EUCLIDEAN, MANHATTAN AND CHEBYSHEV DISTANCES

The Euclidean, Manhattan, and Chebyshev distances between two points in a multi-dimensional space can be calculated as follows:

1. **Euclidean Distance**: It is the straight-line distance between two points.
   In a 2-dimensional space, the Euclidean distance between two points (x_1, y_1) and (x_2, y_2) is calculated as:

   $$\sqrt{(x_2 - x_1)^2 + (y_2 - y_1)^2}$$

   In a 3-dimensional space, the Euclidean distance between two points (x_1, y_1, z_1) and (x_2, y_2, z_2) is calculated as:

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

2. **Manhattan Distance**: It is the sum of the absolute differences of their coordinates. The formula is:
   In a 2-dimensional space, the Manhattan distance between two points (x_1, y_1) and (x_2, y_2) is calculated as:

   $$|x_2 - x_1| + |y_2 - y_1|$$

   In a 3-dimensional space, the Manhattan distance between two points (x_1, y_1, z_1) and (x_2, y_2, z_2) is calculated as:

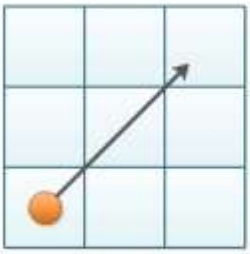
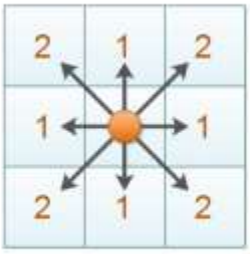
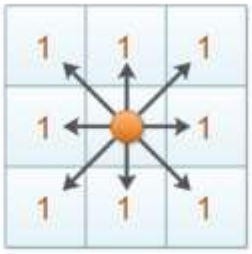
   $$|x_2 - x_1| + |y_2 - y_1| + |z_2 - z_1|$$

3. **Chebyshev Distance**: It is the maximum of absolute differences of their coordinates. The formula is:
   In a 2-dimensional space, the Chebyshev distance between two points (x_1, y_1) and (x_2, y_2) is calculated as:

   $$max(|x_2 - x_1|, |y_2 - y_1|)$$

   In a 3-dimensional space, the Manhattan distance between two points (x_1, y_1, z_1) and (x_2, y_2, z_2) is calculated as:

   $$max(|x_2 - x_1|, |y_2 - y_1|, |z_2 - z_1|)$$

Euclidean Distance	Manhattan Distance	Chebyshev Distance
		
$\sqrt{(x_1 - x_2)^2 + (y_1 - y_2)^2}$	$\lvert x_1 - x_2 \rvert + \lvert y_1 - y_2 \rvert$	$\max(\lvert x_1 - x_2 \rvert, \lvert y_1 - y_2 \rvert)$

Example

1. Calculate Euclidean, Manhattan and Chebyshev distance between the points P = (1, 2) and Q = (3, 5)

   - Euclidean Distance:

$$\sqrt{(3-1)^2 + (5-2)^2} = \sqrt{13}$$

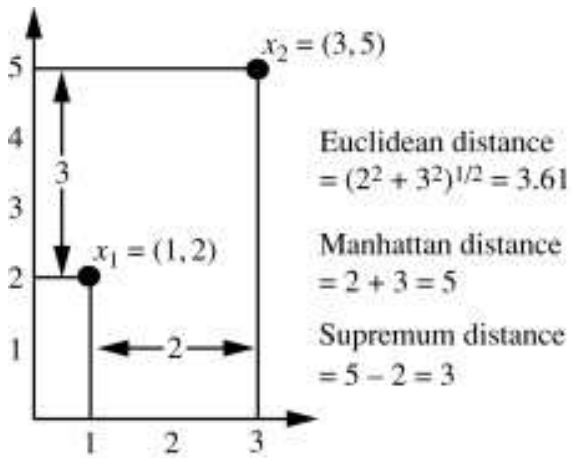
   - Manhattan Distance:

$$|(3-1)| + |(5-2)| = 5$$

   - Chebyshev Distance:

$$max(|(3-1)|, |(5-2)|) = 3$$

So, the Euclidean distance is $\sqrt{13}$ units, the Manhattan distance is 5 units and the Chebyshev distance is 3 units.



