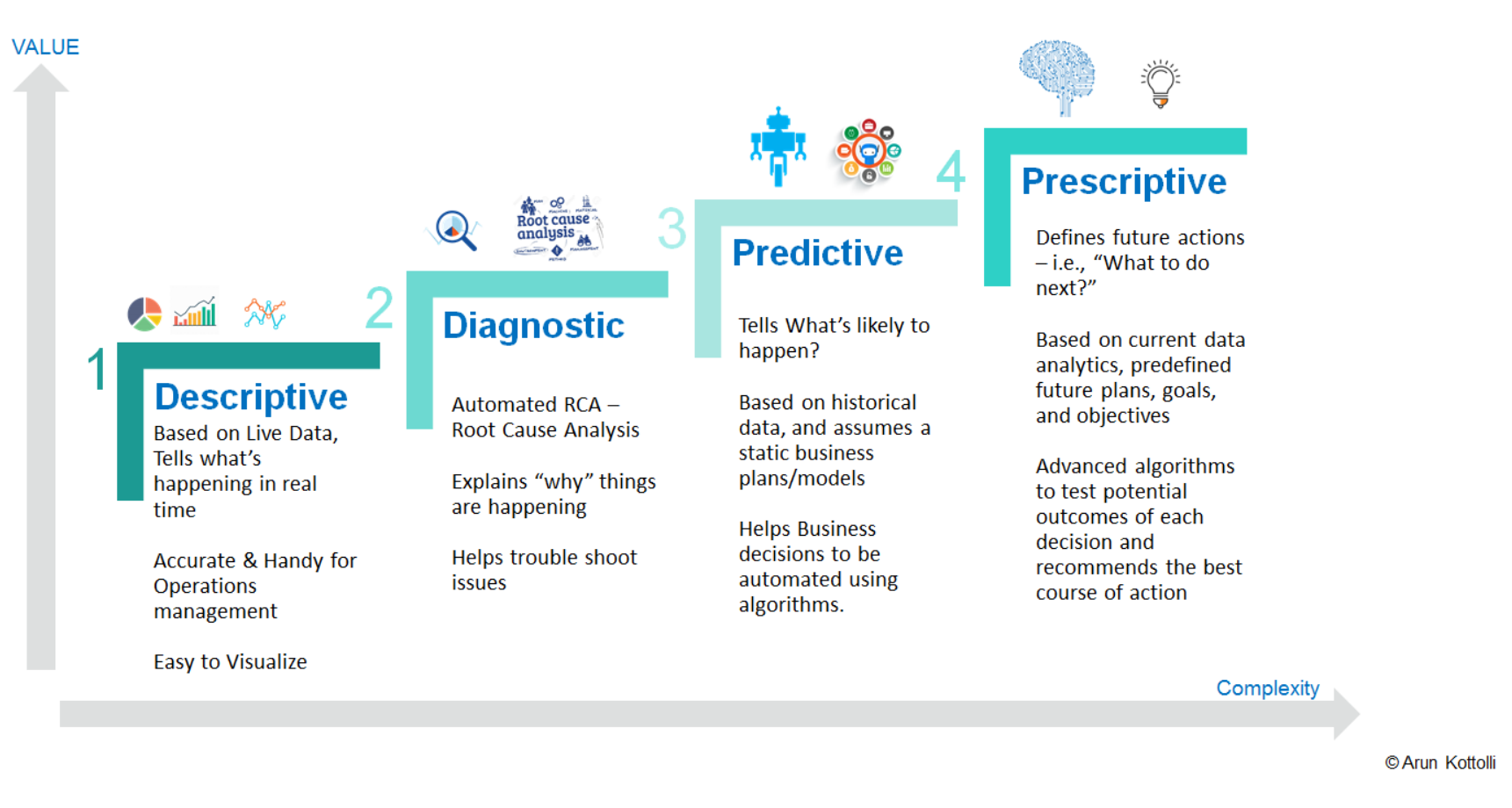
Today's Agenda

- Types of Data Analytics
- Python Libraries for DA
- Codes and Examples of various statistical measurements
- Data Visualization
- Outlier Detection

