IT350 Data Analytics Assignment

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Descriptive Analysis of Wine Quality Dataset

About the dataset

The dataset is taken from the UCIML Respository (https://archive.ics.uci.edu/ml/datasets/wine+quality). The goal of the dataset is to model wine quality based on physicochemical tests. The wines are rated in a range of 0-10 based on their quality.

The dataset contains total 11 attributes out of which 10 are input variables and 1 is the output variable.

Input variables (based on physicochemical tests):
1 - fixed acidity
2 - volatile acidity
3 - citric acid
4 - residual sugar
5 - chlorides
6 - free sulfur dioxide
7 - total sulfur dioxide
8 - density
9 - pH
10 - sulphates
11 - alcohol

Output variable (based on sensory data):
12 - quality (score between 0 and 10)

Following is the citation of dataset:
P. Cortez, A. Cerdeira, F. Almeida, T. Matos and J. Reis.
Modeling wine preferences by data mining from physicochemical properties.
In Decision Support Systems, Elsevier, 47(4):547-553. ISSN: 0167-9236.

Available at: [@Elsevier] http://dx.doi.org/10.1016/j.dss.2009.05.016
[Pre-press (pdf)] http://www3.dsi.uminho.pt/pcortez/winequality09.pdf
[bib] http://www3.dsi.uminho.pt/pcortez/dss09.bib

In [2]:
```
# Importing the libraries
import pandas as pd
import matplotlib.pyplot as plt
import numpy as np
import scipy.stats as stats
```

In [3]:
```
# Importing the Dataset
# Source: https://archive.ics.uci.edu/ml/datasets/wine+quality
data = pd.read_csv("winequality-white.csv", delimiter=";")
```

Exploring the dataset

In [5]:
```
data.head(len(data))
```

Out[5]:

	fixed acidity	volatile acidity	citric acid	residual sugar	chlorides	free sulfur dioxide	total sulfur dioxide	density	pH	sulphates	alcohol	quality
0	7.0	0.27	0.36	20.7	0.045	45.0	170.0	1.00100	3.00	0.45	8.8	6
1	6.3	0.30	0.34	1.6	0.049	14.0	132.0	0.99400	3.30	0.49	9.5	6
2	8.1	0.28	0.40	6.9	0.050	30.0	97.0	0.99510	3.26	0.44	10.1	6
3	7.2	0.23	0.32	8.5	0.058	47.0	186.0	0.99560	3.19	0.40	9.9	6
4	7.2	0.23	0.32	8.5	0.058	47.0	186.0	0.99560	3.19	0.40	9.9	6
...	...	...	...	...	...	...	...	...	...	...	...	...
4893	6.2	0.21	0.29	1.6	0.039	24.0	92.0	0.99114	3.27	0.50	11.2	6
4894	6.6	0.32	0.36	8.0	0.047	57.0	168.0	0.99490	3.15	0.46	9.6	5
4895	6.5	0.24	0.19	1.2	0.041	30.0	111.0	0.99254	2.99	0.46	9.4	6
4896	5.5	0.29	0.30	1.1	0.022	20.0	110.0	0.98869	3.34	0.38	12.8	7
4897	6.0	0.21	0.38	0.8	0.020	22.0	98.0	0.98941	3.26	0.32	11.8	6

4898 rows × 12 columns

Observations:

We observe that the dataset has a total of 4897 instances and a total of 12 attributes. The dataset is complete and has no missing values. The last column **quality** is the class label of a row nad rest all columns are independent of each other.

