.700         0.00             1.9      0.076
...             ...               ...          ...             ...        ...
```

```
1594           6.2             0.600        0.08             2.0      0.090
1595           5.9             0.550        0.10             2.2      0.062
1596           6.3             0.510        0.13             2.3      0.076
1597           5.9             0.645        0.12             2.0      0.075
1598           6.0             0.310        0.47             3.6      0.067

      free sulfur dioxide  total sulfur dioxide  density    pH  sulphates  \
0                    11.0                  34.0  0.99780  3.51       0.56
1                    25.0                  67.0  0.99680  3.20       0.68
2                    15.0                  54.0  0.99700  3.26       0.65
3                    17.0                  60.0  0.99800  3.16       0.58
4                    11.0                  34.0  0.99780  3.51       0.56
...                   ...                   ...      ...   ...        ...
1594                 32.0                  44.0  0.99490  3.45       0.58
1595                 39.0                  51.0  0.99512  3.52       0.76
1596                 29.0                  40.0  0.99574  3.42       0.75
1597                 32.0                  44.0  0.99547  3.57       0.71
1598                 18.0                  42.0  0.99549  3.39       0.66

      alcohol  quality
0         9.4        5
1         9.8        5
2         9.8        5
3         9.8        6
4         9.4        5
...       ...      ...
1594     10.5        5
1595     11.2        6
1596     11.0        6
1597     10.2        5
1598     11.0        6

[1599 rows x 12 columns]>
```

In [4]:
```
data.columns
```

Out[4]:
```
Index(['fixed acidity', 'volatile acidity', 'citric acid', 'residual sugar',
       'chlorides', 'free sulfur dioxide', 'total sulfur dioxide', 'density',
       'pH', 'sulphates', 'alcohol', 'quality'],
      dtype='object')
```

In [5]:
```
data.info()
```

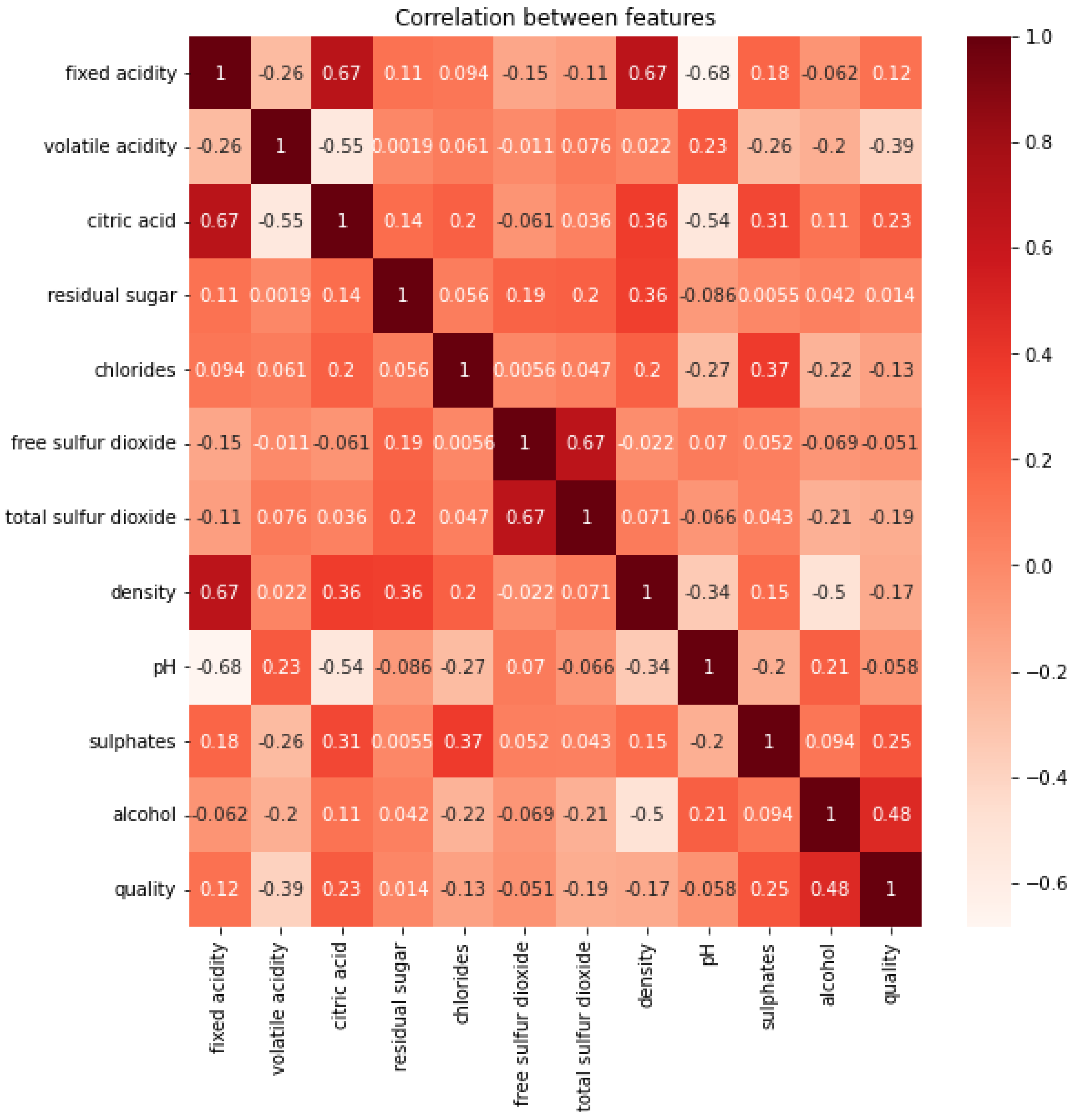
```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 1599 entries, 0 to 1598
Data columns (total 12 columns):
 #   Column                Non-Null Count  Dtype  
---  ------                --------------  -----  
 0   fixed acidity         1599 non-null   float64
 1   volatile acidity      1599 non-null   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 [6]:
```
data['quality'].unique()
```