In [ ]:

4 Types of Data Analytics



Credits - Image from Internet

In [ ]:

Python tools for Data Analysis

NumPy, SciPy, matplotlib, IPython Interactive Computing, pandas, scikit learn

Credits - Image from Internet

Other libraries

- OpenCV
- Pandas Profiling
- GeoPandas
- Plotly
- Statsmodel
- Statistics
- Tensorflow
- Pytorch
- -
- Dash
- Flask

Basic Statistics

- Mean → Average of all the data values
  - Sum of all data values divied by total number of data values
- Median → The value separating the higher half from the lower half of the data
- Mode → The value that appears most frequently in the data set
- Standard deviation → Used to measure of the amount of variation or dispersion of set of values
  - Low standard deviation → All values very close to mean
  - High standard deviation → All values are far from the mean

`import` the necessary packages

In [1]:
```
import pandas as pd
import numpy as np
from collections import Counter
```

Mean

In [2]:
```
def calculate_mean(data_values):
    return sum(data_values) / len(data_values)
```

In [3]:
```
# show example
x = [5, 6, 1, -10, 4, 8, 10]
mean_value = calculate_mean(data_values=x)
print(mean_value)
```

```
3.4285714285714284
```

Median

In [4]: `5 / 2`

Out[4]: 2.5

In [5]: `int(5 / 2)`

Out[5]: 2

In [6]: `5 // 2`

Out[6]: 2

Procedure -

- First sort the values
- If the total number of values is odd
  - Take the middle value
- If the total number of values is even
  - Take the two middle values
  - Find the average of those two middle values

In [7]:
```
def calculate_median(data_values):
    sorted_values = sorted(data_values)
    mid_index = len(data_values) // 2

    # odd case
    if len(data_values) % 2 != 0:
        median = sorted_values[mid_index]
    # even case
    else:
        mid_index_l = mid_index - 1
        mini_data = [sorted_values[mid_index_l], sorted_values[mid_index]]
        median = calculate_mean(mini_data)

    return median
```

In [8]:
```
# show example
x = [5, 6, 1, -10, 4, 8, 10, 9, 100, 32]
median_value = calculate_median(data_values=x)
print(median_value)
```

```
7.0
```

Mode

In [9]:
```
# show dictionary example
d = [1, 1, 2, 3, 4, 4, 5, 6, 7, 8, 9, 8, 8]
Counter(d).items()
# in case repetition is similar, take the the minimum value from the repetition (key - original)
```

Out[9]: dict_items([(1, 2), (2, 1), (3, 1), (4, 2), (5, 1), (6, 1), (7, 1), (8, 3), (9, 1)])

In [10]:
```
def calculate_mode(data_values):
    data_counter = Counter(data_values)
    max_freq = max(list(data_counter.values()))

    if max_freq == 1:
        return "Mode doesn't exist"

    mode = [i for i, j in data_counter.items() if j == max_freq]
    return min(mode)
```

In [11]:
```
# show example
x = [1, 2, 3, 4, 4, 5, 6, 7, 8, 9, 8]
mode_value = calculate_mode(data_values=x)
print(mode_value)
```

```
4
```

Standard deviation

Formula

$$\sigma = \sqrt{\frac{\sum(x_i - \mu)^2}{N}} \rightarrow i = 1, 2, 3, \ldots n$$

where

- σ = Standard deviation
- x_i = each data value
- μ = Mean
- N = Total size of the data

In [12]:
```
def calculate_stddev(data_values):
    return np.std(a=data_values)
```

In [13]:
```
# show example

x_list = [1, 1, 2, 3, 4, 4, 5, 6, 7]
std_v = calculate_stddev(data_values=x_list)
print(std_v)
```

```
2.0
```