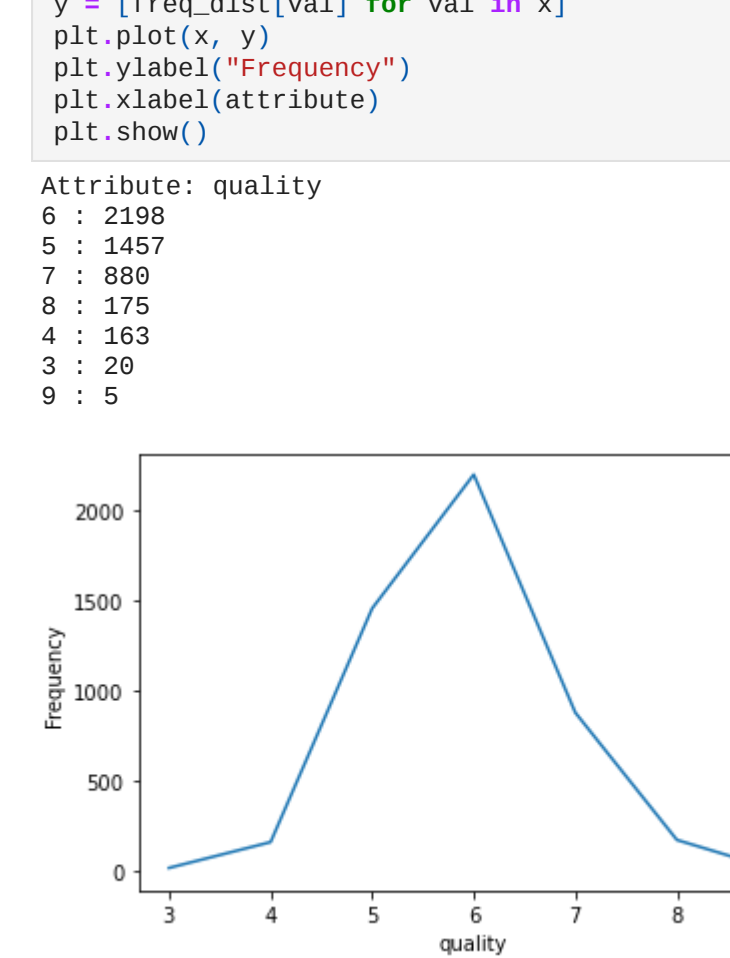
All the input variable attributes are **floating point numbers** and the class label is an **integer**.

In [9]:
```
# Categorizing data into numerical data and the result data
num_data = data.columns[:-1]
class_label = ["quality"]
```

Frequency Distribution of of class labels

In [10]:
```
# Frequency Distribution of Quality

attribute = "quality"
freq_dist = dict.fromkeys(data[attribute].unique(), 0)
for a in range(len(data[attribute])):
    freq_dist[data[attribute][a]] += 1

print("Attribute:", attribute)
for val in data[attribute].unique():
    print(val, ":", freq_dist[val])
print()

x = sorted(data[attribute].unique())
y = [freq_dist[val] for val in x]
plt.plot(x, y)
plt.ylabel("Frequency")
plt.xlabel(attribute)
plt.show()
```

```
Attribute: quality
6 : 2198
5 : 1457
7 : 880
8 : 175
4 : 163
3 : 20
9 : 5
```

