Wine Quality model prediction

(Kaggle project)

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In [1]:

```
!python --version # version of python
```

```
Python 3.7.6
```

In [2]:

```
import sklearn,pandas,numpy
```

In [3]:

```
pandas.__version__
```

Out[3]:

```
'1.0.1'
```

In [4]:

```
numpy.__version__
```

Out[4]:

```
'1.18.1'
```

In [5]:

```
sklearn. __version__
```

Out[5]:

```
'0.24.2'
```

In [6]:

```
import pandas as pd  # import all library as per require
import numpy as np
import matplotlib.pyplot as plt
from sklearn.model_selection import train_test_split
from sklearn.decomposition import PCA
from sklearn.ensemble import RandomForestClassifier
from sklearn.metrics import accuracy_score
from scipy.stats import norm,boxcox
```

In [7]:

```
wine = pd.read_csv('winequality-red.csv') # Dataset is given on Kaggle ,just downloaded fro
wine.head()
```

Out[7]:

	fixed acidity	volatile acidity	citric acid	residual sugar	chlorides	free sulfur dioxide	total sulfur dioxide	density	pH	sulphates	alcoh
0	7.4	0.70	0.00	1.9	0.076	11.0	34.0	0.9978	3.51	0.56	9
1	7.8	0.88	0.00	2.6	0.098	25.0	67.0	0.9968	3.20	0.68	9
2	7.8	0.76	0.04	2.3	0.092	15.0	54.0	0.9970	3.26	0.65	9
3	11.2	0.28	0.56	1.9	0.075	17.0	60.0	0.9980	3.16	0.58	9
4	7.4	0.70	0.00	1.9	0.076	11.0	34.0	0.9978	3.51	0.56	9

In [8]:

```
wine.shape
```

Out[8]:

```
(1599, 12)
```

In [9]:

```
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 [10]:

```
wine.info
```

Out[10]:

```
<bound method DataFrame.info of       fixed acidity  volatile acidity  citri
c acid  residual sugar  chlorides  \
0               7.4             0.700         0.00             1.9      0.07
6
1               7.8             0.880         0.00             2.6      0.09
8
2               7.8             0.760         0.04             2.3      0.09
2
3              11.2             0.280         0.56             1.9      0.07
5
4               7.4             0.700         0.00             1.9      0.07
6
...             ...               ...          ...             ...
...
1594            6.2             0.600         0.08             2.0      0.09
0
1595            5.9             0.550         0.10             2.2      0.06
2
1596            6.3             0.510         0.13             2.3      0.07
6
1597            5.9             0.645         0.12             2.0      0.07
5
1598            6.0             0.310         0.47             3.6      0.06
7

      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 [11]:

```
wine.describe()
```

Out[11]:

	fixed acidity	volatile acidity	citric acid	residual sugar	chlorides	free sulfur dioxide	total su dio
count	1599.000000	1599.000000	1599.000000	1599.000000	1599.000000	1599.000000	1599.000
mean	8.319637	0.527821	0.270976	2.538806	0.087467	15.874922	46.467
std	1.741096	0.179060	0.194801	1.409928	0.047065	10.460157	32.895
min	4.600000	0.120000	0.000000	0.900000	0.012000	1.000000	6.000
25%	7.100000	0.390000	0.090000	1.900000	0.070000	7.000000	22.000
50%	7.900000	0.520000	0.260000	2.200000	0.079000	14.000000	38.000
75%	9.200000	0.640000	0.420000	2.600000	0.090000	21.000000	62.000
max	15.900000	1.580000	1.000000	15.500000	0.611000	72.000000	289.000

In [12]:

```
wine.shape
```

Out[12]:

```
(1599, 12)
```

Null values visualization

In [13]:

```
wine.isnull().any()
```

Out[13]:

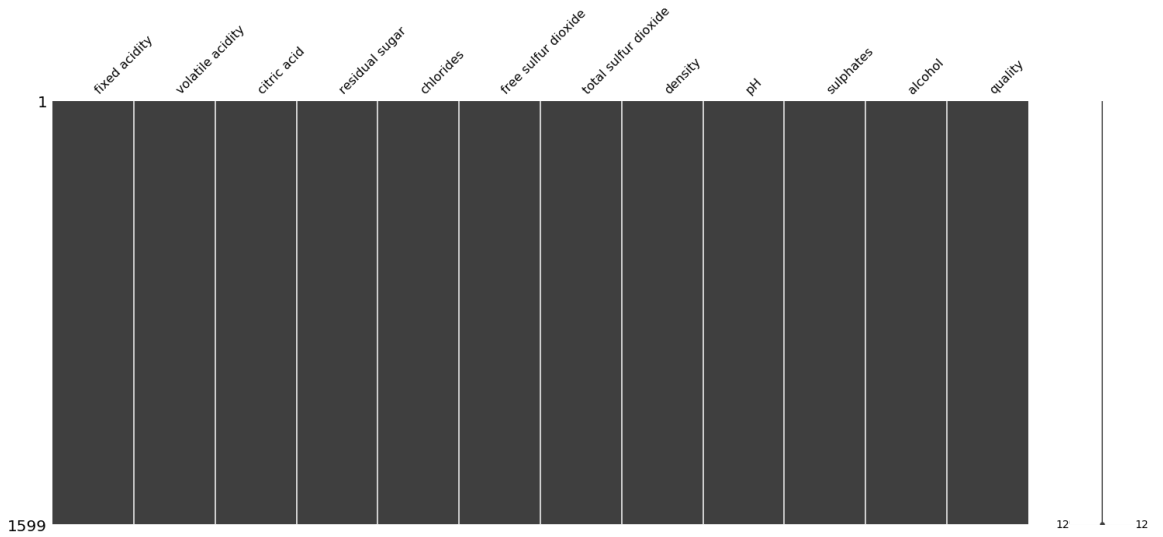
```
fixed acidity           False
volatile acidity        False
citric acid             False
residual sugar          False
chlorides               False
free sulfur dioxide     False
total sulfur dioxide    False
density                 False
pH                      False
sulphates               False
alcohol                 False
quality                 False
dtype: bool
```