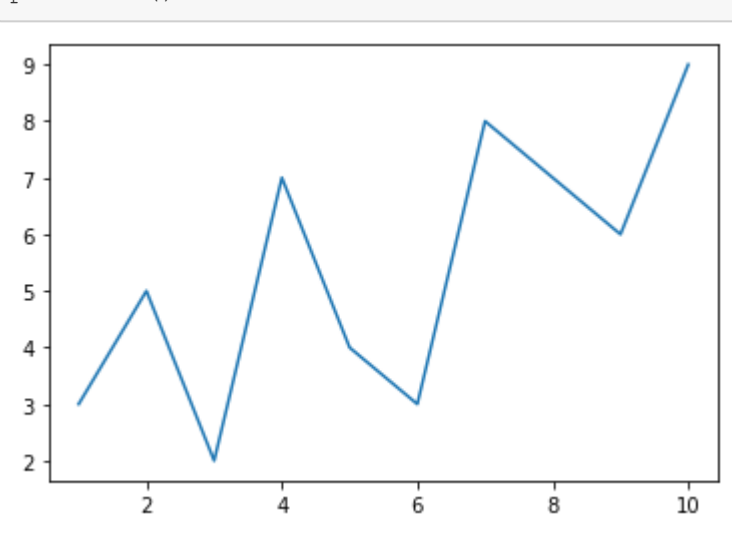
In [ ]:

Data visualization

In [14]:
```
from matplotlib import pyplot as plt
```

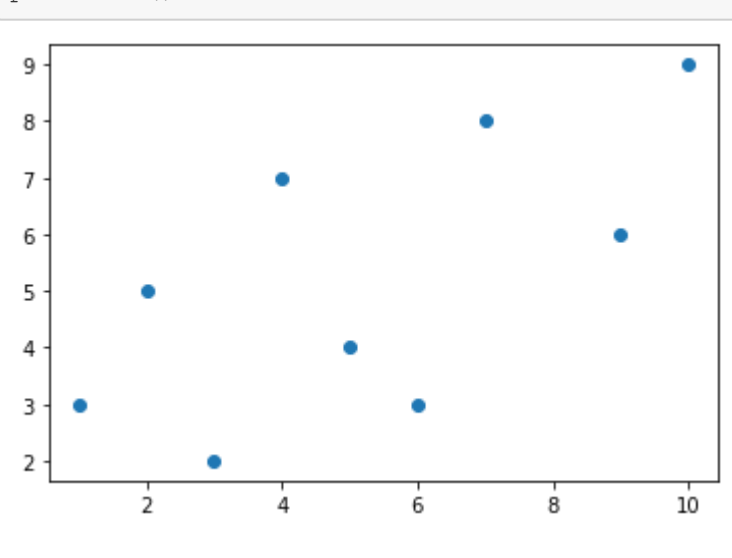
Line Plot

In [15]:
```
x = [1, 2, 3, 4, 5, 6, 7, 9, 10]
y = [3, 5, 2, 7, 4, 3, 8, 6, 9]

# show example
plt.plot(x, y)
plt.show()
```



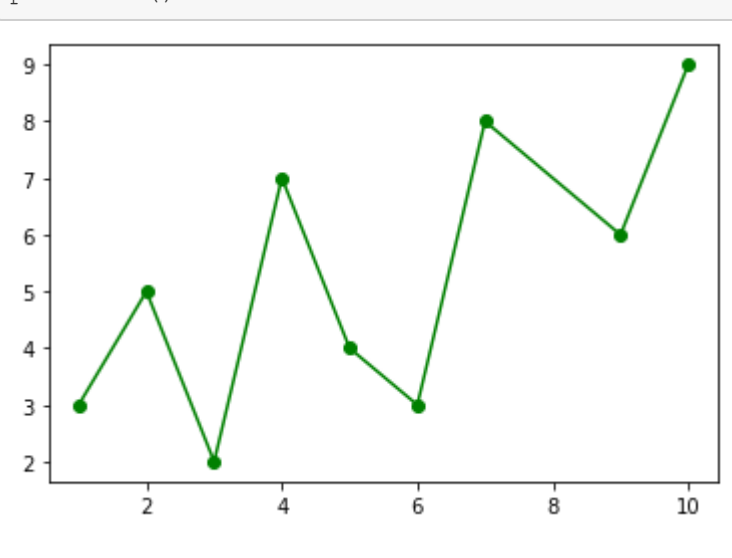
Scatter Plot

In [16]:
```
x = [1, 2, 3, 4, 5, 6, 7, 9, 10]
y = [3, 5, 2, 7, 4, 3, 8, 6, 9]

# show example
plt.scatter(x, y)
plt.show()
```



