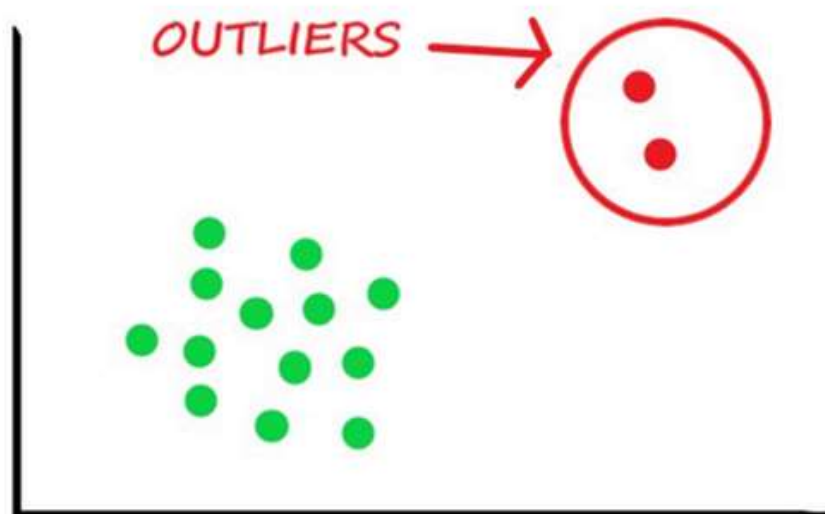


ML-Cheat-Codes (/github/nikitaprasad21/ML-Cheat-Codes/tree/main)  
/ Feature-Engineering (/github/nikitaprasad21/ML-Cheat-Codes/tree/main/Feature-Engineering)  
/  
Outlier-Handling (/github/nikitaprasad21/ML-Cheat-Codes/tree/main/Feature-Engineering/Outlier-Handling)

## What are Outliers? 🤔

An Outlier is an observation in a given dataset that lies "far" from the rest of the observations. That means an outlier is vastly larger or smaller than the remaining values in the set.



### Why Do they Occur?

An outlier may occur due to the variability in the data, or due to experimental error/human error.

They may indicate an experimental error or heavy skewness in the data (heavy-tailed distribution).

### What Do They Affect?

In statistics, we have three measures of central tendency namely Mean, Median, and Mode. They help us describe the data.

- **Mean** is the accurate measure to describe the data when we do not have any outliers present.
- **Mean'** is the only measure of central tendency that is affected by the outliers which in turn impacts Standard deviation.
- **Median** is used if there is an outlier in the dataset.
- **Mode** is used if there is an outlier AND about ½ or more of the data is the same.

## Detecting Outliers

If our dataset is small, we can detect the outlier by just looking at the dataset. But what if we have a huge dataset, how do we identify the outliers then? We need to use visualization and mathematical techniques.

Below are some of the techniques of detecting outliers

- Boxplots
- Z-score
- Inter Quantile Range(IQR)

## How to Handle Outliers?

Below are some of the methods of treating the outliers:

### Method 1: Trimming/Remove the outliers

In this technique, we remove the outliers from the dataset. Although it is not a good practice to follow.

### Method 2: Quantile Based Flooring and Capping

In this technique, the outlier is capped at a certain value above the 90th percentile value or floored at a factor below the 10th percentile value. Python code to delete the outlier and copy the rest of the elements to another array.

### Method 3: Mean/Median Imputation

As the mean value is highly influenced by the outliers, it is advised to replace the outliers with the median value.

```
In [149... import numpy as np
import pandas as pd
import matplotlib.pyplot as plt
import seaborn as sns
```

```
In [150... data = pd.read_csv("scores.csv")
data.shape
```

```
Out[150]: (80, 3)
```

In [151... `data.sample(5)`

Out[151]:

	Emotional_Quotient	Intelligence_Quotient	Marks
21	70	215	75
19	72	130	77
3	75	129	78
9	64	130	76
13	73	151	74

In [152... `data.describe()`

Out[152]:

	Emotional_Quotient	Intelligence_Quotient	Marks
count	80.000000	80.000000	80.000000
mean	73.125000	145.262500	76.062500
std	6.672018	21.560479	9.195959
min	50.000000	120.000000	45.000000
25%	68.000000	130.000000	72.000000
50%	73.000000	135.000000	76.000000
75%	78.000000	160.250000	81.250000
max	92.000000	215.000000	100.000000

## Distribution plot of all three columns

In [153... `plt.figure(figsize=(16,5))`  
`plt.subplot(1,3,1)`  
`sns.distplot(data['Emotional_Quotient'])`  
  
