Red Wine Quality Prediction Project:

In [2]:
```
# importing data sets library
import pandas as pd
import numpy as np
import matplotlib.pyplot as plt
import seaborn as sns
from sklearn.model_selection import train_test_split
from sklearn.ensemble import RandomForestClassifier
from sklearn.metrics import accuracy_score
```

In [3]:
```
import warnings
warnings.filterwarnings('ignore')
```

In [4]:
```
df = pd.read_csv('https://raw.githubusercontent.com/dsrscientist/DSData/master/wine
df
```

Out[4]:

	fixed acidity	volatile acidity	citric acid	residual sugar	chlorides	free sulfur dioxide	total sulfur dioxide	density	pH	sulphates	alcol
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	1
1595	5.9	0.550	0.10	2.2	0.062	39.0	51.0	0.99512	3.52	0.76	1
1596	6.3	0.510	0.13	2.3	0.076	29.0	40.0	0.99574	3.42	0.75	1
1597	5.9	0.645	0.12	2.0	0.075	32.0	44.0	0.99547	3.57	0.71	1
1598	6.0	0.310	0.47	3.6	0.067	18.0	42.0	0.99549	3.39	0.66	1

1599 rows × 12 columns

In [5]:
```
df.head(15)
```

Out[5]:

	fixed acidity	volatile acidity	citric acid	residual sugar	chlorides	free sulfur dioxide	total sulfur dioxide	density	pH	sulphates	alcohol
0	7.4	0.700	0.00	1.9	0.076	11.0	34.0	0.9978	3.51	0.56	9.4
1	7.8	0.880	0.00	2.6	0.098	25.0	67.0	0.9968	3.20	0.68	9.8
2	7.8	0.760	0.04	2.3	0.092	15.0	54.0	0.9970	3.26	0.65	9.8
3	11.2	0.280	0.56	1.9	0.075	17.0	60.0	0.9980	3.16	0.58	9.8
4	7.4	0.700	0.00	1.9	0.076	11.0	34.0	0.9978	3.51	0.56	9.4
5	7.4	0.660	0.00	1.8	0.075	13.0	40.0	0.9978	3.51	0.56	9.4
6	7.9	0.600	0.06	1.6	0.069	15.0	59.0	0.9964	3.30	0.46	9.4
7	7.3	0.650	0.00	1.2	0.065	15.0	21.0	0.9946	3.39	0.47	10.0
8	7.8	0.580	0.02	2.0	0.073	9.0	18.0	0.9968	3.36	0.57	9.5
9	7.5	0.500	0.36	6.1	0.071	17.0	102.0	0.9978	3.35	0.80	10.5
10	6.7	0.580	0.08	1.8	0.097	15.0	65.0	0.9959	3.28	0.54	9.2
11	7.5	0.500	0.36	6.1	0.071	17.0	102.0	0.9978	3.35	0.80	10.5
12	5.6	0.615	0.00	1.6	0.089	16.0	59.0	0.9943	3.58	0.52	9.9
13	7.8	0.610	0.29	1.6	0.114	9.0	29.0	0.9974	3.26	1.56	9.1
14	8.9	0.620	0.18	3.8	0.176	52.0	145.0	0.9986	3.16	0.88	9.2

In [6]:
```
# Checking missing value in data set
df.isnull().sum()
```

Out[6]:
```
fixed acidity           0
volatile acidity        0
citric acid             0
residual sugar          0
chlorides               0
free sulfur dioxide     0
total sulfur dioxide    0
density                 0
pH                      0
sulphates               0
alcohol                 0
quality                 0
dtype: int64
```

In [7]:
```
df.shape
```

Out[7]:
```
(1599, 12)
```

In [8]:
```
df.columns
```

Out[8]:
```
Index(['fixed acidity', 'volatile acidity', 'citric acid', 'residual sugar',
       'chlorides', 'free sulfur dioxide', 'total sulfur dioxide', 'density',
       'pH', 'sulphates', 'alcohol', 'quality'],
      dtype='object')
```

In [9]:
```
df.columns.tolist()
```

Out[9]:
```
['fixed acidity',
 'volatile acidity',
 'citric acid',
 'residual sugar',
 'chlorides',
 'free sulfur dioxide',
 'total sulfur dioxide',
 'density',
 'pH',
 'sulphates',
 'alcohol',
 'quality']
```