Line and Scatter together

In [17]:
```
x = [1, 2, 3, 4, 5, 6, 7, 9, 10]
y = [3, 5, 2, 7, 4, 3, 8, 6, 9]

# show example
plt.plot(x, y, 'o-g')
plt.show()
```



Read data

In [18]:
```
df = pd.read_csv('students_hw.csv')
df.head()
```

Out[18]:

	Height(Inches)	Weight(Pounds)
0	65.78	112.99
1	71.52	136.49
2	69.40	153.03
3	68.22	142.34
4	67.79	144.30

Heights → Mean, Median, Mode

In [19]:
```
x_list = df['Height(Inches)'].to_list()
y_list = [0 for i in range(len(x_list))]
```

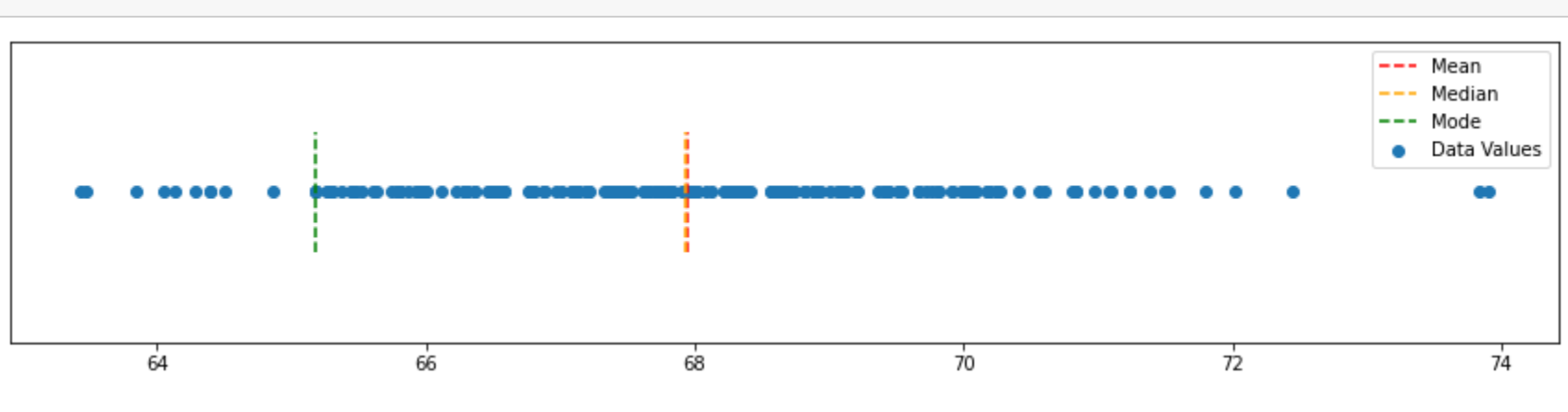
In [20]:
```
print(x_list)
```

```
[65.78, 71.52, 69.4, 68.22, 67.79, 68.7, 69.8, 70.01, 67.9, 66.78, 66.49, 67.62, 68.3, 67.12, 68.28,
71.09, 66.46, 68.65, 71.23, 67.13, 67.83, 68.88, 63.48, 68.42, 67.63, 67.21, 70.84, 67.49, 66.53, 65.
44, 69.52, 65.81, 67.82, 70.6, 71.8, 69.21, 66.8, 67.66, 67.81, 64.05, 68.57, 65.18, 69.66, 67.97, 6
5.98, 68.67, 66.88, 67.7, 69.82, 69.09, 69.91, 67.33, 70.27, 69.1, 65.38, 70.18, 70.41, 66.54, 66.36,
67.54, 66.5, 69.0, 68.3, 67.01, 70.81, 68.22, 69.06, 67.73, 67.22, 67.37, 65.27, 70.84, 69.92, 64.29,
68.25, 66.36, 68.36, 65.48, 69.72, 67.73, 68.64, 66.78, 70.05, 66.28, 69.2, 69.13, 67.36, 70.09, 70.1
8, 68.23, 68.13, 70.24, 71.49, 69.2, 70.06, 70.56, 66.29, 63.43, 66.77, 68.89, 64.87, 67.09, 68.35, 6
5.61, 67.76, 68.02, 67.66, 66.31, 69.44, 63.84, 67.72, 70.05, 70.19, 65.95, 70.01, 68.61, 68.81, 69.7
6, 65.46, 68.83, 65.8, 67.21, 69.42, 68.94, 67.94, 65.63, 66.5, 67.93, 68.89, 70.24, 68.27, 71.23, 6
9.1, 64.4, 71.1, 68.22, 65.92, 67.44, 73.9, 69.98, 69.52, 65.18, 68.01, 68.34, 65.18, 68.26, 68.57, 6
4.5, 68.71, 68.89, 69.54, 67.4, 66.48, 66.01, 72.44, 64.13, 70.98, 67.5, 72.02, 65.31, 67.08, 64.39,
69.37, 68.38, 65.31, 67.14, 68.39, 66.29, 67.19, 65.99, 69.43, 67.97, 67.76, 65.28, 73.83, 66.81, 66.
89, 65.74, 65.98, 66.58, 67.11, 65.87, 66.78, 68.74, 66.23, 65.96, 68.58, 66.59, 66.97, 68.08, 70.19,
65.52, 67.46, 67.41, 69.66, 65.8, 66.11, 68.24, 68.02, 71.39]
```