Out[6]:
```
array([5, 6, 7, 4, 8, 3], dtype=int64)
```

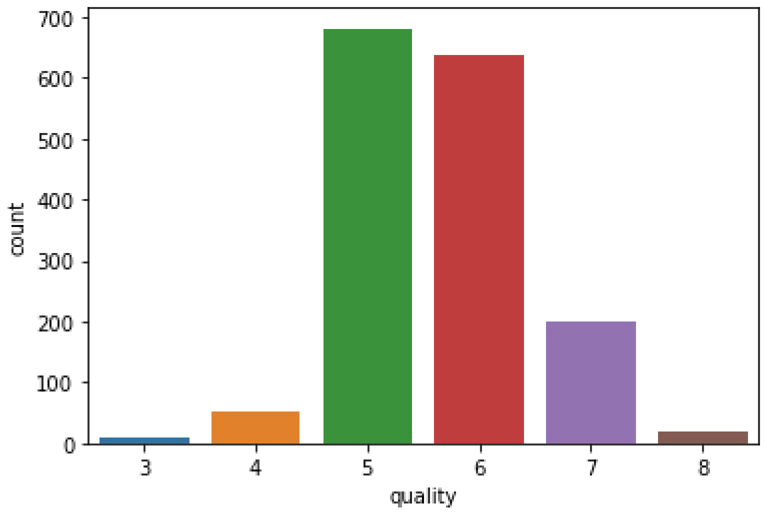
Check correleation between the attributes using heatmap

In [7]:
```
plt.figure(figsize=(9, 9))
correlation = data.corr()
heatmap = sns.heatmap(correlation, annot=True, cmap="Reds")
plt.title("Correlation between features")
plt.show()
```