`plt.subplot(1,3,2)`  
`sns.distplot(data['Intelligence_Quotient'])`  
  
`plt.subplot(1,3,3)`  
`sns.distplot(data['Marks'])`  
  
`plt.show()`

```
c:\Users\lenovo\anaconda3\lib\site-packages\seaborn\distributions.py:2619: FutureWarning: `distplot` is a deprecated function and will be removed in a future version. Please adapt your code to use either `displot` (a figure-level function with similar flexibility) or `histplot` (an axes-level function for histograms).
```

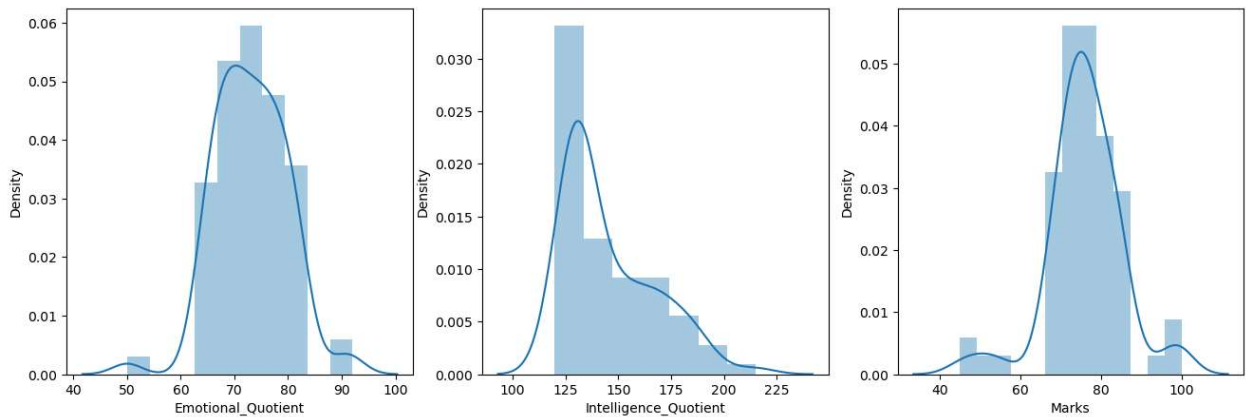
```
warnings.warn(msg, FutureWarning)
```

```
c:\Users\lenovo\anaconda3\lib\site-packages\seaborn\distributions.py:2619: FutureWarning: `distplot` is a deprecated function and will be removed in a future version. Please adapt your code to use either `displot` (a figure-level function with similar flexibility) or `histplot` (an axes-level function for histograms).
```

```
warnings.warn(msg, FutureWarning)
```

```
c:\Users\lenovo\anaconda3\lib\site-packages\seaborn\distributions.py:2619: FutureWarning: `distplot` is a deprecated function and will be removed in a future version. Please adapt your code to use either `displot` (a figure-level function with similar flexibility) or `histplot` (an axes-level function for histograms).
```

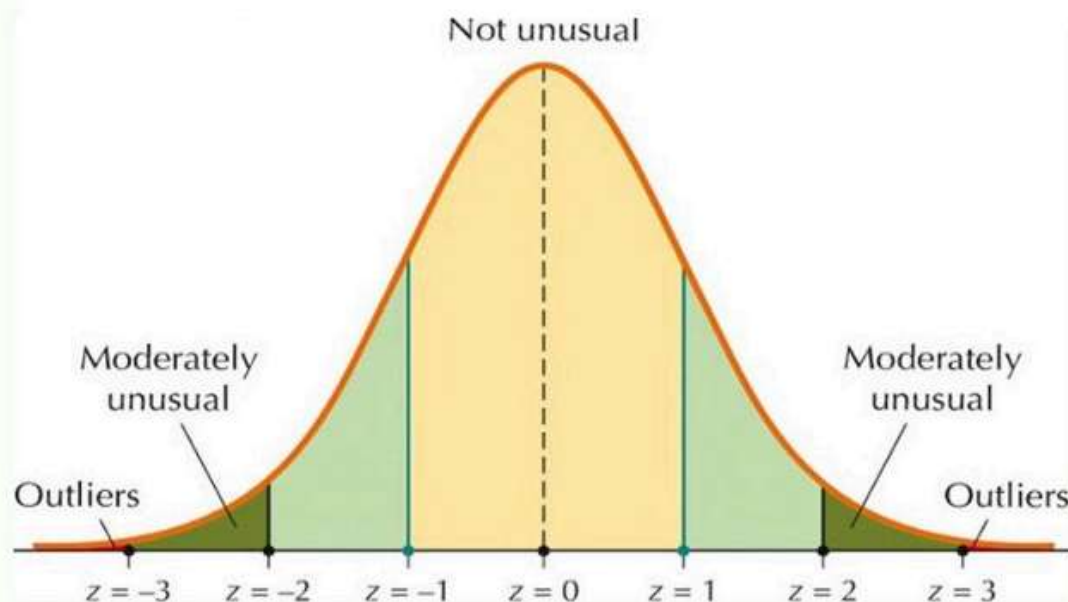
```
warnings.warn(msg, FutureWarning)
```