In [21]:
```
mean_val = calculate_mean(data_values=x_list)
median_val = calculate_median(data_values=x_list)
mode_val = calculate_mode(data_values=x_list)
print(mean_val)
print(median_val)
print(mode_val)
```

```
67.94979999999998
67.935
65.18
```

In [22]:
```
plt.figure(figsize=(15, 3))

plt.yticks([])

plt.scatter(x_list, y_list, label='Data Values')

plt.axvline(x=mean_val, ymin=0.3, ymax=0.7, ls='--', color='red', label='Mean')
plt.axvline(x=median_val, ymin=0.3, ymax=0.7, ls='--', color='orange', label='Median')
plt.axvline(x=mode_val, ymin=0.3, ymax=0.7, ls='--', color='green', label='Mode')

plt.legend()

plt.show()
```



In [ ]:

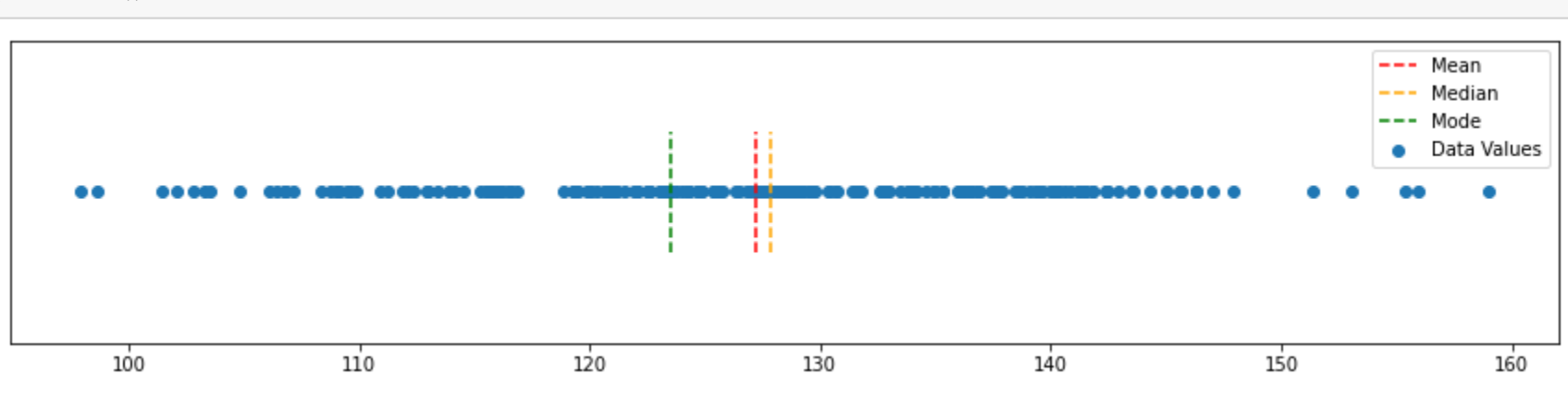
Weights → Mean, Median, Mode

In [23]:
```
x_list = df['Weight(Pounds)'].to_list()
y_list = [0 for i in range(len(x_list))]
```

In [24]:
```
mean_val = calculate_mean(data_values=x_list)
median_val = calculate_median(data_values=x_list)
mode_val = calculate_mode(data_values=x_list)
print(mean_val)
