Mathematics 3
Euclidean & Manhattan Distance

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Class
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Task 1

Find the Euclidean distance from the center at (2,4)

1. (2,4) & (3,6)

$$\begin{aligned} d &= \sqrt{(3-2)^2+(6-4)^2} \\ &= \sqrt{(1)^2+(2)^2} \\ &= \sqrt{5} \\ &= 2.23 \end{aligned}$$

2. (2,4) & (5,3)

$$\begin{aligned} d &= \sqrt{(5-2)^2+(3-4)^2} \\ &= \sqrt{(3)^2+(-1)^2} \\ &= \sqrt{10} \\ &= 3.16 \end{aligned}$$

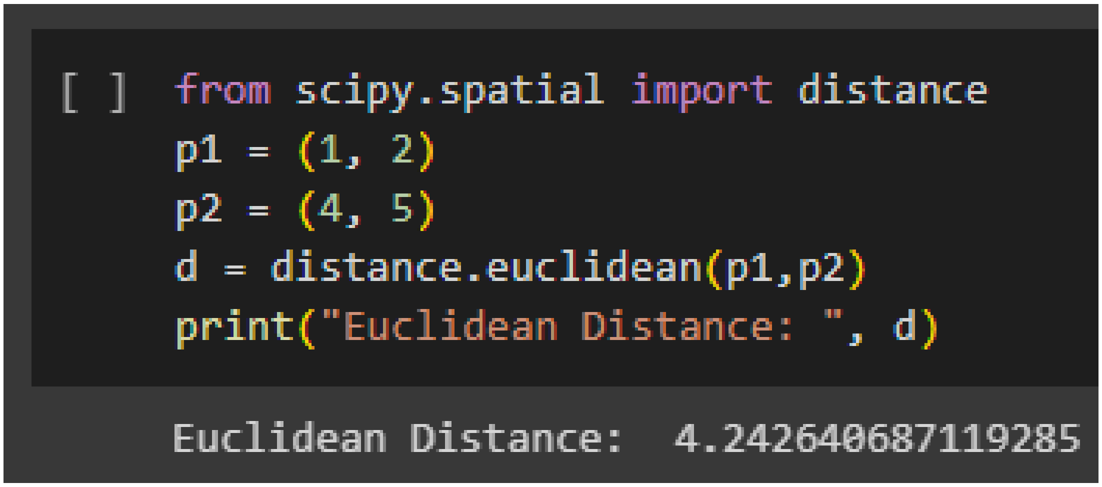
3. (2,4) & (7,1)

$$\begin{aligned} d &= \sqrt{(7-2)^2+(1-4)^2} \\ &= \sqrt{(5)^2+(-3)^2} \\ &= \sqrt{34} \\ &= 5.83 \end{aligned}$$

4. (2,4) & (6,8)

$$\begin{aligned} d &= \sqrt{(6-2)^2+(8-4)^2} \\ &= \sqrt{(4)^2+(4)^2} \\ &= 4\sqrt{2} \\ &= 5.65 \end{aligned}$$

Task 2



```
[ ]  from scipy.spatial import distance
     p1 = (1, 2)
     p2 = (4, 5)
     d = distance.euclidean(p1,p2)
     print("Euclidean Distance: ", d)
```

```
Euclidean Distance:  4.242640687119285
```