In [10]:
```
df.dtypes
```

Out[10]:
```
fixed acidity           float64
volatile acidity        float64
citric acid             float64
residual sugar          float64
chlorides               float64
free sulfur dioxide     float64
total sulfur dioxide    float64
density                 float64
pH                      float64
sulphates               float64
alcohol                 float64
quality                   int64
dtype: object
```

In [11]:
```
df.isnull().sum()
```

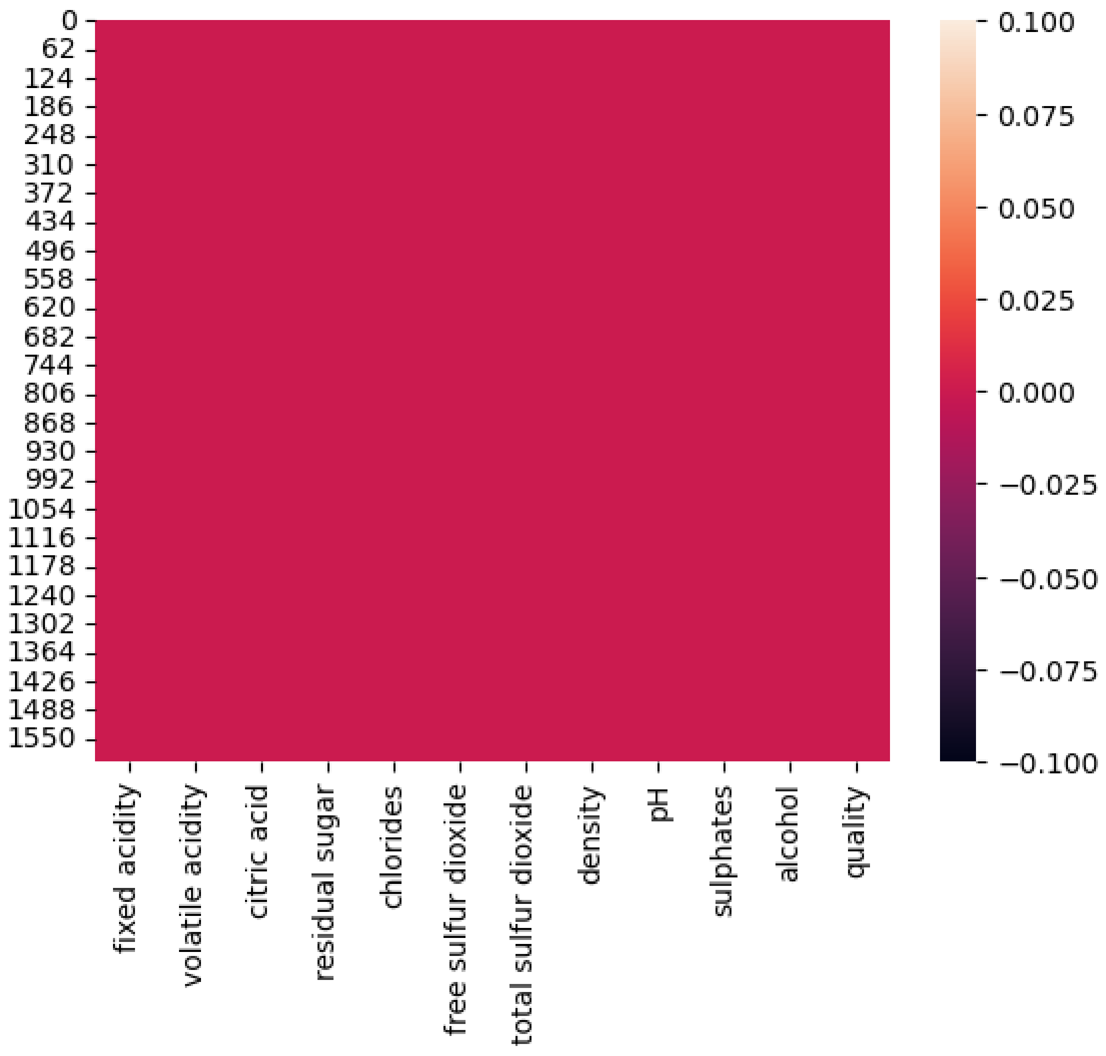
Out[11]:
```
fixed acidity           0
volatile acidity        0
citric acid             0
residual sugar          0
chlorides               0
free sulfur dioxide     0
total sulfur dioxide    0
density                 0
pH                      0
sulphates               0
alcohol                 0
quality                 0
dtype: int64
```