print(median_val)
print(mode_val)
```

```
127.2219500000001
127.875
123.49
```

In [25]:
```
plt.figure(figsize=(15, 3))

plt.yticks([])

plt.scatter(x_list, y_list, label='Data Values')

plt.axvline(x=mean_val, ymin=0.3, ymax=0.7, ls='--', color='red', label='Mean')
plt.axvline(x=median_val, ymin=0.3, ymax=0.7, ls='--', color='orange', label='Median')
plt.axvline(x=mode_val, ymin=0.3, ymax=0.7, ls='--', color='green', label='Mode')

plt.legend()

plt.show()
```



In [ ]:

Outliers

- An outlier is a data point that differs significantly from other data values

In [26]:
```
x = [1, 2, 3, 4, 5, 6, 7, 9, 10, 50, 5, 6, 9, 4, 7]
y = [3, 5, 2, 7, 4, 3, 8, 6, 9, 65, 6, 8, 3, 6, 9]
```

How can we detect outliers?

1. By graphing
   - scatter plot
   - box plot
2. By calculating z_score values
   - if z_score value is > 3 → reject
   - if z_score value is < -3 → reject

Formula

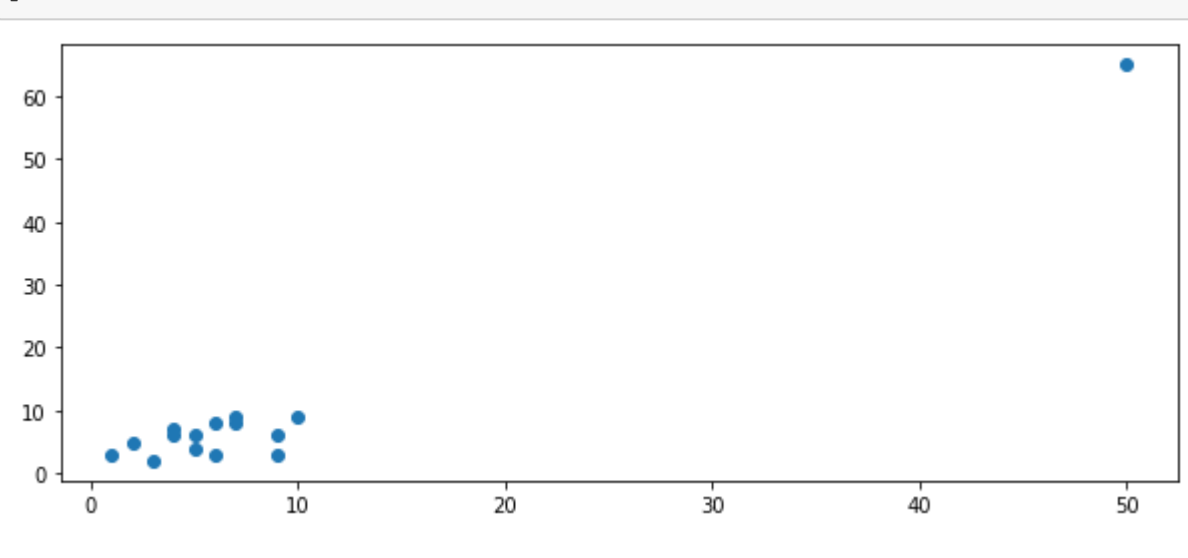
$$z = \frac{(x_i - \mu)}{\sigma} \rightarrow i = 1, 2, 3 \ldots n$$

where

- μ = Mean
- σ = Standard deviation
- x_i = each data value

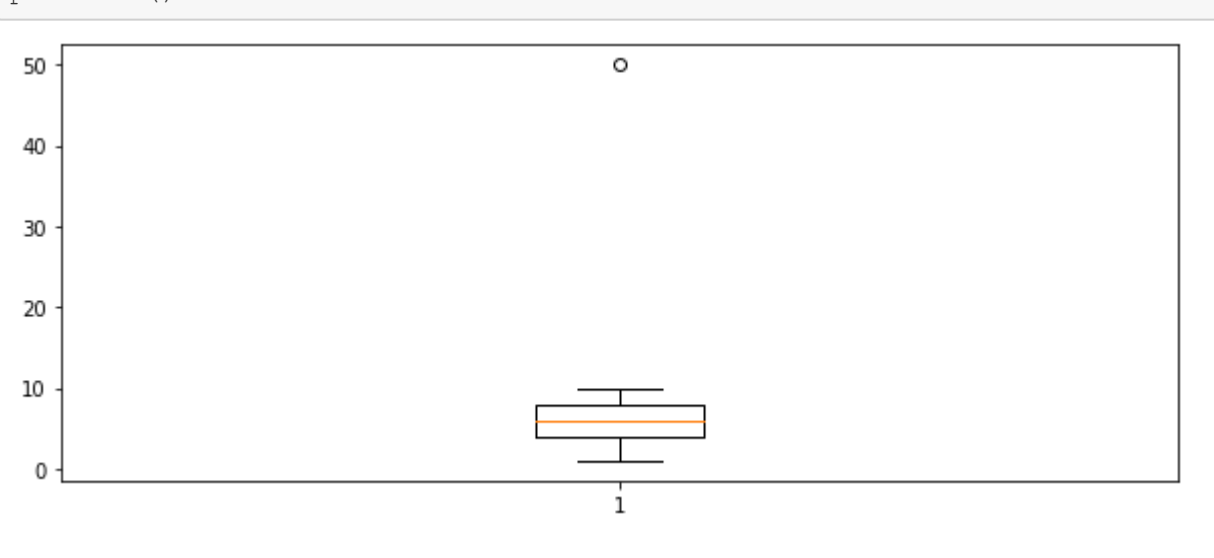
1 - a) scatter plot

In [27]:
```
plt.figure(figsize=(10, 4))
plt.scatter(x, y)
plt.show()
```

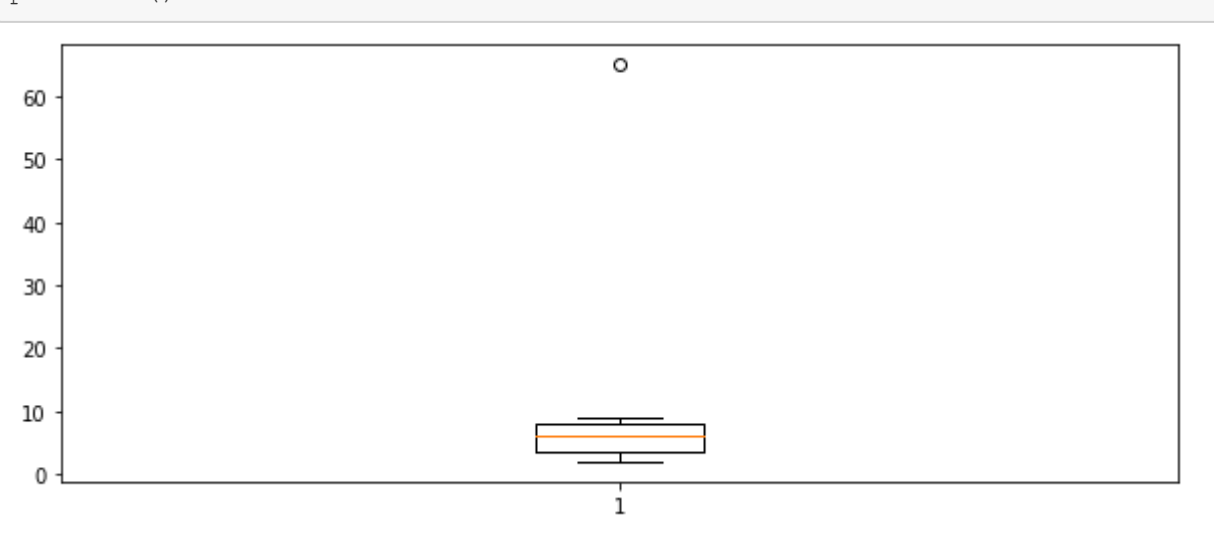


1 - b) box plot

In [28]:
```
plt.figure(figsize=(10, 4))
plt.boxplot(x)
plt.show()
```



In [29]:
```
plt.figure(figsize=(10, 4))
plt.boxplot(y)
plt.show()
```



2 - zscore method

In [30]:
```
def calculate_zscore(data_values):
    # mean
    mean_vals = calculate_mean(data_values)
    # standard deviation
    std_dev = calculate_stddev(data_values=data_values)
    # applying the formula for all the values
    zscore = [(i - mean_vals)/std_dev for i in data_values]
    return zscore
```

In [31]:
```
z_x = calculate_zscore(data_values=x)
print(z_x)
```

```
[-0.6631473670024701, -0.5751189554534697, -0.4870905439044692, -0.3990621323554687, -0.3110337208064
683, -0.2230053092574678, -0.13497689770846735, 0.041079925389533554, 0.12910833693853402, 3.65024479
88985525, -0.3110337208064683, -0.2230053092574678, 0.041079925389533554, -0.3990621323554687, -0.134
97689770846735]
```

In [32]:
```
def get_outlier_indices(data_values):
    # z_score values of all the data values
    z_score = calculate_zscore(data_values=data_values)
    # get the index of the outlier
    # whose value is > 3
    # whose value is < -3
    outlier_indices = [i for i, j in enumerate(z_score) if j > 3 or j < -3]
    return outlier_indices
```

In [33]:
```
x_index = get_outlier_indices(data_values=x)
print(x_index)
```

```
[9]
```

In [34]:
```
y_index = get_outlier_indices(data_values=y)
print(y_index)
```

```
[9]
```

In [35]: `z_x = x[x_index[0]]`

In [36]: `z_x`

Out[36]: 50

In [37]:
```
heights = df['Height(Inches)'].to_list()
weights = df['Weight(Pounds)'].to_list()
```

In [38]:
```
out_heights = get_outlier_indices(data_values=heights)
print(out_heights)
```

```
[138, 174]
```

In [39]: `heights[138]`

Out[39]: 73.9

In [40]: `heights[174]`

Out[40]: 73.83

In [41]:
```
out_weights = get_outlier_indices(data_values=weights)
print(out_weights)
```

```
[]
```

In [ ]:

What did we learn?

- Statistical Measurements
- Data Preprocessing in DA
- Visualization
- Visualization of the dataset
- Outlier detection