Additional Task

1. A(2,3) & B(4,1)

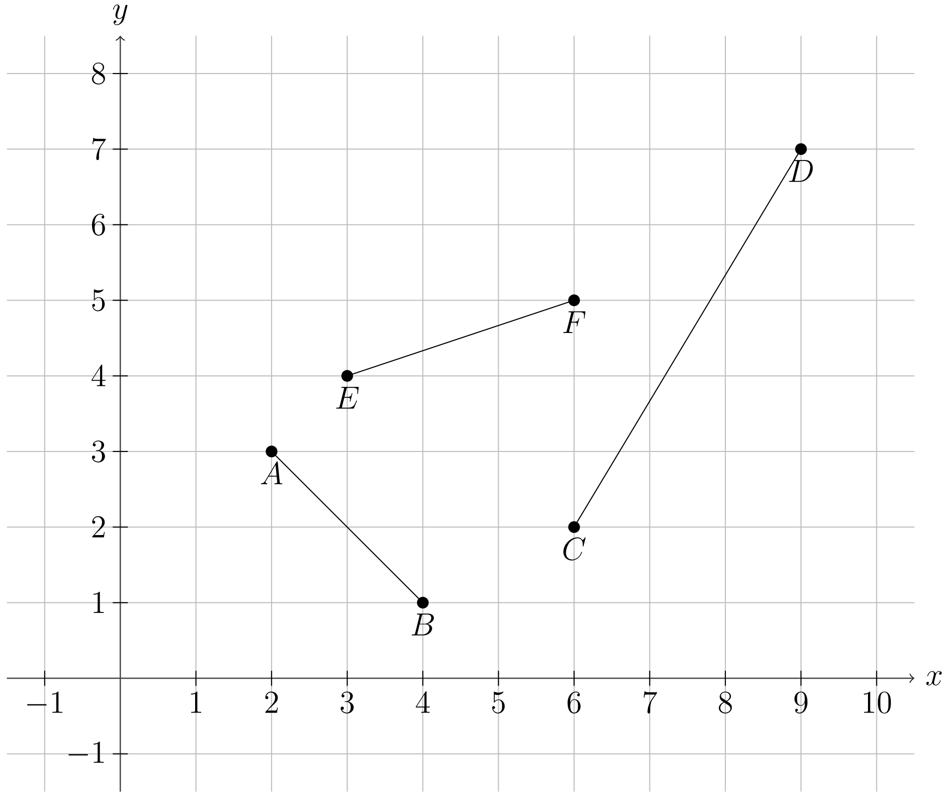
$$\begin{aligned} d &= \sqrt{(4-2)^2 + (1-3)^2} \\ &= \sqrt{(2)^2 + (-2)^2} \\ &= \sqrt{32} = 4\sqrt{2} \\ &= 5.65685 \end{aligned}$$

2. C(6,2) & D(9,7)

$$\begin{aligned} d &= \sqrt{(9-6)^2 + (7-2)^2} \\ &= \sqrt{(3)^2 + (5)^2} \\ &= \sqrt{34} \\ &= 5.83095 \end{aligned}$$

3. E(3,4) & F(6,5)

$$\begin{aligned} d &= \sqrt{(6-3)^2 + (5-4)^2} \\ &= \sqrt{(3)^2 + (1)^2} \\ &= \sqrt{10} \\ &= 3.16228 \end{aligned}$$


y
8
7
6
5
4
3
2
1
−1
x
−1
1
2
3
4
5
6
7
8
9
10
A
B
C
D
E
F

Task 3

1. (2,4) & (3,5)

$$\begin{aligned} d_{cd} &= |3-2| + |5-4| \\ &= |1| + |1| \\ &= 2 \end{aligned}$$

2. (2,4) & (5,3)

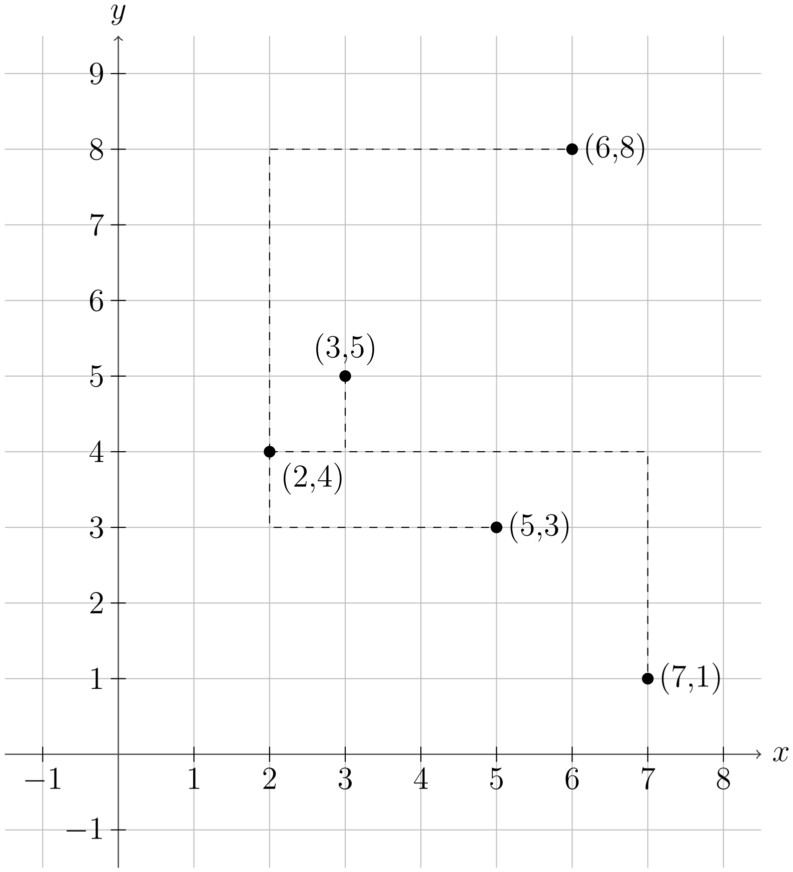
$$\begin{aligned} d_{cd} &= |5-2| + |3-4| \\ &= |3| + |-1| \\ &= 4 \end{aligned}$$

3. (2,4) & (7,1)

$$\begin{aligned} d_{cd} &= |7-2| + |1-4| \\ &= |5| + |-3| \\ &= 8 \end{aligned}$$

4. (2,4) & (6,8)

$$\begin{aligned} d_{cd} &= |6-2| + |8-4| \\ &= |4| + |4| \\ &= 8 \end{aligned}$$


y
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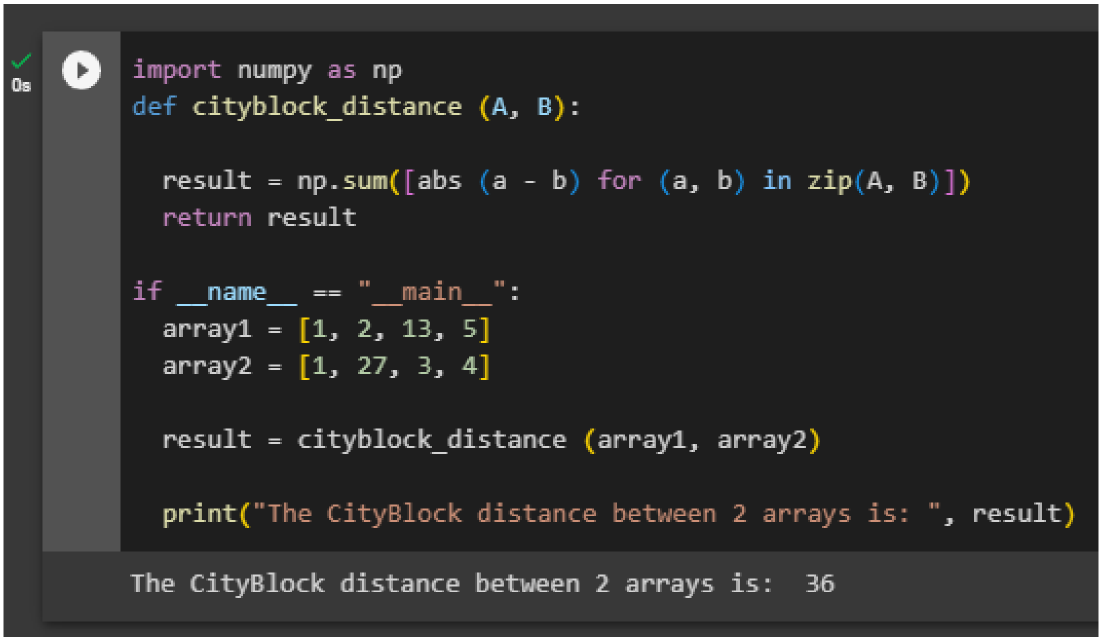
1
2
3
4
5
6
7
8
(6,8)
(3,5)
(2,4)
(5,3)
(7,1)

Task 4



```
import numpy as np
def cityblock_distance (A, B):

  result = np.sum([abs (a - b) for (a, b) in zip(A, B)])
  return result

if __name__ == "__main__":
  array1 = [1, 2, 13, 5]
  array2 = [1, 27, 3, 4]

  result = cityblock_distance (array1, array2)

  print("The CityBlock distance between 2 arrays is: ", result)
```

```
The CityBlock distance between 2 arrays is:  36
```

Task 5

The Euclidean and City Block distance is method of measuring difference between two point to get the distance betweeen the two point. The Euclidean distance measure the shortest distance in a straight line, while the City Block measure the absolute distance betweeen two point from every axis or dimension it has.

The Euclidean formula goes as followed:

$$d = \sqrt{(x_2 - x_1)^2 + (y_2 - y_1)^2 + (z_2 - z_1)^2}$$

Adding more Variables as the dimension increase or for n-dimension it can be rewritten as

$$d = \sqrt{\textstyle\sum_{i=1}^{k} (p_i - q_i)}$$

While the City Block formula goes as followed:

$$d_{cd} = |x_2 - x_1| + |y_2 - y_1| + |z_2 - z_1|$$

Adding more Variables as the dimension increase or for n-dimension it can be rewritten as

$$d_{cd} = \textstyle\sum_{i=1}^{k} |p_i - q_i|$$

An applicative example of both method of measurement is for measuring shortest distance betweeen two point. Other use of both method including but not limited to calculating the distance between two rows of data, clustering, and etc.