In [14]:

```
import missingno as msno
msno.matrix(wine)
```

Out[14]:

```
<matplotlib.axes._subplots.AxesSubplot at 0x1e12e6628c8>
```

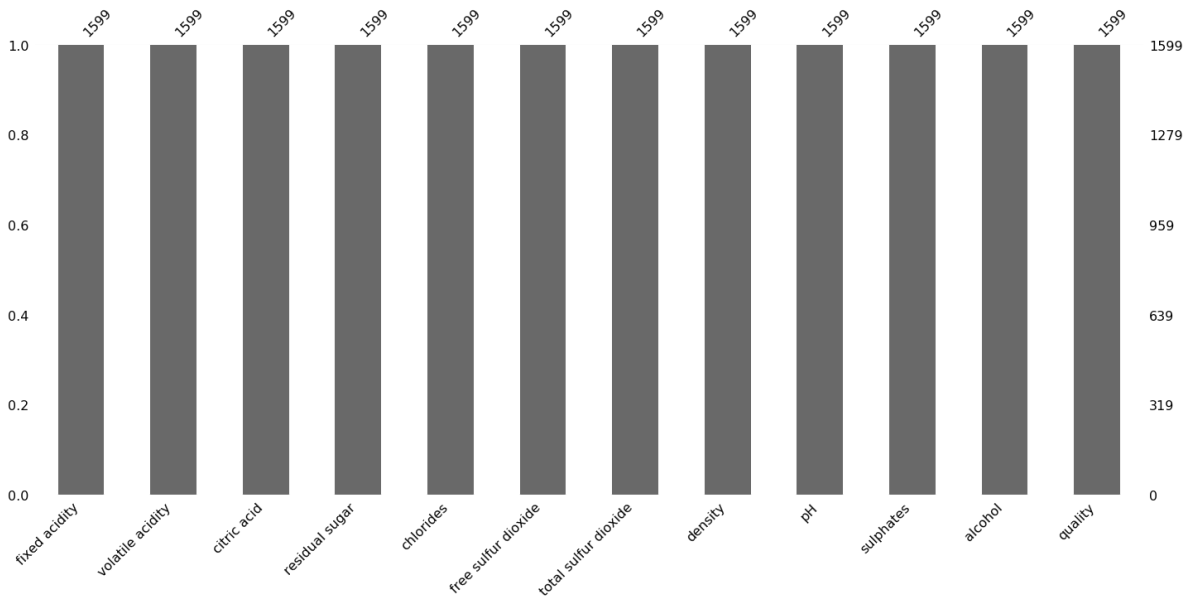


In [15]:

```
msno.bar(wine)
```

Out[15]:

```
<matplotlib.axes._subplots.AxesSubplot at 0x1e12e779c08>
```

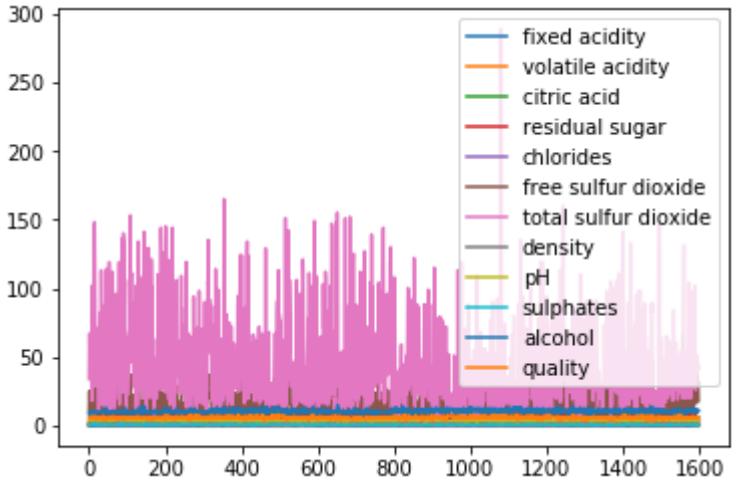


In [16]:

```
wine.plot()
```

Out[16]:

```
<matplotlib.axes._subplots.AxesSubplot at 0x1e12e913948>
```



correlation work

In [17]:

```
wine_corr = wine.corr()
wine_corr
```

Out[17]:

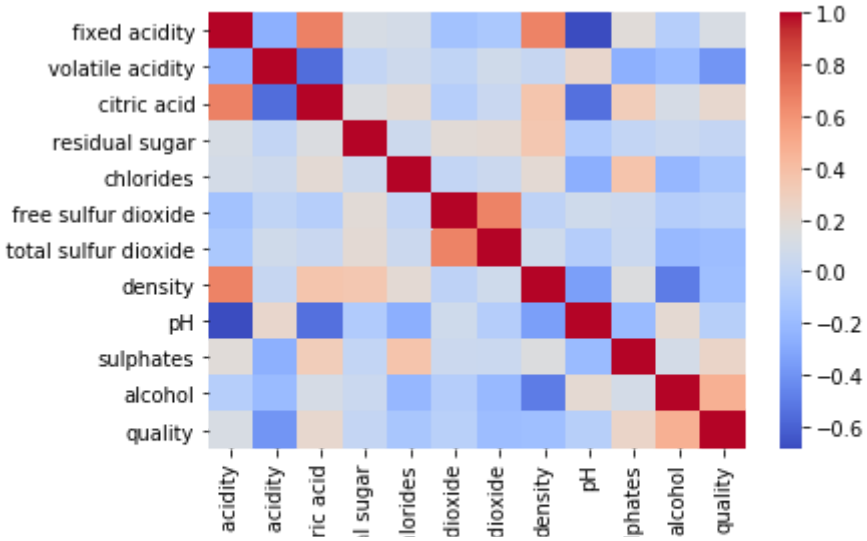
	fixed acidity	volatile acidity	citric acid	residual sugar	chlorides	free sulfur dioxide	total sulfur dioxide	density	pH	s
fixed acidity	1.000000	-0.256131	0.671703	0.114777	0.093705	-0.153794	-0.113181	0.668047	-0.682978	
volatile acidity	-0.256131	1.000000	-0.552496	0.001918	0.061298	-0.010504	0.076470	0.022026	0.234937	
citric acid	0.671703	-0.552496	1.000000	0.143577	0.203823	-0.060978	0.035533	0.364947	-0.541904	
residual sugar	0.114777	0.001918	0.143577	1.000000	0.055610	0.187049	0.203028	0.355283	-0.085652	
chlorides	0.093705	0.061298	0.203823	0.055610	1.000000	0.005562	0.047400	0.200632	-0.265026	
free sulfur dioxide	-0.153794	-0.010504	-0.060978	0.187049	0.005562	1.000000	0.667666	-0.021946	0.070377	

In [18]:

```
import seaborn as sns
sns.heatmap(wine_corr,cmap = 'coolwarm')
```

Out[18]:

```
<matplotlib.axes._subplots.AxesSubplot at 0x1e12e2d75c8>
```



In [19]:

```
col_names = wine.columns
col_names
```

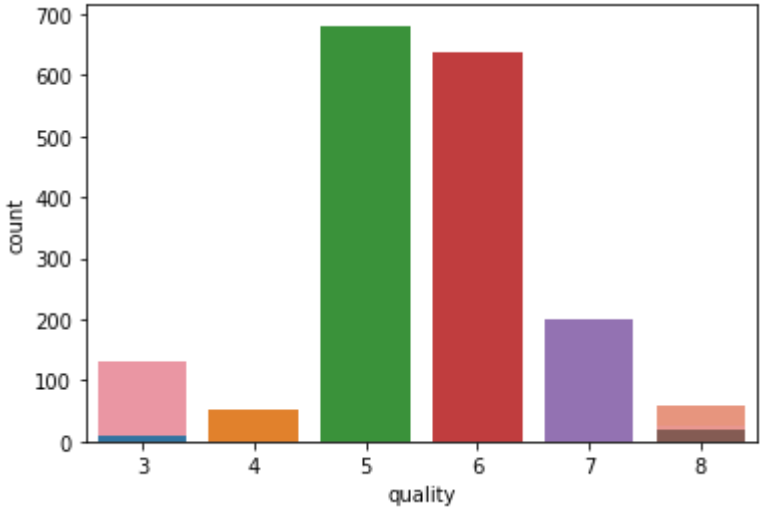
Out[19]:

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

EDA part

In [20]:

```
for col in col_names :
    sns.countplot(x =col, data = wine)
```

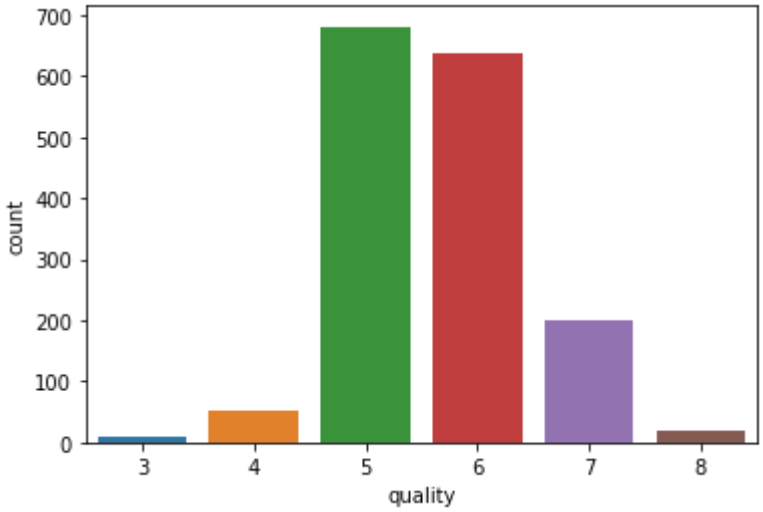


In [21]:

```
sns.countplot(x ='quality', data = wine)
```

Out[21]:

```
<matplotlib.axes._subplots.AxesSubplot at 0x1e1317f7248>
```

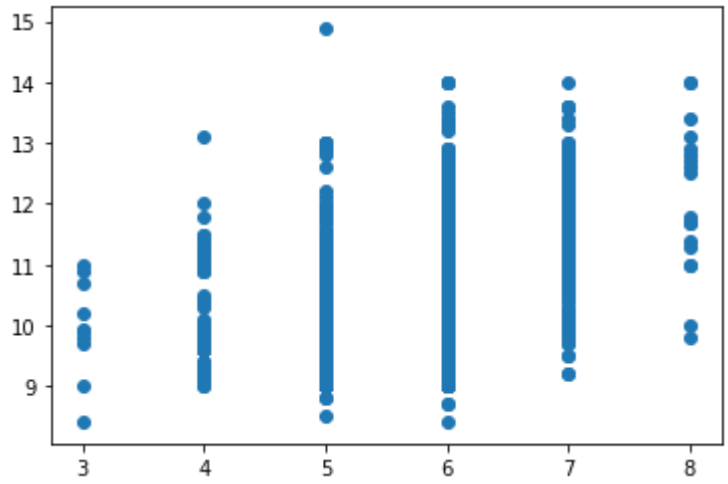


In [22]:

```
plt.scatter(wine["quality"],wine["alcohol"])
```

Out[22]:

```
<matplotlib.collections.PathCollection at 0x1e12f9b1308>
```

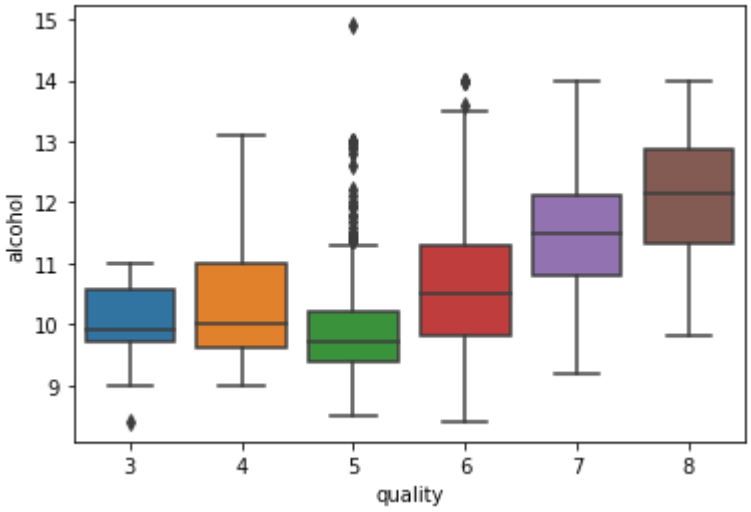


In [23]:

```
sns.boxplot(x="quality",y="alcohol", data=wine)
```

Out[23]:

```
<matplotlib.axes._subplots.AxesSubplot at 0x1e12eb60708>
```



In [24]:

```
from collections import Counter
Counter(wine['quality'])
```

Out[24]:

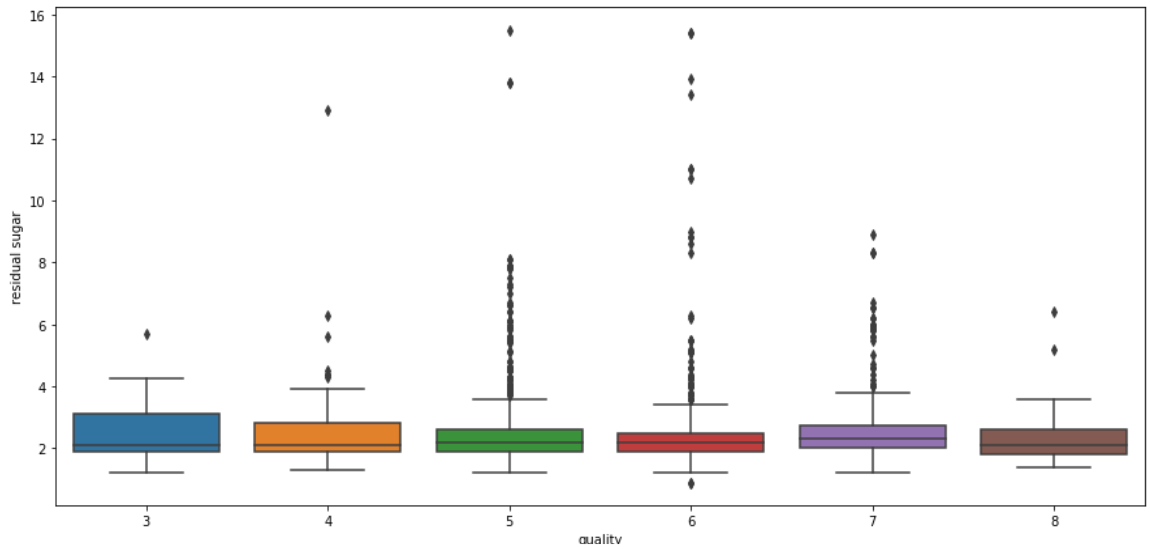
```
Counter({5: 681, 6: 638, 7: 199, 4: 53, 8: 18, 3: 10})
```

In [25]:

```
plot = plt.figure(figsize=(15,7))
sns.boxplot(x="quality",y="residual sugar", data=wine)
```

Out[25]:

```
<matplotlib.axes._subplots.AxesSubplot at 0x1e131504848>
```



In [26]:

```
cols = ['fixed acidity', 'volatile acidity', 'citric acid','residual sugar', 'chlorides', '
```

In [27]:

```
Q1 = wine[cols].quantile(0.25)
Q3 = wine[cols].quantile(0.75)

IQR = Q3- Q1
print(IQR)
```

```
fixed acidity           2.100000
volatile acidity        0.250000
citric acid             0.330000
residual sugar          0.700000
chlorides               0.020000
free sulfur dioxide    14.000000
density                 0.002235
pH                      0.190000
sulphates               0.180000
alcohol                 1.600000
dtype: float64
```

visualized with normal graph,

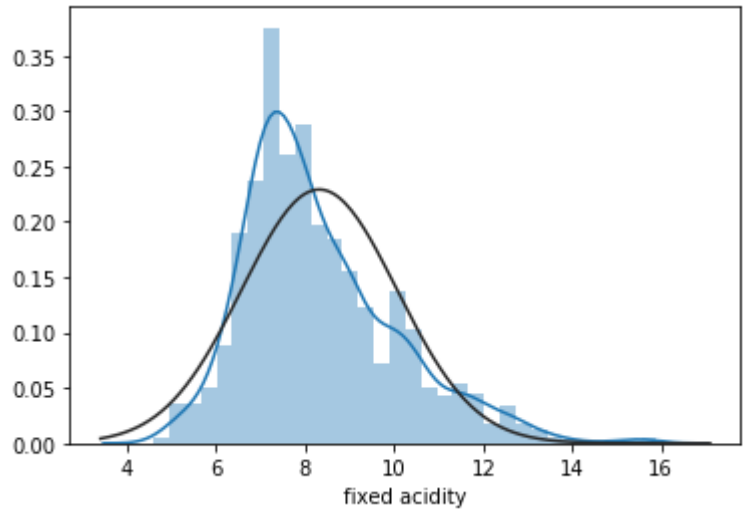
skewedness

In [31]:

```
from scipy import stats
sns.distplot(wine['fixed acidity'],fit = norm)
```

Out[31]:

```
<matplotlib.axes._subplots.AxesSubplot at 0x1e1318c97c8>
```

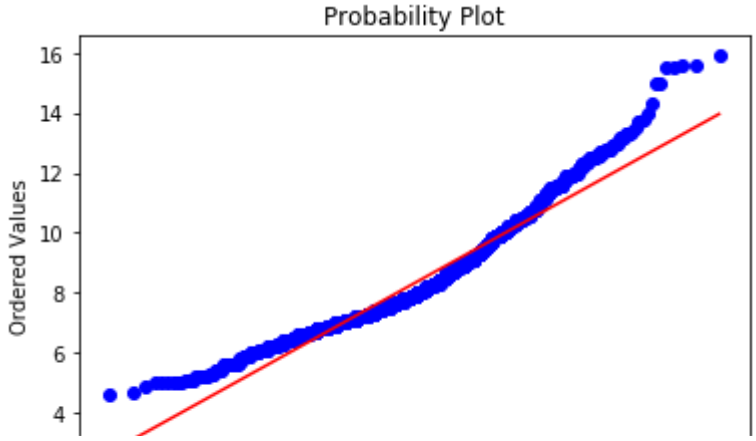


In [33]:

```
stats.probplot(wine["fixed acidity"], plot = plt)
```

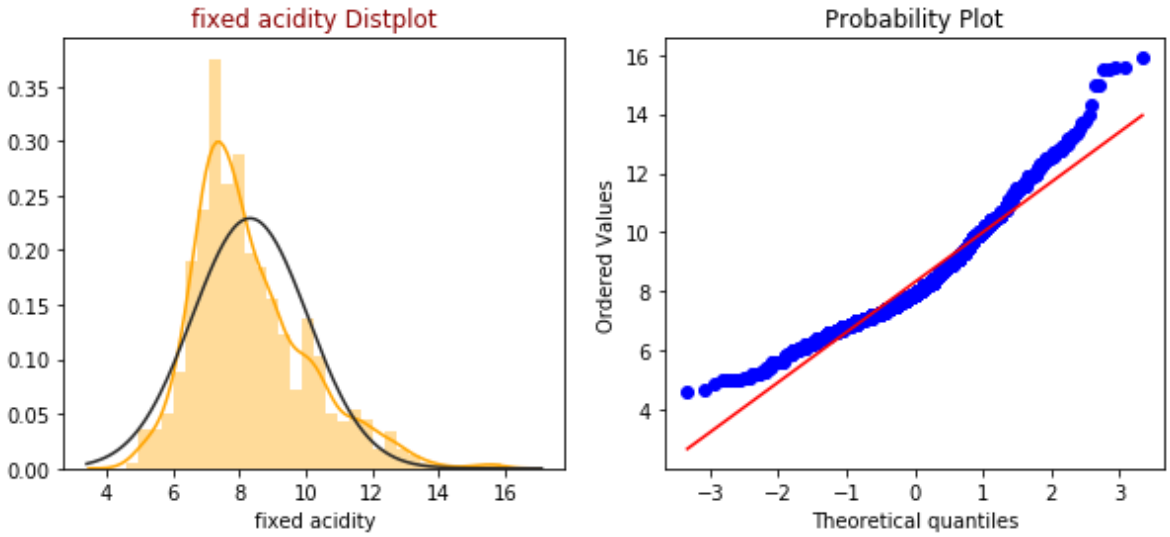
Out[33]:

```
((array([-3.33053651, -3.075151  , -2.93323893, ...,  2.93323893,
          3.075151  ,  3.33053651]),
  array([ 4.6,  4.7,  4.9, ..., 15.6, 15.6, 15.9])),
 (1.692490335637927, 8.31963727329581, 0.9705990367383132))
```