## 1. Detecting Outliers using the Z-scores

Criteria: Data should be normal or almost normally distributed. Any data point whose Z-score falls out of 3rd standard deviation is an outlier.

## Detecting Outliers with z-Scores



```
In [154... z_score_upper_limit = data['Emotional_Quotient'].mean() + 3*data['Emotional_Quotient'].
z_score_lower_limit = data['Emotional_Quotient'].mean() - 3*data['Emotional_Quotient'].
```

```
In [155... z_score_upper_limit
```

```
Out[155]: 93.14105368356338
```

```
In [156... z_score_lower_limit
```

```
Out[156]: 53.108946316436615
```

## Capping

In this technique called "outlier detection," we cap our data to set limits.

```
In [157... data["Emotional_Quotient"] = np.where(
    data["Emotional_Quotient"] > z_score_upper_limit,
    z_score_upper_limit,
    np.where(
        data["Emotional_Quotient"] < z_score_lower_limit,
        z_score_lower_limit,
        data["Emotional_Quotient"]
    )
)
```

```
In [158... data.describe()
```

Out[158]:

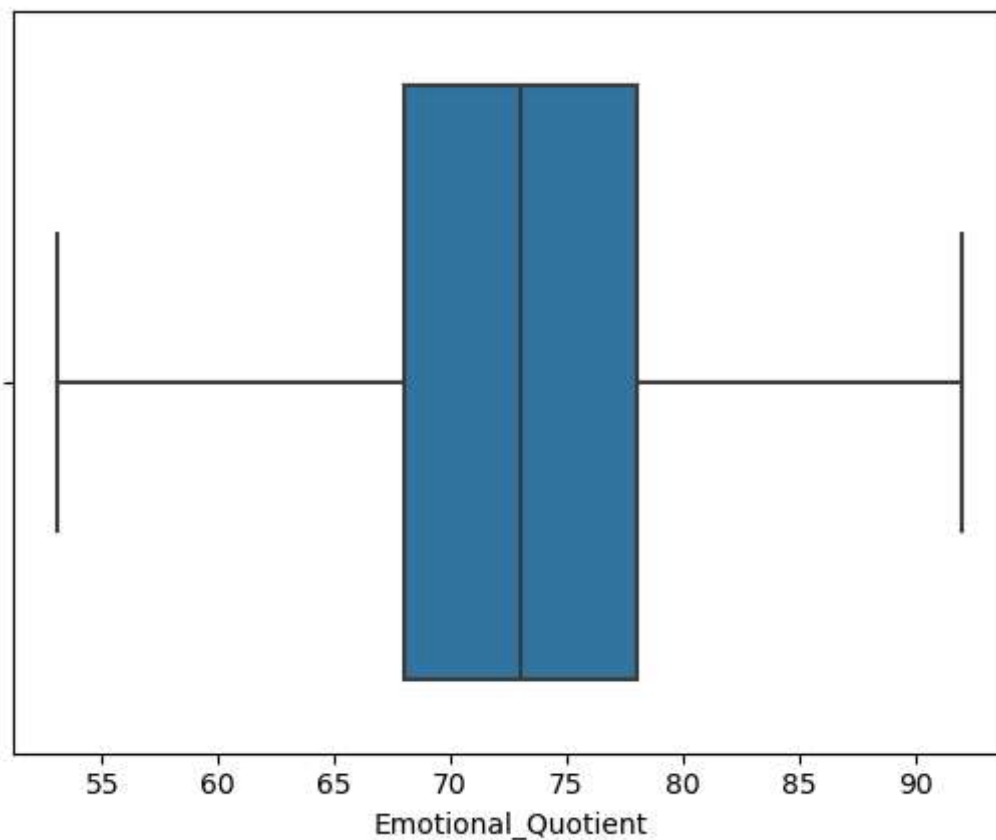
	Emotional_Quotient	Intelligence_Quotient	Marks
<b>count</b>	80.000000	80.000000	80.000000
<b>mean</b>	73.163862	145.262500	76.062500
<b>std</b>	6.543434	21.560479	9.195959
<b>min</b>	53.108946	120.000000	45.000000
<b>25%</b>	68.000000	130.000000	72.000000
<b>50%</b>	73.000000	135.000000	76.000000
<b>75%</b>	78.000000	160.250000	81.250000
<b>max</b>	92.000000	215.000000	100.000000

In [159... `sns.boxplot(data["Emotional_Quotient"])`

c:\Users\lenovo\anaconda3\lib\site-packages\seaborn\\_decorators.py:36: FutureWarning: Pass the following variable as a keyword arg: x. From version 0.12, the only valid positional argument will be `data`, and passing other arguments without an explicit keyword will result in an error or misinterpretation.

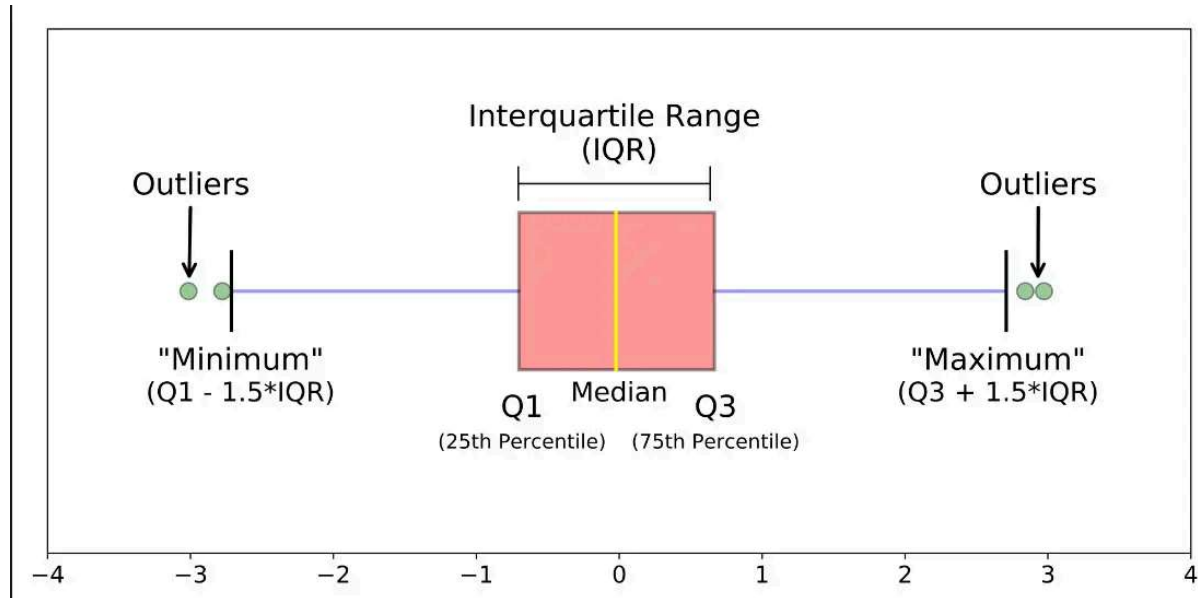
```
warnings.warn(
```

Out[159]: `<AxesSubplot:xlabel='Emotional_Quotient'>`



## 2. Detecting Outliers using the Inter Quartile Range(IQR)

Criteria: If data is skewed or not normally distributed then data points that lie 1.5 times of IQR above Q3 and below Q1 are outliers.



In statistics, interquartile range or IQR is a quantity that measures the difference between the first and the third quartiles in a given dataset.

- The first quartile is also called the one-fourth quartile, or the 25% quartile .
- If q25 is the first quartile, it means 25% of the points in the dataset have values less than q25.
- The third quartile is also called the three-fourth, or the 75% quartile .
- If q75 is the three-fourth quartile, 75% of the points have values less than q75.
- Using the above notations,  $IQR = q75 - q25$  .

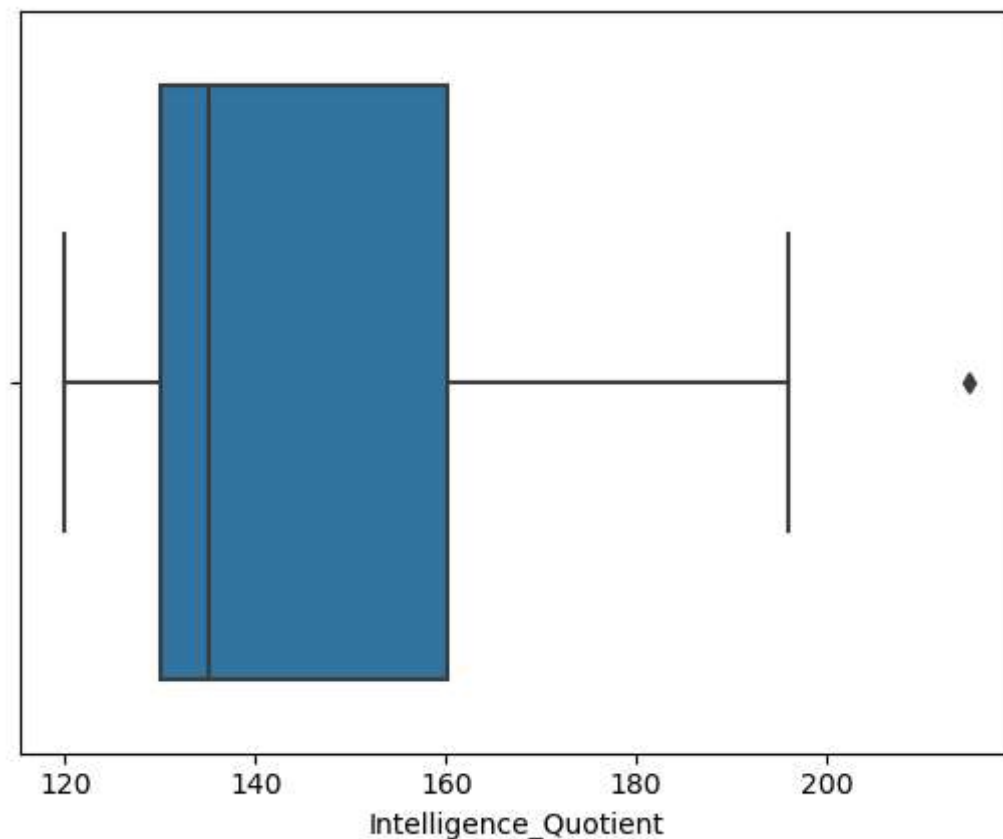
```
In [160...] data["Intelligence_Quotient"].skew()
```

```
Out[160]: 1.0638929876178798
```

```
In [162...] sns.boxplot(data['Intelligence_Quotient'])
```

```
c:\Users\lenovo\anaconda3\lib\site-packages\seaborn\_decorators.py:36: FutureWarning:
Pass the following variable as a keyword arg: x. From version 0.12, the only valid positional argument will be `data`, and passing other arguments without an explicit keyword will result in an error or misinterpretation.
warnings.warn(
```

```
Out[162]: <AxesSubplot:xlabel='Intelligence_Quotient'>
```



```
In [163... # Finding the IQR
percentile25 = data['Intelligence_Quotient'].quantile(0.25)
percentile75 = data['Intelligence_Quotient'].quantile(0.75)
```

```
In [164... percentile25
```

```
Out[164]: 130.0
```

```
In [165... percentile75
```

```
Out[165]: 160.25
```

```
In [166... iqr = percentile75 - percentile25
iqr
```

```
Out[166]: 30.25
```

```
In [167... iqr_upper_limit = percentile75 + 1.5 * iqr
iqr_lower_limit = percentile25 - 1.5 * iqr

print("Upper limit", iqr_upper_limit)
print("Lower limit", iqr_lower_limit)
```

```
Upper limit 205.625
Lower limit 84.625
```

```
In [168... data[data['Intelligence_Quotient'] > iqr_upper_limit]
```



Out[168]:

	Emotional_Quotient	Intelligence_Quotient	Marks
21	70.0	215	75

In [169... data[data['Intelligence\_Quotient'] < iqr\_lower\_limit]

Out[169]:

	Emotional_Quotient	Intelligence_Quotient	Marks
--	--------------------	-----------------------	-------

In [170... data["Intelligence\_Quotient"] = np.where(  
 data["Intelligence\_Quotient"] > iqr\_upper\_limit,  
 iqr\_upper\_limit,  
 np.where(  
 data["Intelligence\_Quotient"] < iqr\_lower\_limit,  
 iqr\_lower\_limit,  
 data["Intelligence\_Quotient"]  
 )  
 )

In [171... data.describe()

Out[171]:

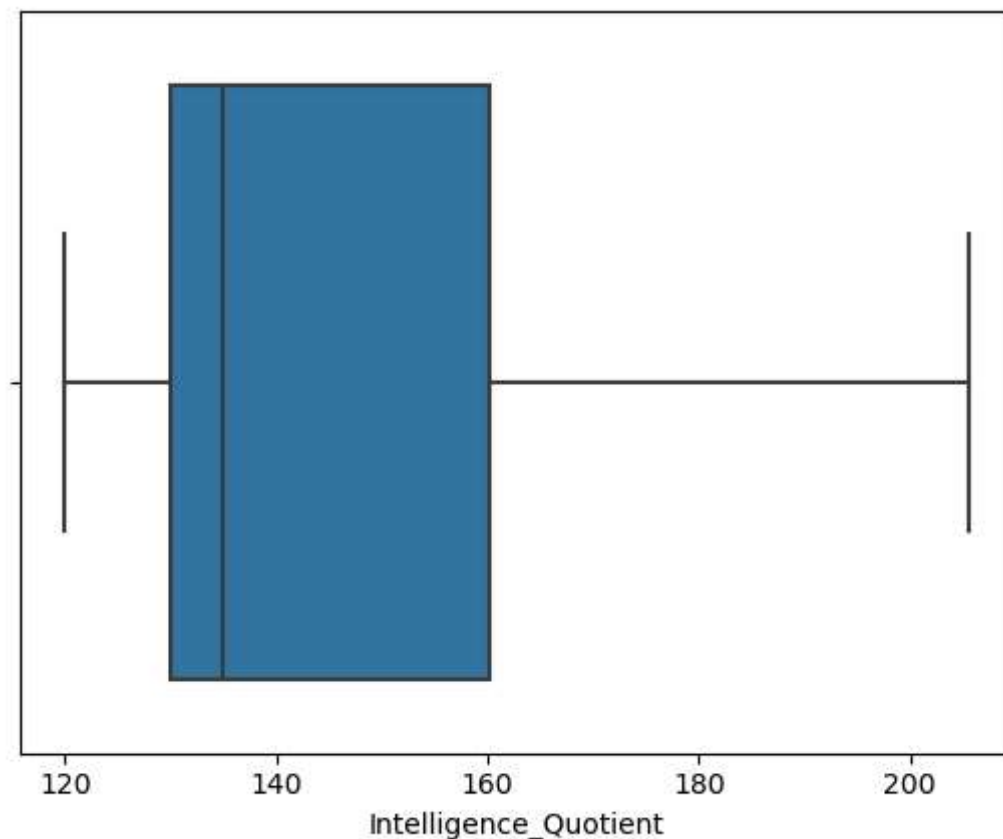
	Emotional_Quotient	Intelligence_Quotient	Marks
count	80.000000	80.000000	80.000000
mean	73.163862	145.145312	76.062500
std	6.543434	21.199087	9.195959
min	53.108946	120.000000	45.000000
25%	68.000000	130.000000	72.000000
50%	73.000000	135.000000	76.000000
75%	78.000000	160.250000	81.250000
max	92.000000	205.625000	100.000000

In [172... sns.boxplot(data['Intelligence\_Quotient'])

c:\Users\lenovo\anaconda3\lib\site-packages\seaborn\\_decorators.py:36: FutureWarning:  
 Pass the following variable as a keyword arg: x. From version 0.12, the only valid pos  
 itional argument will be `data`, and passing other arguments without an explicit keywo  
 rd will result in an error or misinterpretation.

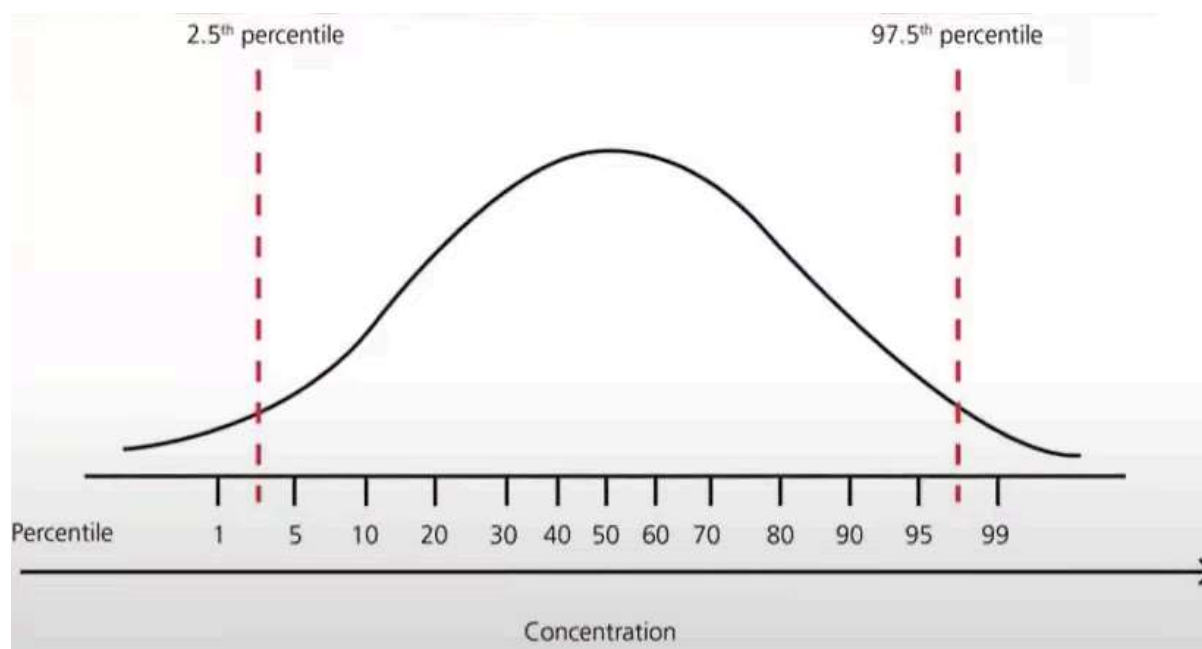
warnings.warn(  
 )

Out[172]: <AxesSubplot:xlabel='Intelligence\_Quotient'>



### 3. Detecting Outliers Using Percentile

Defining a custom range that accommodates all data points that lie anywhere between 0.5 and 99.5 percentile of the dataset.



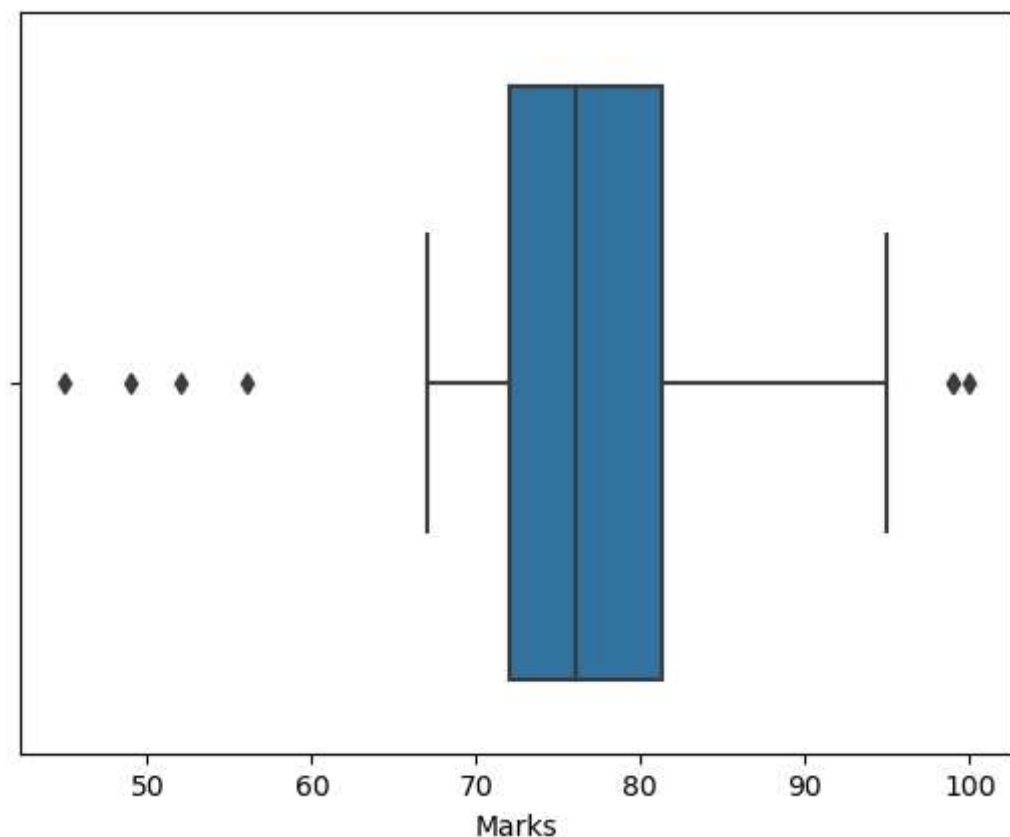
To do this, set `q = [0.10, 90.0]` in the percentile function.