In [12]:
```
df.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 [13]:
```
# Visualisation by using heatmap
sns.heatmap(df.isnull())
```

Out[13]:
```
<Axes: >
```



In [14]:
```
df['fixed acidity'].unique()
```

```
Out[14]: array([ 7.4,  7.8, 11.2,  7.9,  7.3,  7.5,  6.7,  5.6,  8.9,  8.5,  8.1,
                 7.6,  6.9,  6.3,  7.1,  8.3,  5.2,  5.7,  8.8,  6.8,  4.6,  7.7,
                 8.7,  6.4,  6.6,  8.6, 10.2,  7. ,  7.2,  9.3,  8. ,  9.7,  6.2,
                 5. ,  4.7,  8.4, 10.1,  9.4,  9. ,  8.2,  6.1,  5.8,  9.2, 11.5,
                 5.4,  9.6, 12.8, 11. , 11.6, 12. , 15. , 10.8, 11.1, 10. , 12.5,
                11.8, 10.9, 10.3, 11.4,  9.9, 10.4, 13.3, 10.6,  9.8, 13.4, 10.7,
                11.9, 12.4, 12.2, 13.8,  9.1, 13.5, 10.5, 12.6, 14. , 13.7,  9.5,
                12.7, 12.3, 15.6,  5.3, 11.3, 13. ,  6.5, 12.9, 14.3, 15.5, 11.7,
                13.2, 15.9, 12.1,  5.1,  4.9,  5.9,  6. ,  5.5])
```

```
In [15]: df['fixed acidity'].nunique()
```

```
Out[15]: 96
```

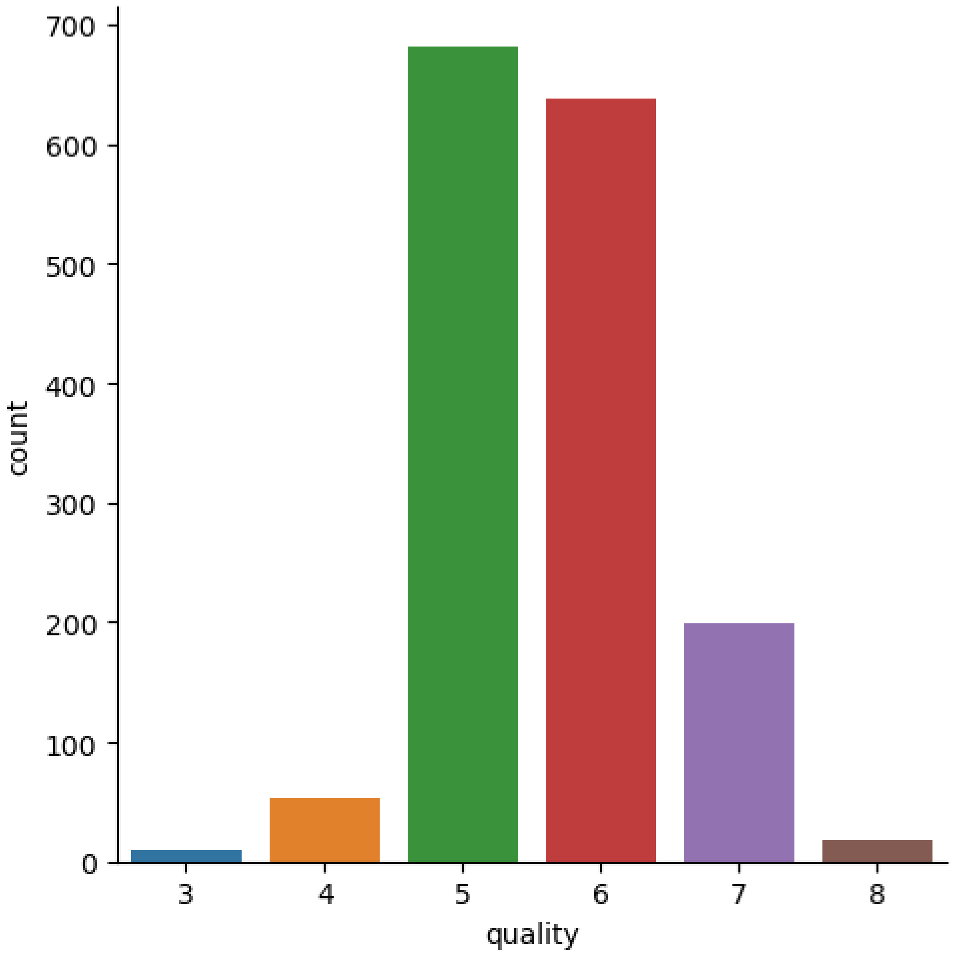
```
In [16]: # data analysis and visualization
         df.describe()
```

Out[16]:

	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
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
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

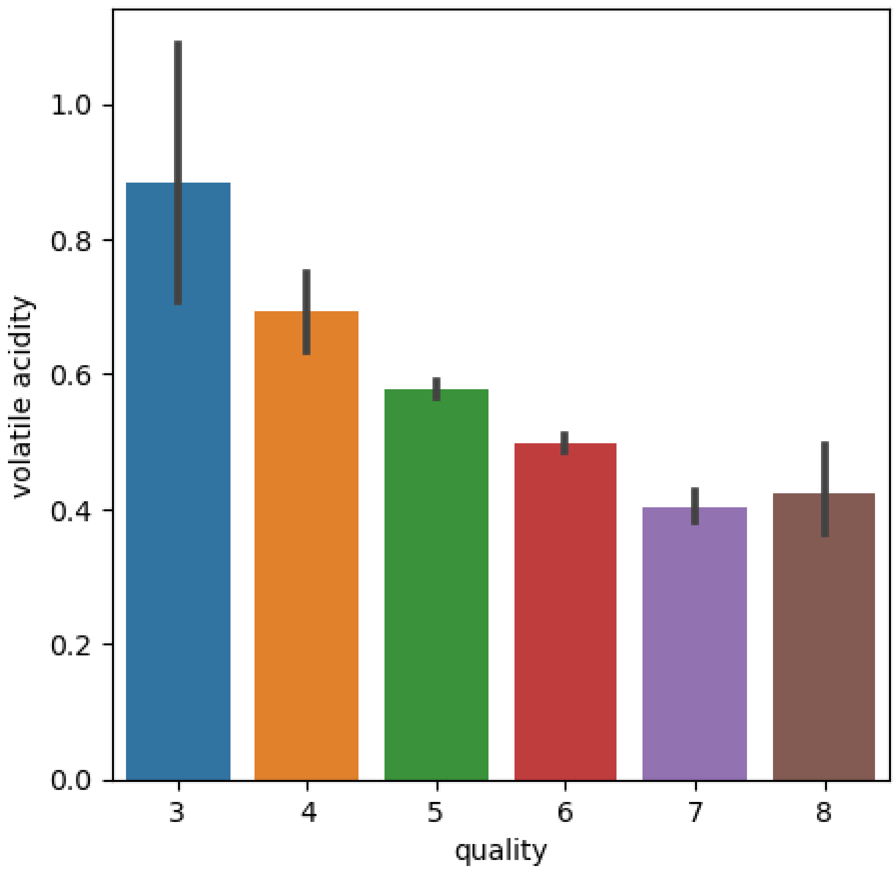
```
In [17]: # Number of values of each quality
         sns.catplot(x='quality', data = df, kind = "count")
```