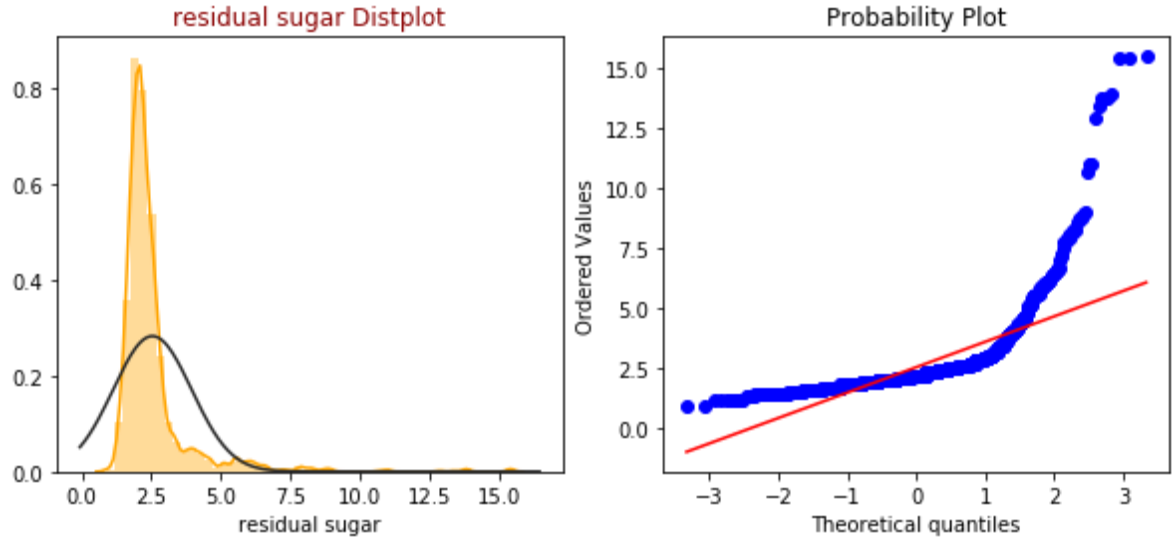
In [34]:

```
plt.figure(figsize=(10,4))
plt.subplot(1,2,1)
sns.distplot(wine["fixed acidity"], fit=norm, color="orange")
plt.title("fixed acidity Distplot", color = "darkred")
plt.subplot(1,2,2)
stats.probplot(wine["fixed acidity"], plot = plt)
plt.show()
```



In [35]:

```
plt.figure(figsize=(10,4))
plt.subplot(1,2,1)
sns.distplot(wine["residual sugar"], fit=norm, color="orange")
plt.title("residual sugar Distplot", color = "darkred")
plt.subplot(1,2,2)
stats.probplot(wine["residual sugar"], plot = plt)
plt.show()
```

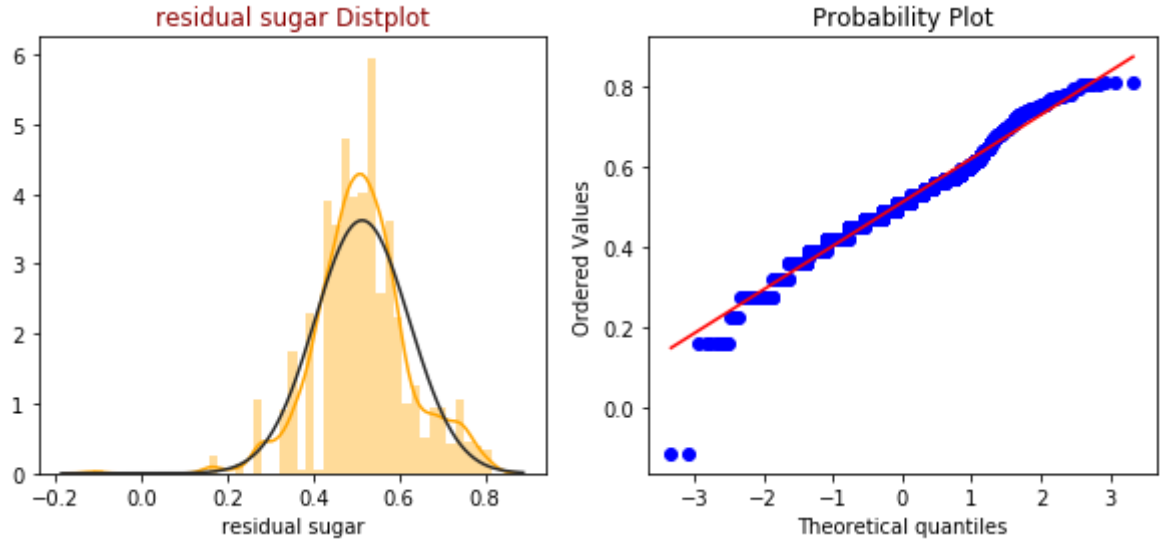


In [36]:

```
wine["residual sugar"], lam_fixed_acidity = boxcox(wine["residual sugar"])
```

In [37]:

```
plt.figure(figsize=(10,4))
plt.subplot(1,2,1)
sns.distplot(wine["residual sugar"], fit=norm, color="orange")
plt.title("residual sugar Distplot", color = "darkred")
plt.subplot(1,2,2)
stats.probplot(wine["residual sugar"], plot = plt)
plt.show()
```



fixing skewness using boxcox

In [38]:

```
wine["fixed acidity"], lam = boxcox(wine["fixed acidity"])
```

In [39]:

```
#Fixing skewness using boxcox
wine["free sulfur dioxide"], lam_fixed_acidity = boxcox(wine["free sulfur dioxide"])
```

In [40]:

```
#Fixing skewness using boxcox
wine["total sulfur dioxide"], lam_fixed_acidity = boxcox(wine["total sulfur dioxide"])
```

In [41]:

```
#Fixing skewness using boxcox
wine["alcohol"], lam_fixed_acidity = boxcox(wine["alcohol"])
```

In [42]:

```
wine['quality'].values
```

Out[42]:

```
array([5, 5, 5, ..., 6, 5, 6], dtype=int64)
```

wine quality scalling in 1,2,3 with column rating

In [43]:

```
rating = []
for num in wine['quality']:
    if num <= 4:
        rating.append('1')
    elif num <=7 :
        rating.append('2')
    elif num ==8 :
        rating.append('3')
wine["rating"] = rating
```

In [44]:

```
from collections import Counter
Counter(wine['quality'])  # count every row with number
```

Out[44]:

```
Counter({5: 681, 6: 638, 7: 199, 4: 53, 8: 18, 3: 10})
```

In [45]:

```
Counter(wine['rating'])
```

Out[45]:

```
Counter({'2': 1518, '1': 63, '3': 18})
```

In [46]:

```
x = wine.drop('quality',axis = 1)
```

PCA

In [47]:

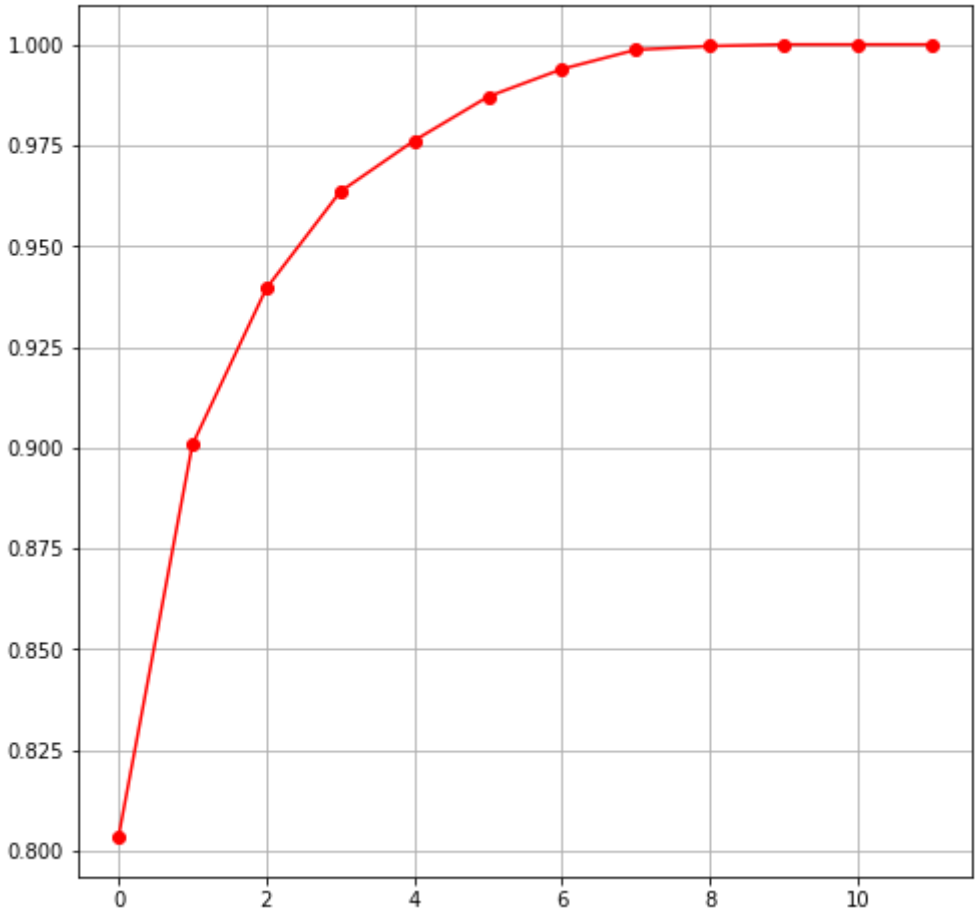
```
pca = PCA()
```

In [48]:

```
x_pca = pca.fit_transform(x)
```

In [49]:

```
plt.figure(figsize = (8,8))
plt.plot(np.cumsum(pca.explained_variance_ratio_),'ro-')
plt.grid()
plt.show()
```



In [50]:

```
new_pca = PCA(n_components = 8)
new_pca.fit_transform(x)
```

Out[50]:

```
array([[-0.26421366,  0.05051731,  0.33922719, ...,  0.04888194,
         0.00845628,  0.03111742],
       [ 1.21455873, -0.05860345,  0.27227432, ..., -0.31664888,
         0.04964319, -0.08699835],
       [ 0.43810846,  0.22526499,  0.24008532, ..., -0.16144937,
         0.0587462 , -0.06772005],
       ...,
       [ 0.99772982, -0.71313651,  0.02715106, ...,  0.02671376,
        -0.02238335, -0.0461304 ],
       [ 1.19670756, -0.73696865,  0.16420511, ...,  0.03647319,
        -0.07637579,  0.09559929],
       [ 0.45147704, -0.1705262 , -0.22301896, ...,  0.15792403,
        -0.18086472, -0.02620968]])
```

In [51]:

```
new_x = new_pca.fit_transform(x)
```

In [95]:

```
x_train,x_test,y_train,y_test = train_test_split(new_x,rating,test_size = 0.50)
```

working with imbalanced dataset with help of imlearn library

In [96]:

```
from scipy import stats
from imblearn.over_sampling import SMOTE
```

In [97]:

```
sm = SMOTE(random_state = 14)
```

In [98]:

```
x_train,y_train = sm.fit_resample(x_train,y_train)
```

In [99]:

```
import collections
collections.Counter(y_train)
```

Out[99]:

```
Counter({'2': 759, '1': 759, '3': 759})
```

In [91]:

```
model = RandomForestClassifier() # used random forest classifier
```

In [100]:

```
model.fit(x_train,y_train)
```

Out[100]:

```
RandomForestClassifier()
```

In [101]:

```
prediction_x = model.predict(x_test)
```

accuracy with random forest

In [102]:

```
accuracy = accuracy_score(prediction_x , y_test)
accuracy
```

Out[102]:

```
0.99875
```

classification report ,score and confusion matrix

In [104]:

```
from sklearn.metrics import confusion_matrix,classification_report
classification_report(y_test,prediction_x)
```

Out[104]:

```
'              precision    recall  f1-score   support\n\n           1
1.00      0.97      0.98        32\n           2       1.00      1.00
1.00       759\n           3       1.00      1.00      1.00         9\n\n
accuracy                           1.00       800\n   macro avg       1.00
0.99      0.99       800\nweighted avg       1.00      1.00      1.00
800\n'
```

In [105]:

```
confusion_matrix(prediction_x, y_test)
```

Out[105]:

```
array([[ 31,   0,   0],
       [  1, 759,   0],
       [  0,   0,   9]], dtype=int64)
```

In [109]:

```
model.score(x_train,y_train)
```

Out[109]:

```
1.0
```

In [107]:

```
accuracy
```

Out[107]:

```
0.99875
```

Now working with support vector machine

In [110]:

```
from sklearn.svm import SVC
```

In [119]:

```
x_train,x_test,y_train,y_test = train_test_split(new_x,rating,test_size = 0.80)
```

In [120]:

```
classifier_svm = SVC(kernel= 'sigmoid')
```

In [121]:

```
classifier_svm.fit(x_train,y_train) # used sigmoid function
```

Out[121]:

```
SVC(kernel='sigmoid')
```

training score

In [122]:

```
classifier_svm.score(x_train,y_train)
```

Out[122]:

```
0.9780564263322884
```

In [123]:

```
y_pred = classifier_svm.predict(x_test)
```

Model accuracy

In [125]:

```
accuracy=accuracy_score(y_pred,y_test)
accuracy
```

Out[125]:

```
0.9640625
```

classification report ,score, confusion matrix

In [126]:

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

```
C:\Users\hp\anaconda3\lib\site-packages\sklearn\metrics\_classification.p
y:1248: UndefinedMetricWarning: Recall and F-score are ill-defined and bei
ng set to 0.0 in labels with no true samples. Use `zero_division` paramete
r to control this behavior.
  _warn_prf(average, modifier, msg_start, len(result))
C:\Users\hp\anaconda3\lib\site-packages\sklearn\metrics\_classification.p
y:1248: UndefinedMetricWarning: Recall and F-score are ill-defined and bei
ng set to 0.0 in labels with no true samples. Use `zero_division` paramete
r to control this behavior.
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y:1248: UndefinedMetricWarning: Recall and F-score are ill-defined and bei
ng set to 0.0 in labels with no true samples. Use `zero_division` paramete
r to control this behavior.
  _warn_prf(average, modifier, msg_start, len(result))
```

Out[126]:

```
'              precision    recall  f1-score   support\n\n           1
0.46      0.96      0.62        25\n           2       1.00      0.96
```

In [127]:

```
confusion_matrix(y_pred,y_test)
```

Out[127]:

```
array([[  24,    1,    0],
       [  28, 1210,   17],
       [   0,    0,    0]], dtype=int64)
```

accuracy

In [128]:

```
accuracy
```

Out[128]:

```
0.9640625
```