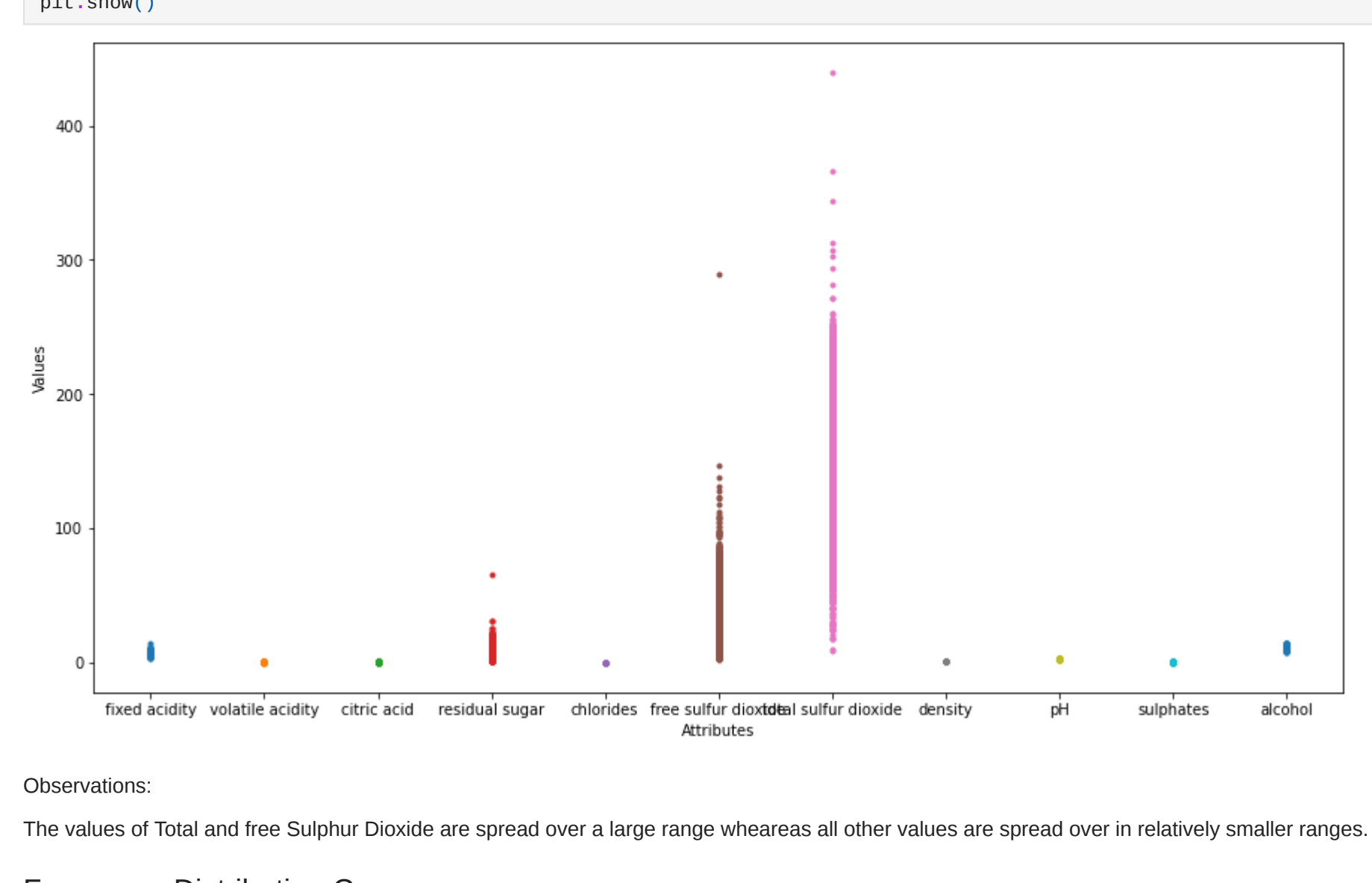


Observations:

As we can visulaize from the graphs, the data is distributed only among the classes **3 to 9**. Out of which majority of the data is distributed among the middle quality classes of **5 to 7**. Therefore the data is **not uniformly distributed**.

Frequncy distribution of attributes

In [18]:
```
# Graphical frequency distribution of Numerical Attributes
f = plt.figure()
f.set_figwidth(15)
f.set_figheight(8)
for a in range(len(num_data)):
    plt.plot(len(data[num_data[a]]) * [a], data[num_data[a]], ".")

plt.ylabel("Values")
plt.xlabel("Attributes")
plt.xticks([a for a in range(len(num_data))], num_data)
plt.show()
```