In [173... `sns.boxplot(data[ 'Marks ' ])`

```
c:\Users\lenovo\anaconda3\lib\site-packages\seaborn\_decorators.py:36: FutureWarning:
Pass the following variable as a keyword arg: x. From version 0.12, the only valid positional argument will be `data`, and passing other arguments without an explicit keyword will result in an error or misinterpretation.
```

```
warnings.warn(
```

```
Out[173]: <AxesSubplot:xlabel='Marks'>
```



## What is winsorization in outliers?

Winsorization is the process of replacing the extreme values of statistical data in order to limit the effect of the outliers on the calculations or the results obtained by using that data.

```
In [174... upper_limit = data['Marks'].quantile(0.90)
upper_limit
```

```
Out[174]: 85.0
```

```
In [175... lower_limit = data['Marks'].quantile(0.10)
lower_limit
```

```
Out[175]: 68.0
```

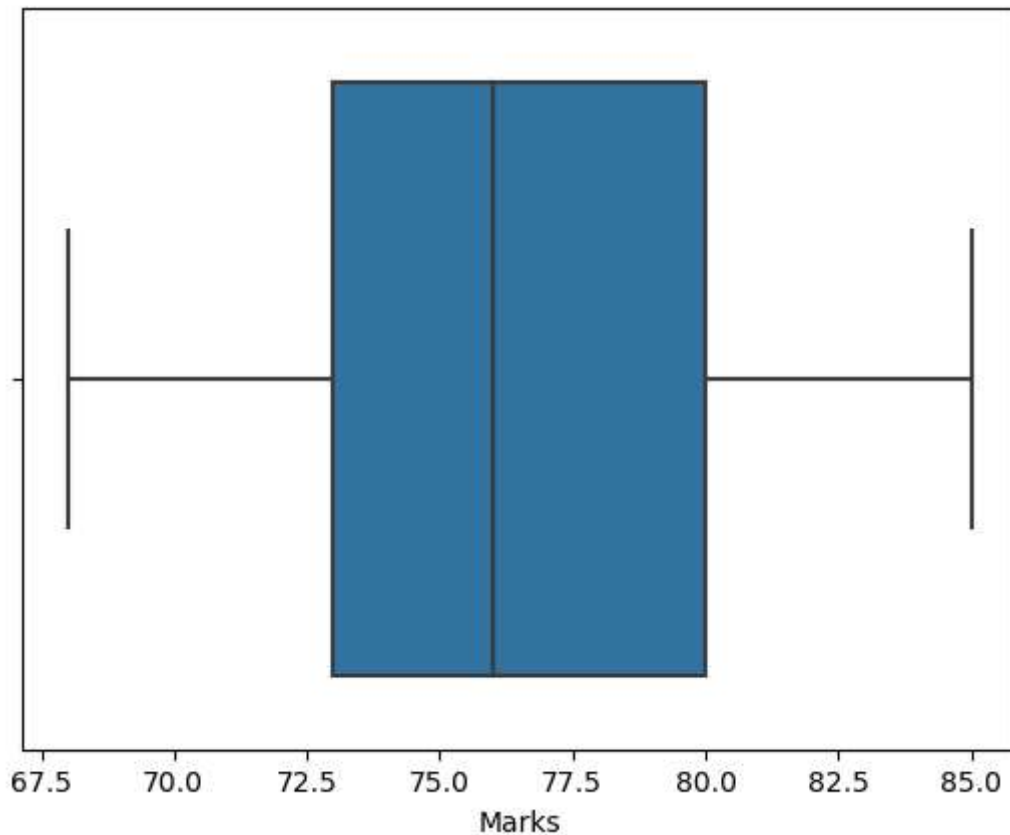
```
In [176... data = data[(data['Marks'] <= upper_limit) & (data['Marks'] >= lower_limit)]
```

```
In [177... sns.boxplot(data["Marks"])
```

```
c:\Users\lenovo\anaconda3\lib\site-packages\seaborn\_decorators.py:36: FutureWarning:
Pass the following variable as a keyword arg: x. From version 0.12, the only valid pos
itional argument will be `data`, and passing other arguments without an explicit keywo
rd will result in an error or misinterpretation.
```

```
warnings.warn(
```

```
Out[177]: <AxesSubplot:xlabel='Marks'>
```



```
In [180]: data.head()
```

```
Out[180]:
```

	Emotional_Quotient	Intelligence_Quotient	Marks
0	72.0	120.0	75
2	68.0	169.0	70
3	75.0	129.0	78
4	80.0	180.0	82
5	64.0	125.0	68

**Note:** *GitHub repo to check out the Jupyter notebook*

Frequently Asked Questions

Q1. How should you handle outliers?

A. In conclusion, identifying and addressing outliers is really important in data analysis. These data anomalies can skew results, leading to inaccurate insights and decisions.

By employing robust detection techniques to handle outliers effectively, through visualization or statistical methods, to enhance the integrity of analyses and unlock hidden patterns within our data.

Apply appropriate techniques like trimming or capping to mitigate their influence, and contribute to more informed and reliable decision-making processes.