2. Calculate Euclidean, Manhattan and Chebyshev distance between the points A = (2, 3, 4) and B = (1, 0, −1)

- Euclidean Distance:

$$\sqrt{(1-2)^2 + (0-3)^2 + (-1-4)^2} = \sqrt{35}$$

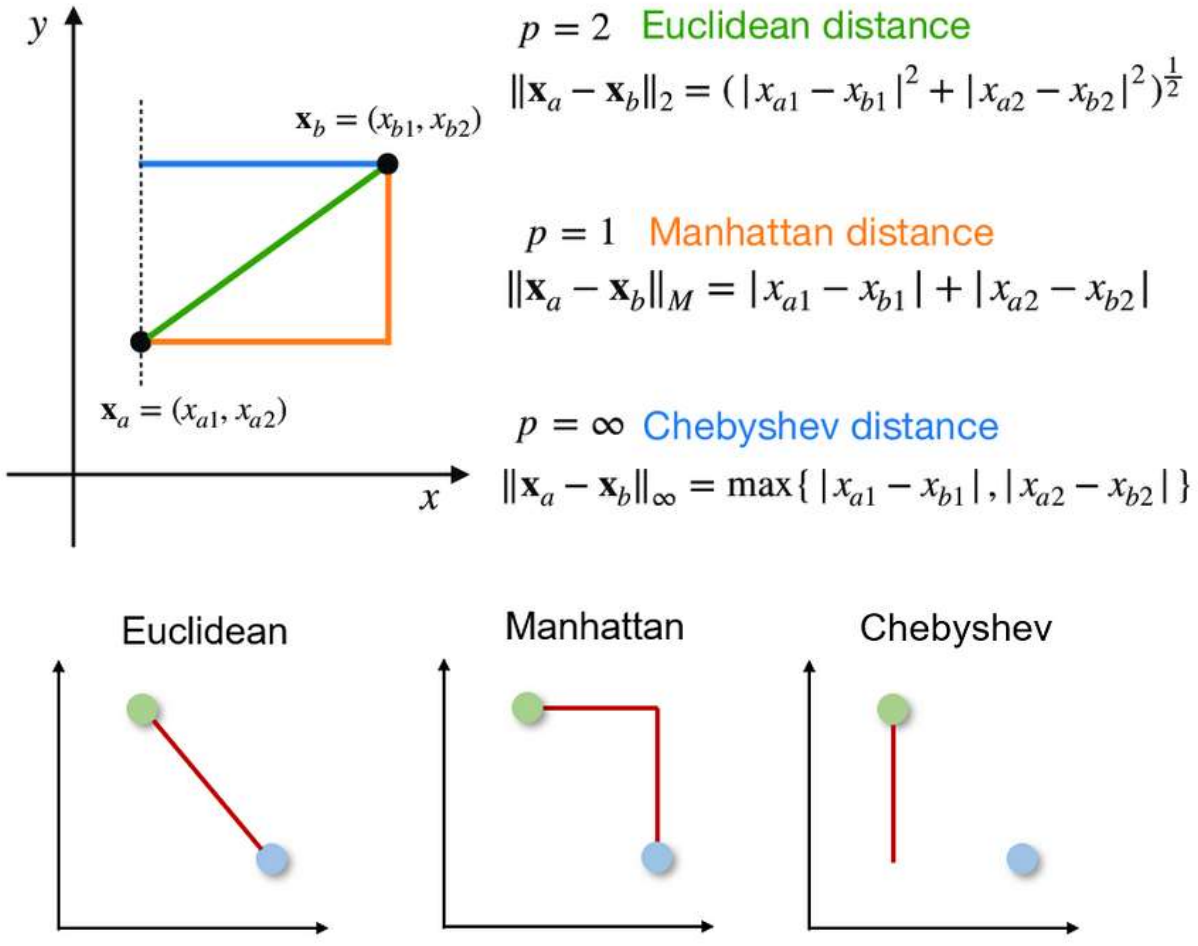
- Manhattan Distance:

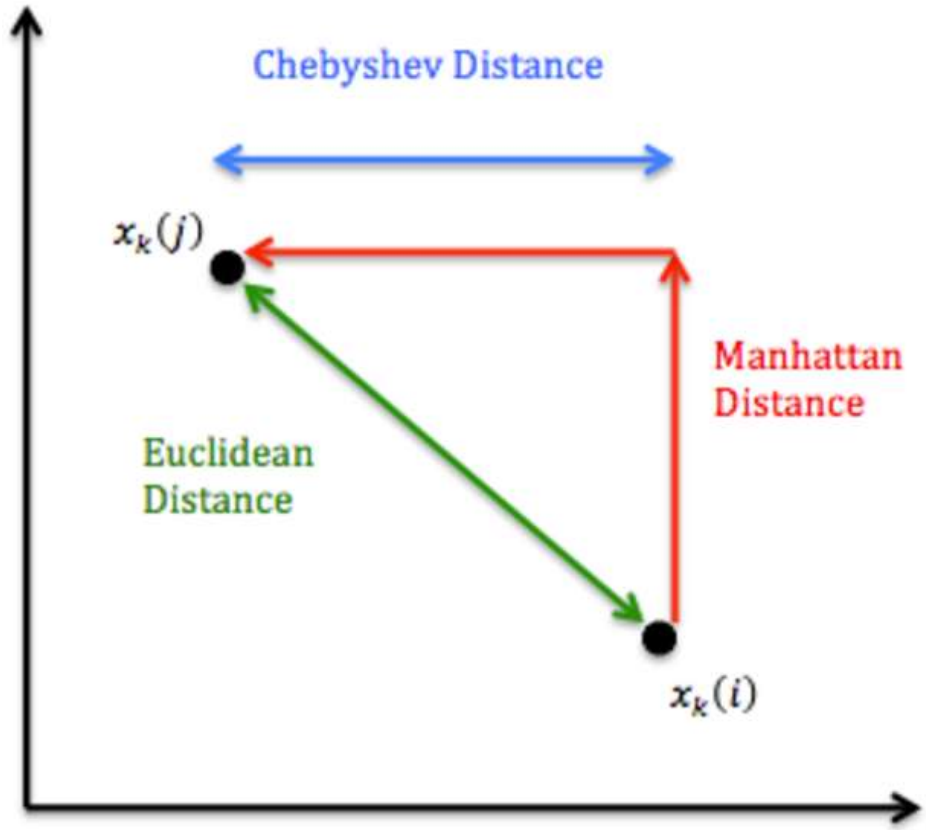
$$|(1-2)| + |(0-3)| + |(-1-4)| = 9$$

- Chebyshev Distance:

$$max(|(1-2)|, |(0-3)|, |(-1-4)|) = 5$$

So, the Euclidean distance is14 units, the Manhattan distance is 9 units, and the Chebyshev distance is 5 units.





Euclidean Distance and **Manhattan Distance**

PYTHON CODE TO FIND EUCLIDEAN, MANHATTAN AND CHEBYSHEV DISTANCES

PYTHON Syntax

- np.linalg.norm(P - Q) calculates the Euclidean distance between points P and Q.
- np.sum(np.abs(P - Q)) calculates the Manhattan distance between points P and Q.
- np.max(np.abs(P - Q)) calculates the Chebyshev distance between points P and Q.

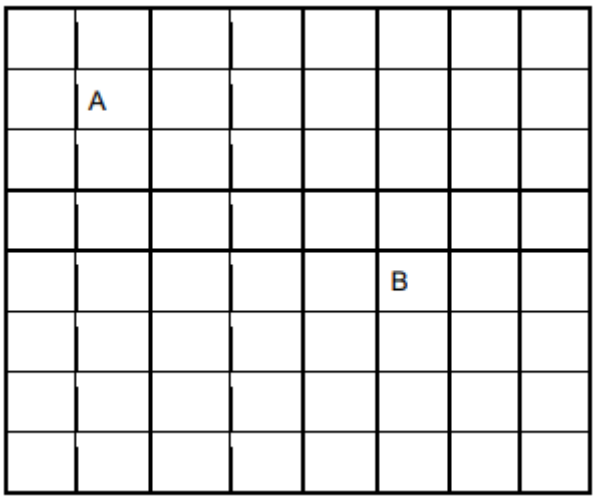
Example

Calculate Euclidean, Manhattan and Chebyshev distance between the points $P = (2, 3, 4)$ and $Q = (1, 0, -1)$

```
import numpy as np

# Define the points
P = np.array([2, 3, 4])
Q = np.array([1, 0, -1])

# Calculate Euclidean distance
euclidean_distance = np.linalg.norm(P - Q)
print(f"Euclidean Distance: {euclidean_distance}")

# Calculate Manhattan distance
manhattan_distance = np.sum(np.abs(P - Q))
print(f"Manhattan Distance: {manhattan_distance}")

# Calculate Chebyshev distance
chebyshev_distance = np.max(np.abs(P - Q))
print(f"Chebyshev Distance: {chebyshev_distance}")
```

```
Euclidean Distance: 5.916079783099616
Manhattan Distance: 9
Chebyshev Distance: 5
```

Which distance metric is suitable for calculating the least number of squares moved between the starting position(A) and ending position (B) on the chessboard (each square of unit length) for the Queen (Queen can move either diagonally or vertically or horizontally)? Give formula for the same.



For calculating the least number of squares moved between the starting position (A) and ending position (B) on a chessboard for a Queen, you can use the Chebyshev distance metric. The Chebyshev distance is also known as the chessboard distance or the maximum metric, and it is suitable for measuring the minimum number of moves a Queen needs to go from one square to another.

The formula for the Chebyshev distance between two points (x1, y1) and (x2, y2) on a chessboard is given by:

$$D_{Chebyshev} = max(|x_2 - x_1|, |y_2 - y_1|)$$

In the case of a chessboard, this formula accounts for both horizontal and vertical moves as well as diagonal moves since the Queen can move in any direction. The maximum of the absolute differences in the x and y coordinates gives the minimum number of squares the Queen needs to move to reach the destination.

So, for a Queen moving from position A to position B, you would calculate the Chebyshev distance using the coordinates of the two positions. The

result will be the minimum number of squares the Queen needs to move on the chessboard.