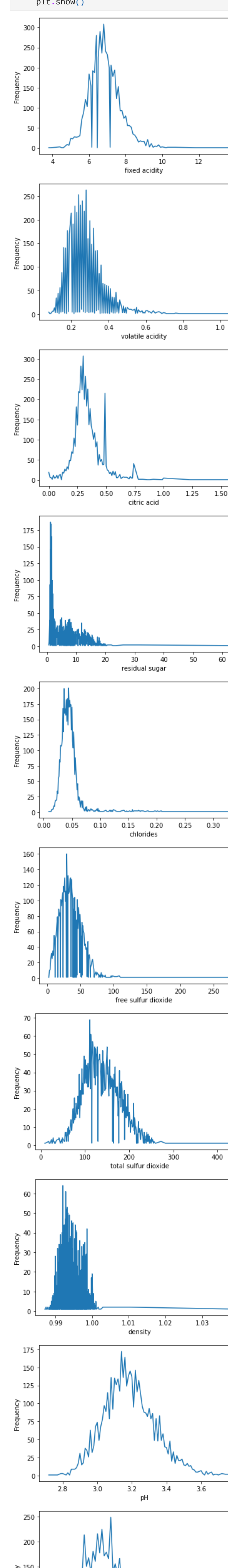


Observations:

The values of Total and free Sulphur Dioxide are spread over a large range wheareas all other values are spread over in relatively smaller ranges.

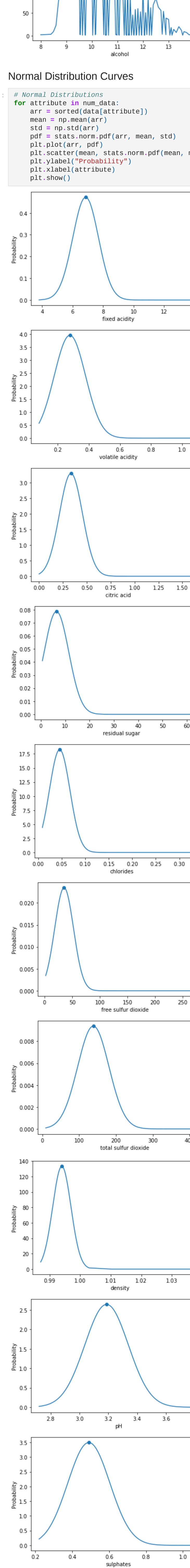
Frequency Distribution Curves

In [19]:
```
# Frequncy Distribution of each numerical attribute

for attribute in num_data:
    freq_dist = dict.fromkeys(data[attribute].unique(), 0)
    for a in range(len(data[attribute])):
        freq_dist[data[attribute][a]] += 1

    x = sorted(data[attribute].unique())
    y = [freq_dist[val] for val in x]
    plt.plot(x, y)
    plt.ylabel("Frequency")
    plt.xlabel(attribute)
    plt.show()
```



Normal Distribution Curves

In [29]:
```
# Normal Distributions
for attribute in num_data:
    arr = sorted(data[attribute])
    mean = np.mean(arr)
    std = np.std(arr)
    pdf = stats.norm.pdf(arr, mean, std)
    plt.plot(arr, pdf)
    plt.scatter(mean, stats.norm.pdf(mean, mean, std))
    plt.ylabel("Probability")
    plt.xlabel(attribute)
    plt.show()
```

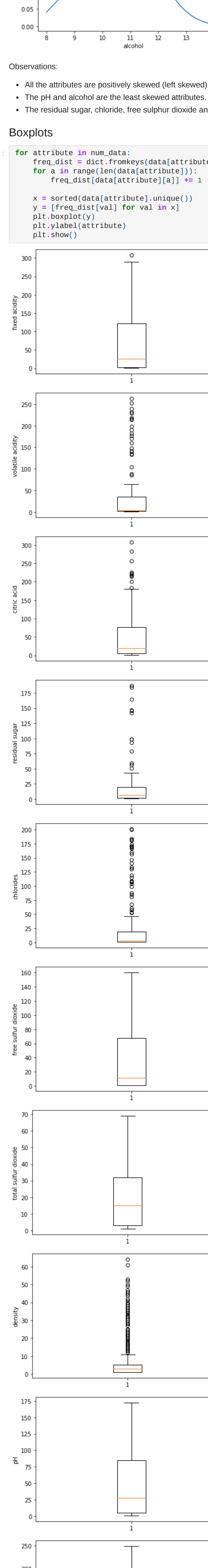


Observations:

- All the attributes are positively skewed (left skewed). Most of their data is concentrated towards the left side.
- The pH and alcohol are the least skewed attributes.
- The residual sugar, chloride, free sulphur dioxide and density attributes are the most skewed attributes.