In [8]:
```
sns.countplot(x='quality', data=data)
```

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

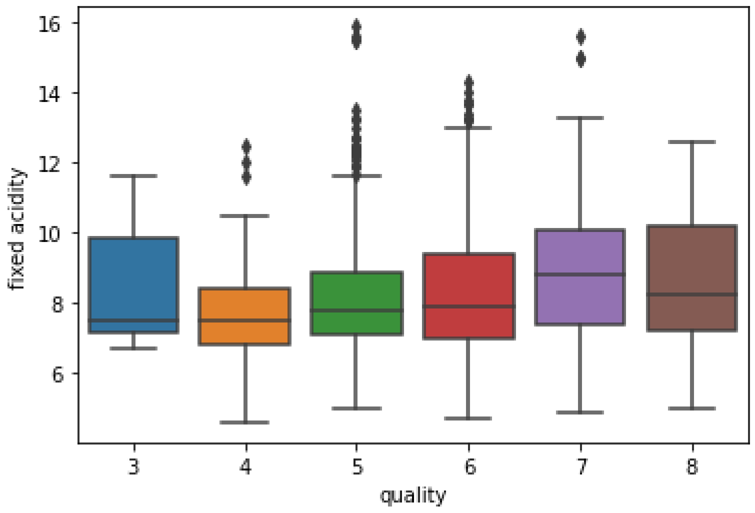


Plot a boxplot to check for Outliers

In [9]:
```
sns.boxplot('quality', 'fixed acidity', data = data)
```

```
C:\Users\LaptopCheckout\software\anaconda\lib\site-packages\seaborn\_decorators.py:36: F
utureWarning: Pass the following variables as keyword args: x, y. From version 0.12, the
only valid positional argument will be `data`, and passing other arguments without an ex
plicit keyword will result in an error or misinterpretation.
  warnings.warn(
```

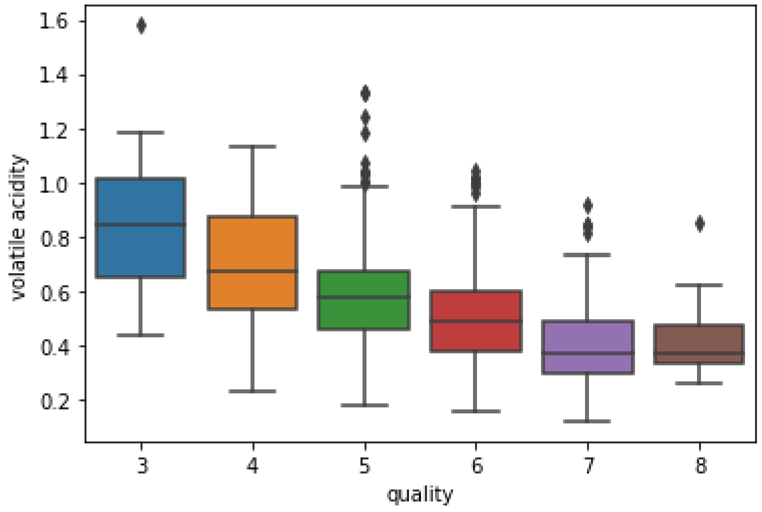
Out[9]:
```
<AxesSubplot:xlabel='quality', ylabel='fixed acidity'>
```



In [10]:
```
sns.boxplot('quality', 'volatile acidity', data = data)
```

```
C:\Users\LaptopCheckout\software\anaconda\lib\site-packages\seaborn\_decorators.py:36: F
utureWarning: Pass the following variables as keyword args: x, y. From version 0.12, the
only valid positional argument will be `data`, and passing other arguments without an ex
plicit keyword will result in an error or misinterpretation.
  warnings.warn(
```

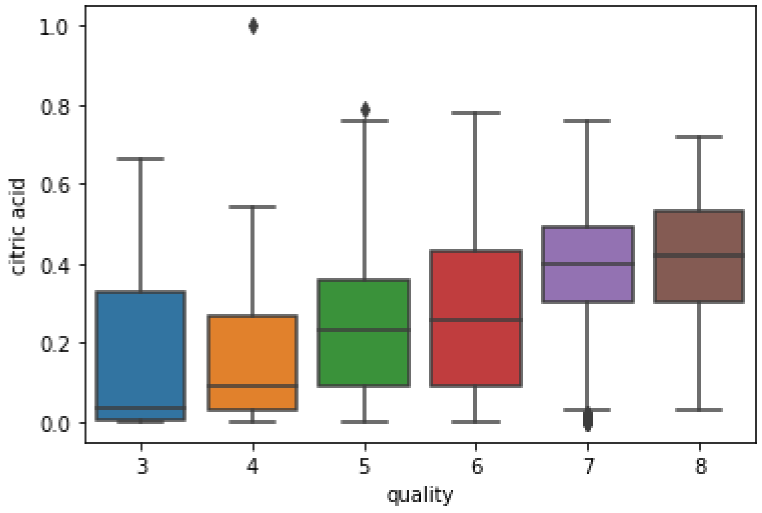
Out[10]:
```
<AxesSubplot:xlabel='quality', ylabel='volatile acidity'>
```



In [11]:
```
sns.boxplot('quality', 'citric acid', data = data)
```

```
C:\Users\LaptopCheckout\software\anaconda\lib\site-packages\seaborn\_decorators.py:36: F
utureWarning: Pass the following variables as keyword args: x, y. From version 0.12, the
only valid positional argument will be `data`, and passing other arguments without an ex
plicit keyword will result in an error or misinterpretation.
  warnings.warn(
```

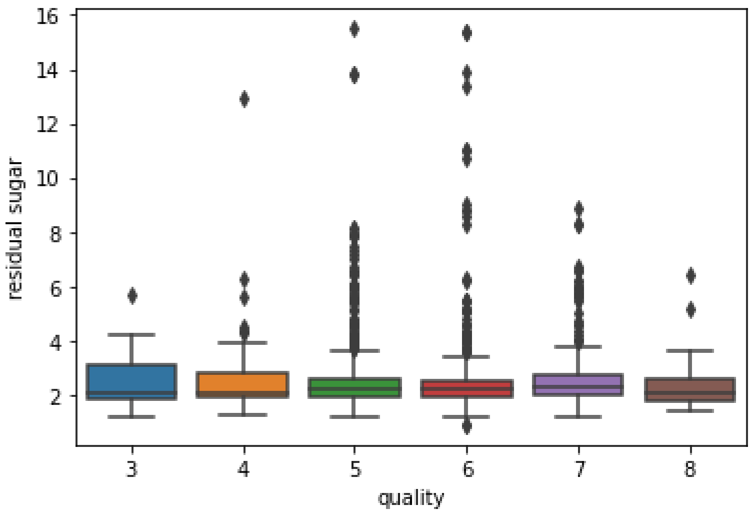
Out[11]:
```
<AxesSubplot:xlabel='quality', ylabel='citric acid'>
```



In [12]:
```
sns.boxplot('quality', 'residual sugar', data = data)
```

```
C:\Users\LaptopCheckout\software\anaconda\lib\site-packages\seaborn\_decorators.py:36: F
utureWarning: Pass the following variables as keyword args: x, y. From version 0.12, the
only valid positional argument will be `data`, and passing other arguments without an ex
plicit keyword will result in an error or misinterpretation.
  warnings.warn(
```

Out[12]:
```
<AxesSubplot:xlabel='quality', ylabel='residual sugar'>
```



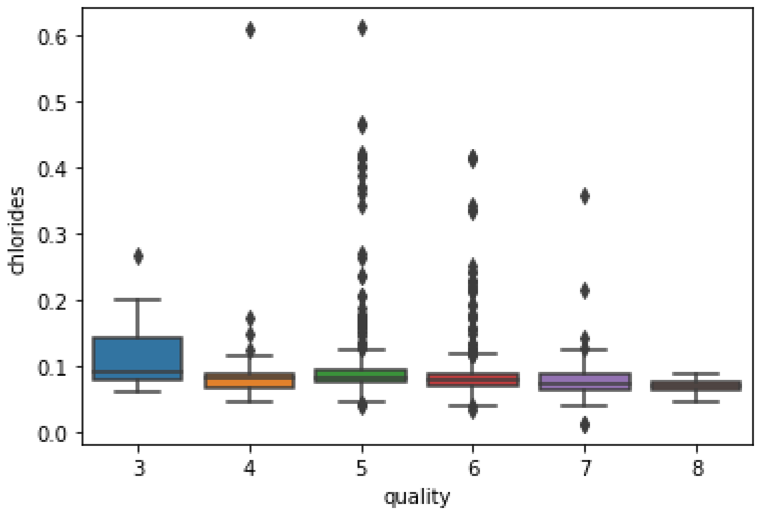
In [13]:

```
sns.boxplot('quality', 'chlorides', data = data)
```

```
C:\Users\LaptopCheckout\software\anaconda\lib\site-packages\seaborn\_decorators.py:36: F
utureWarning: Pass the following variables as keyword args: x, y. From version 0.12, the
only valid positional argument will be `data`, and passing other arguments without an ex
plicit keyword will result in an error or misinterpretation.
  warnings.warn(
```

Out[13]:

```
<AxesSubplot:xlabel='quality', ylabel='chlorides'>
```



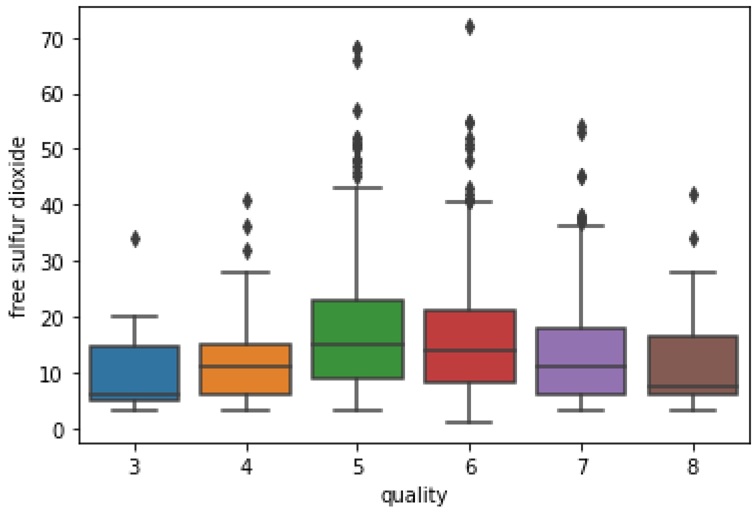
In [14]:

```
sns.boxplot('quality', 'free sulfur dioxide', data = data)
```

```
C:\Users\LaptopCheckout\software\anaconda\lib\site-packages\seaborn\_decorators.py:36: F
utureWarning: Pass the following variables as keyword args: x, y. From version 0.12, the
only valid positional argument will be `data`, and passing other arguments without an ex
plicit keyword will result in an error or misinterpretation.
  warnings.warn(
```

Out[14]:

```
<AxesSubplot:xlabel='quality', ylabel='free sulfur dioxide'>
```



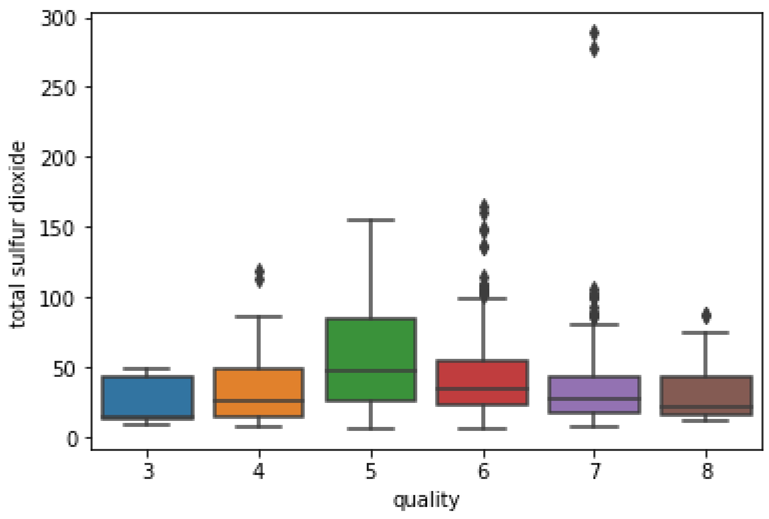
In [15]:

```
sns.boxplot('quality', 'total sulfur dioxide', data = data)
```

```
C:\Users\LaptopCheckout\software\anaconda\lib\site-packages\seaborn\_decorators.py:36: F
utureWarning: Pass the following variables as keyword args: x, y. From version 0.12, the
only valid positional argument will be `data`, and passing other arguments without an ex
plicit keyword will result in an error or misinterpretation.
  warnings.warn(
```

Out[15]:

```
<AxesSubplot:xlabel='quality', ylabel='total sulfur dioxide'>
```



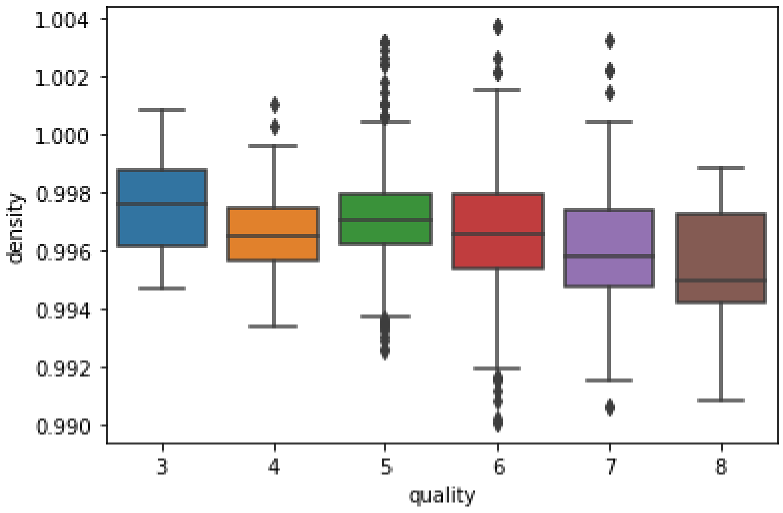
In [16]:

```
sns.boxplot('quality', 'density', data = data)
```

```
C:\Users\LaptopCheckout\software\anaconda\lib\site-packages\seaborn\_decorators.py:36: F
utureWarning: Pass the following variables as keyword args: x, y. From version 0.12, the
only valid positional argument will be `data`, and passing other arguments without an ex
plicit keyword will result in an error or misinterpretation.
  warnings.warn(
```

Out[16]:

```
<AxesSubplot:xlabel='quality', ylabel='density'>
```



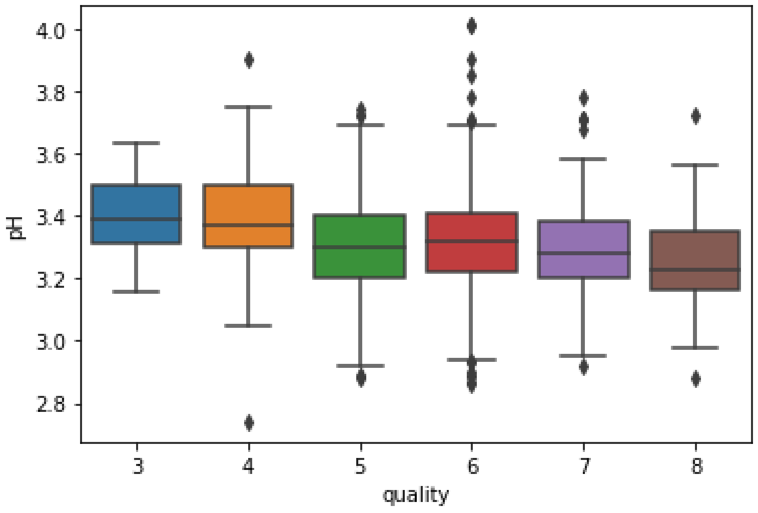
In [17]:

```
sns.boxplot('quality', 'pH', data = data)
```

```
C:\Users\LaptopCheckout\software\anaconda\lib\site-packages\seaborn\_decorators.py:36: F
utureWarning: Pass the following variables as keyword args: x, y. From version 0.12, the
only valid positional argument will be `data`, and passing other arguments without an ex
plicit keyword will result in an error or misinterpretation.
  warnings.warn(
```

Out[17]:

```
<AxesSubplot:xlabel='quality', ylabel='pH'>
```



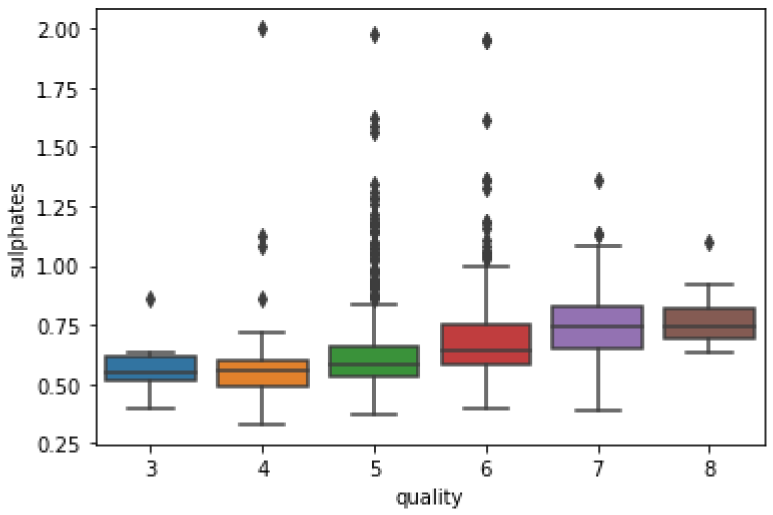
In [18]:

```
sns.boxplot('quality', 'sulphates', data = data)
```

```
C:\Users\LaptopCheckout\software\anaconda\lib\site-packages\seaborn\_decorators.py:36: F
utureWarning: Pass the following variables as keyword args: x, y. From version 0.12, the
only valid positional argument will be `data`, and passing other arguments without an ex
plicit keyword will result in an error or misinterpretation.
  warnings.warn(
```

Out[18]:

```
<AxesSubplot:xlabel='quality', ylabel='sulphates'>
```



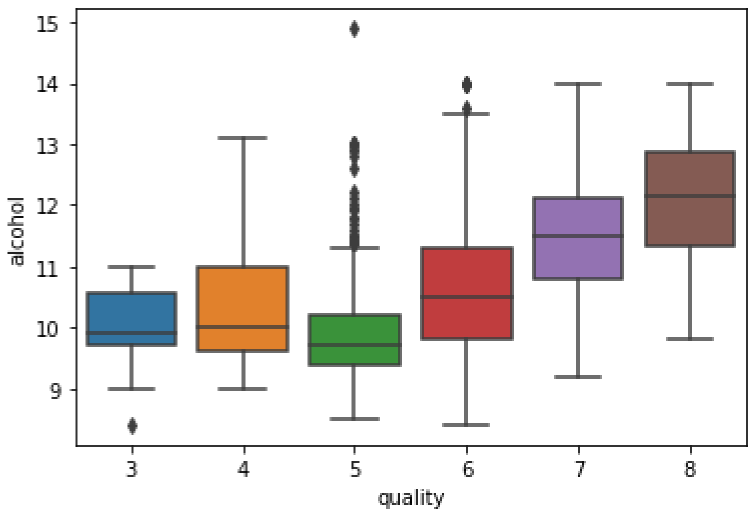
In [19]:

```
sns.boxplot('quality', 'alcohol', data = data)
```

```
C:\Users\LaptopCheckout\software\anaconda\lib\site-packages\seaborn\_decorators.py:36: F
utureWarning: Pass the following variables as keyword args: x, y. From version 0.12, the
only valid positional argument will be `data`, and passing other arguments without an ex
plicit keyword will result in an error or misinterpretation.
  warnings.warn(
```

Out[19]:

```
<AxesSubplot:xlabel='quality', ylabel='alcohol'>
```



In [20]:

```
data.describe()
```

Out[20]:

	fixed acidity	volatile acidity	citric acid	residual sugar	chlorides	free sulfur dioxide	total sulfur dioxide	
count	1599.000000	1599.000000	1599.000000	1599.000000	1599.000000	1599.000000	1599.000000	159
mean	8.319637	0.527821	0.270976	2.538806	0.087467	15.874922	46.467792	(
std	1.741096	0.179060	0.194801	1.409928	0.047065	10.460157	32.895324	(
min	4.600000	0.120000	0.000000	0.900000	0.012000	1.000000	6.000000	(
25%	7.100000	0.390000	0.090000	1.900000	0.070000	7.000000	22.000000	(
50%	7.900000	0.520000	0.260000	2.200000	0.079000	14.000000	38.000000	(

	fixed acidity	volatile acidity	citric acid	residual sugar	chlorides	free sulfur dioxide	total sulfur dioxide
75%	9.200000	0.640000	0.420000	2.600000	0.090000	21.000000	62.000000
max	15.900000	1.580000	1.000000	15.500000	0.611000	72.000000	289.000000

Categorizing the values into high or low quality

In [21]:
```
data['quality']=data.quality.apply(lambda x: "High Quality" if x>= 7 else "Low Quality"
data.head()
```

Out[21]:

	fixed acidity	volatile acidity	citric acid	residual sugar	chlorides	free sulfur dioxide	total sulfur dioxide	density	pH	sulphates	alcohol	quali
0	7.4	0.70	0.00	1.9	0.076	11.0	34.0	0.9978	3.51	0.56	9.4	Lc Quali
1	7.8	0.88	0.00	2.6	0.098	25.0	67.0	0.9968	3.20	0.68	9.8	Lc Quali
2	7.8	0.76	0.04	2.3	0.092	15.0	54.0	0.9970	3.26	0.65	9.8	Lc Quali
3	11.2	0.28	0.56	1.9	0.075	17.0	60.0	0.9980	3.16	0.58	9.8	Lc Quali
4	7.4	0.70	0.00	1.9	0.076	11.0	34.0	0.9978	3.51	0.56	9.4	Lc Quali

Splitting the target and independent variable

In [22]:
```
x=data.iloc[:, 0:11].values
y=data['quality']
```

Label encoder

In [23]:
```
from sklearn.preprocessing import LabelEncoder
le = LabelEncoder()
y = le.fit_transform(y)
```

Split train and test data

In [24]:
```
x_train, x_test, y_train, y_test = train_test_split(x,y,test_size=0.20,random_state=1)
```

In [25]:
```
print(x_train.shape, y_train.shape)
print(x_test.shape, y_test.shape)
```

```
(1279, 11) (1279,)
```

```
(320, 11) (320,)
```

Standardization of features

In [26]:
```
scale=StandardScaler()
x_train= scale.fit_transform(x_train)
x_test= scale.transform(x_test)
```

Logistic regression

In [27]:
```
lm = LogisticRegression(random_state=1)
lm.fit(x_train,y_train)
lm_predict = lm.predict(x_test)
```

Accuracy score

In [28]:
```
acc_score = accuracy_score(y_test,lm_predict)
print("Accuracy ",acc_score*100)
```

```
Accuracy  88.4375
```

Confusion matrix

In [29]:
```
lm_confusion_matrix = confusion_matrix(y_test,lm_predict)
print("Confusion Matrix \n",lm_confusion_matrix)
```

```
Confusion Matrix
 [[  7  25]
 [ 12 276]]
```

Decision Tree

In [30]:
```
from sklearn.tree import DecisionTreeClassifier

dt = DecisionTreeClassifier()
dt.fit(x_train,y_train)
dt_predict = dt.predict(x_test)
```

Accuracy score

In [31]:
```
dt_acc_score = accuracy_score(y_test, dt_predict)
print(dt_acc_score*100)
```

```
89.375
```

Confusion matrix

In [32]:
```
dt_conf_matrix = confusion_matrix(y_test, dt_predict)
dt_conf_matrix
```

Out[32]:
```
array([[ 19,  13],
       [ 21, 267]], dtype=int64)
```

NaiveBayes

In [33]:
```
from sklearn.naive_bayes import GaussianNB

nb = GaussianNB()
nb.fit(x_train,y_train)
nb_predict=nb.predict(x_test)
```

Accuracy score

In [34]:
```
nb_acc_score = accuracy_score(y_test, nb_predict)
print(nb_acc_score*100)
```

```
81.875
```

confusion matrix

In [35]:
```
nb_conf_matrix = confusion_matrix(y_test, nb_predict)
nb_conf_matrix
```

Out[35]:
```
array([[ 22,  10],
       [ 48, 240]], dtype=int64)
```

RandomForest classifier

In [36]:
```
from sklearn.ensemble import RandomForestClassifier

rf = RandomForestClassifier()
rf.fit(x_train, y_train)
rf_predict=rf.predict(x_test)
```

Accuracy score

In [37]:
```
rf_acc_score = accuracy_score(y_test, rf_predict)
print(rf_acc_score*100)
```

```
91.875
```

Confusion matrix

In [38]:
```
rf_conf_matrix = confusion_matrix(y_test, rf_predict)
rf_conf_matrix
```

Out[38]:
```
array([[ 15,  17],
       [  9, 279]], dtype=int64)
```

SVM Classifier

In [39]:
```
from sklearn.svm import SVC

lin_svc = SVC()
```

```
lin_svc.fit(x_train, y_train)
lin_svc=rf.predict(x_test)
```

Accuracy score

In [40]:
```
lin_svc_acc_score = accuracy_score(y_test, rf_predict)
print(lin_svc_acc_score*100)
```

```
91.875
```

Confusion matrix

In [41]:
```
lin_svc_conf_matrix = confusion_matrix(y_test, rf_predict)
lin_svc_conf_matrix
```

Out[41]:
```
array([[ 15,  17],
       [  9, 279]], dtype=int64)
```