```
Out[17]: <seaborn.axisgrid.FacetGrid at 0x1e5f2df6dd0>
```



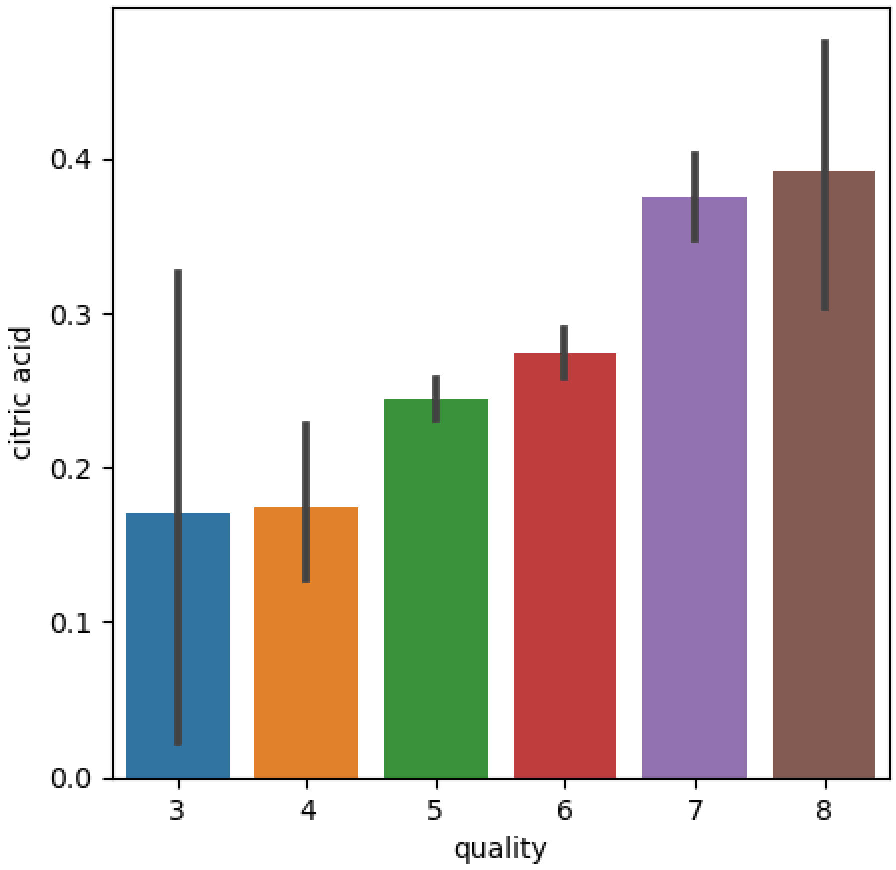
In [18]:
```
# volatile Acidity v/s Quality
plot = plt.figure(figsize=(5,5))
sns.barplot(x= 'quality', y = 'volatile acidity', data = df)
print('volatile acidity is inversely proptional to quality')
```

```
volatile acidity is inversely proptional to quality
```



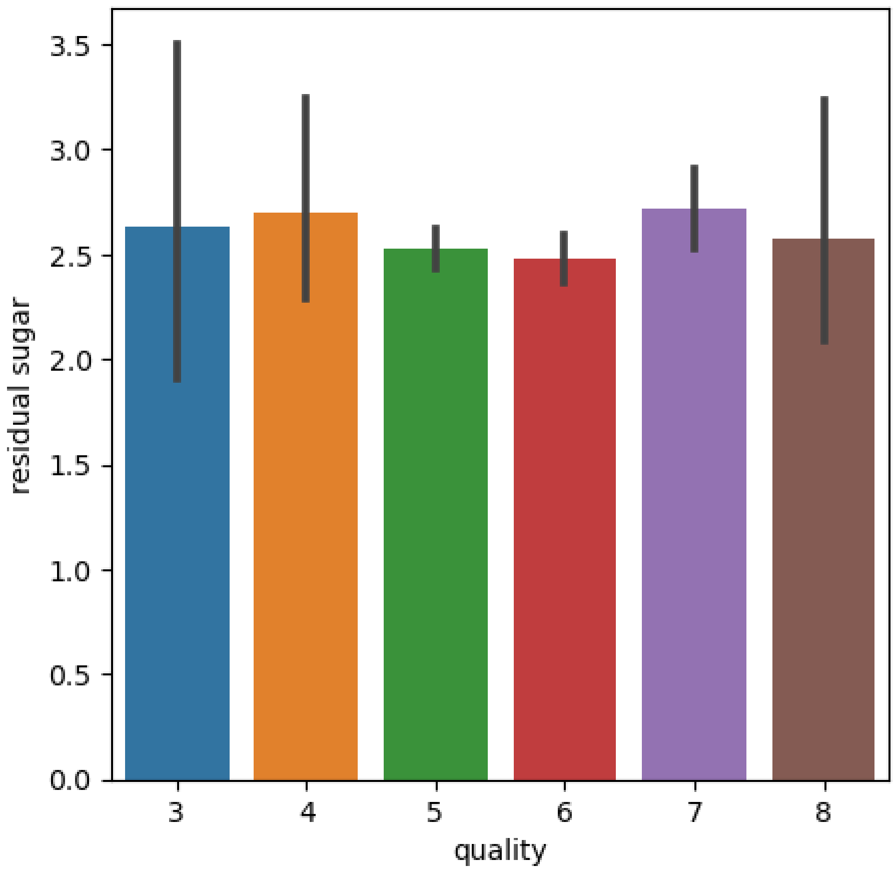
In [19]:
```
# citric acid v/s Quality
plot = plt.figure(figsize=(5,5))
sns.barplot(x= 'quality', y = 'citric acid', data = df)
print('volatile acidity is directly proptional to quality')
```

```
volatile acidity is directly proptional to quality
```



In [20]:
```
# residual sugar v/s Quality
plot = plt.figure(figsize=(5,5))
sns.barplot(x= 'quality', y = 'residual sugar', data = df)
```

Out[20]:
```
<Axes: xlabel='quality', ylabel='residual sugar'>
```



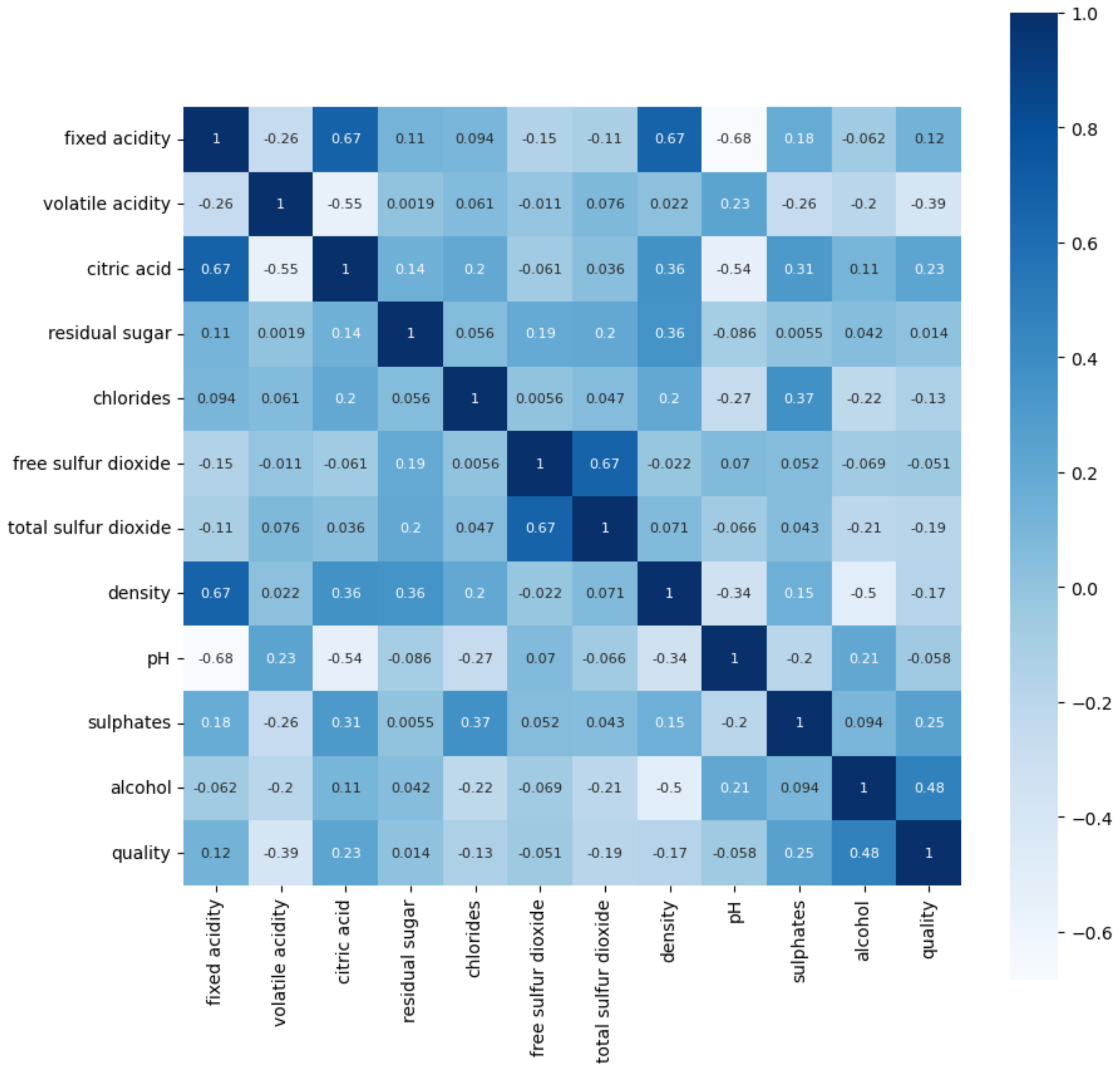
In [21]:
```
correlation = df.corr()
correlation
```

```
Out[21]:
```

	fixed acidity	volatile acidity	citric acid	residual sugar	chlorides	free sulfur dioxide	total sulfur dioxide	density
fixed acidity	1.000000	-0.256131	0.671703	0.114777	0.093705	-0.153794	-0.113181	0.668047
volatile acidity	-0.256131	1.000000	-0.552496	0.001918	0.061298	-0.010504	0.076470	0.022026
citric acid	0.671703	-0.552496	1.000000	0.143577	0.203823	-0.060978	0.035533	0.364947
residual sugar	0.114777	0.001918	0.143577	1.000000	0.055610	0.187049	0.203028	0.355283
chlorides	0.093705	0.061298	0.203823	0.055610	1.000000	0.005562	0.047400	0.200632
free sulfur dioxide	-0.153794	-0.010504	-0.060978	0.187049	0.005562	1.000000	0.667666	-0.021946
total sulfur dioxide	-0.113181	0.076470	0.035533	0.203028	0.047400	0.667666	1.000000	0.071269
density	0.668047	0.022026	0.364947	0.355283	0.200632	-0.021946	0.071269	1.000000
pH	-0.682978	0.234937	-0.541904	-0.085652	-0.265026	0.070377	-0.066495	-0.341699
sulphates	0.183006	-0.260987	0.312770	0.005527	0.371260	0.051658	0.042947	0.148506
alcohol	-0.061668	-0.202288	0.109903	0.042075	-0.221141	-0.069408	-0.205654	-0.496180
quality	0.124052	-0.390558	0.226373	0.013732	-0.128907	-0.050656	-0.185100	-0.174919

```
In [22]: plt.figure(figsize=(10,10))
         sns.heatmap(correlation, cbar = True, square = True, annot = True, annot_kws={'siz
```

```
Out[22]: <Axes: >
```



In [23]:
```
#data prepocessing
x = df.drop('quality',axis=1)
```

In [24]:
```
print(x)
```

```
      fixed acidity  volatile acidity  citric acid  residual 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
0         9.4
1         9.8
2         9.8
3         9.8
4         9.4
...       ...
1594     10.5
1595     11.2
1596     11.0
1597     10.2
1598     11.0

[1599 rows x 11 columns]
```

In [26]:
```
#label binarization
Y = df['quality'].apply(lambda y_value: 1 if y_value>= 7 else 0)

print(Y)
```

```
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 [27]:
```
#train & Test Split

X_train, X_test, Y_train, Y_test = train_test_split(x, Y, test_size=0.2, random_st
In [28]: print(Y.shape, Y_train.shape, Y_test.shape)

(1599,) (1279,) (320,)
```

```
In [29]: #Model Training: Random Forest Classifier
model = RandomForestClassifier()
```

```
In [30]: model.fit(X_train, Y_train)

Out[30]: ▾ RandomForestClassifier
RandomForestClassifier()
```

```
In [31]: #Accuracy Score
# accuracy on test data
X_test_prediction = model.predict(X_test)
test_data_accuracy = accuracy_score(X_test_prediction, Y_test)
```

```
In [32]: print('Accuracy : ', test_data_accuracy)

Accuracy :  0.925
```

```
In [33]: #Building a Predictive System
```

```
In [34]: input_data = ('7.3,0.65,0.0,1.2,0.065,15.0,21.0,0.9946,3.39,0.47,10.0,')
```

```
In [35]: input_data = (7.5,0.5,0.36,6.1,0.071,17.0,102.0,0.9978,3.35,0.8,10.5)
```

```
In [36]: input_data_as_numpy_array = np.asarray(input_data)
```

```
In [37]: input_data_reshaped = input_data_as_numpy_array.reshape(1,-1)
```

```
In [38]: prediction = model.predict(input_data_reshaped)
print(prediction)

if (prediction[0]==1):
  print('Good Quality Wine')
else:
  print('Bad Quality Wine')

[0]
Bad Quality Wine
```

```
In [ ]:
```