Boxplots

In [30]:
```
for attribute in num_data:
    freq_dist = dict.fromkeys(data[attribute].unique(), 0)
    for a in range(len(data[attribute])):
        freq_dist[data[attribute][a]] += 1

    x = sorted(data[attribute].unique())
    y = [freq_dist[val] for val in x]
    plt.boxplot(y)
    plt.ylabel(attribute)
    plt.show()
```



Observations:

- Outliers are present in moret than half of the attributes.
- All the attributes are in the positive side.
- The attributes Free Sulphur dioxide, total sulphur dioxide, pH and sulpahtes **do not contain outliers.**
- The attributes denisty and chlorides contain **most number of outliers**

Summary Statistics

Measures of Central Tendency

In [13]:
```
# Measures of Central Tendency

Central = pd.DataFrame(num_data, columns=["Attribute"])
Central["Arithmetic Mean"] = [data[column].mean() for column in num_data]
Central["Mode"] = [data.mode().iloc[0][column] for column in num_data]
Central["Lower Quartile"] = [data[column].quantile(0.25) for column in num_data]
Central["Median"] = [data[column].median() for column in num_data]
Central["Upper Quartile"] = [data[column].quantile(0.75) for column in num_data]

Central.head(len(num_data))
```

Out[13]:

	Attribute	Arithmetic Mean	Mode	Lower Quartile	Median	Upper Quartile
0	fixed acidity	6.854788	6.800	6.300000	6.80000	7.3000
1	volatile acidity	0.278241	0.280	0.210000	0.26000	0.3200
2	citric acid	0.334192	0.300	0.270000	0.32000	0.3900
3	residual sugar	6.391415	1.200	1.700000	5.20000	9.9000
4	chlorides	0.045772	0.044	0.036000	0.04300	0.0500
5	free sulfur dioxide	35.308085	29.000	23.000000	34.00000	46.0000
6	total sulfur dioxide	138.360657	111.000	108.000000	134.00000	167.0000
7	density	0.994027	0.992	0.991723	0.99374	0.9961
8	pH	3.188267	3.140	3.090000	3.18000	3.2800
9	sulphates	0.489847	0.500	0.410000	0.47000	0.5500
10	alcohol	10.514267	9.400	9.500000	10.40000	11.4000

Measures of Dispersion

In [14]:
```
# Measures of Dispersion

Dispersion = pd.DataFrame(num_data, columns=["Attribute"])
Dispersion["Minimum"] = [data[column].min() for column in num_data]
Dispersion["Maximum"] = [data[column].max() for column in num_data]
Dispersion["Standard Deviation"] = [data[column].std() for column in num_data]
Dispersion["Variance"] = [data[column].std() ** 2 for column in num_data]

Dispersion.head(len(num_data))
```

Out[14]:

	Attribute	Minimum	Maximum	Standard Deviation	Variance
0	fixed acidity	3.80000	14.20000	0.843868	0.712114
1	volatile acidity	0.08000	1.10000	0.100795	0.010160
2	citric acid	0.00000	1.66000	0.121020	0.014646
3	residual sugar	0.60000	65.80000	5.072058	25.725770
4	chlorides	0.00900	0.34600	0.021848	0.000477
5	free sulfur dioxide	2.00000	289.00000	17.007137	289.242720
6	total sulfur dioxide	9.00000	440.00000	42.498065	1806.085491
7	density	0.98711	1.03898	0.002991	0.000009
8	pH	2.72000	3.82000	0.151001	0.022801
9	sulphates	0.22000	1.08000	0.114126	0.013025
10	alcohol	8.00000	14.20000	1.230621	1.514427

In [ ]: