Euclidean and Cityblock

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Euclidean distance

4 Distance Measures for Machine Learning

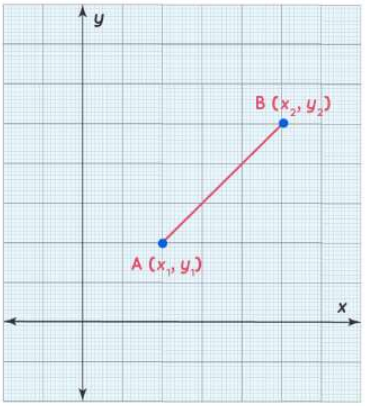
1. Hamming Distance
2. **Euclidean Distance**
3. **Manhattan Distance (Taxicab or City Block)**
4. Minkowski Distance

https://machinelearningmastery.com/distance-measures-for-machine-learning/#:~:text=The%20Manhattan%20distance%2C%20also%20called,a%20chessboard%20or%20city%20blocks.

What Is Euclidean Distance Formula?

The Euclidean distance formula, as its name suggests, gives the distance between two points (or) the straight line distance. Let us assume that (x_1, y_1) and (x_2, y_2) are two points in a two-dimensional plane. Here is the Euclidean distance formula.

Euclidean distance adalah perhitungan jarak dari 2 buah titik dalam Euclidean space. Euclidean space diperkenalkan oleh Euclid, seorang matematikawan dari Yunani sekitar tahun 300 B.C.E. untuk mempelajari hubungan antara sudut dan jarak. Euclidean ini berkaitan dengan Teorema Phytagoras dan biasanya diterapkan pada 1, 2 dan 3 dimensi. Tapi juga sederhana jika diterapkan pada dimensi yang lebih tinggi.



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

Euclidean Distance Formula

The Euclidean distance formula says:

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

where,

- (x_1, y_1) are the coordinates of one point.
- (x_2, y_2) are the coordinates of the other point.
- d is the distance between (x_1, y_1) and (x_2, y_2).

Now we will apply the Pythagoras theorem to the triangle ABC. Then we get,

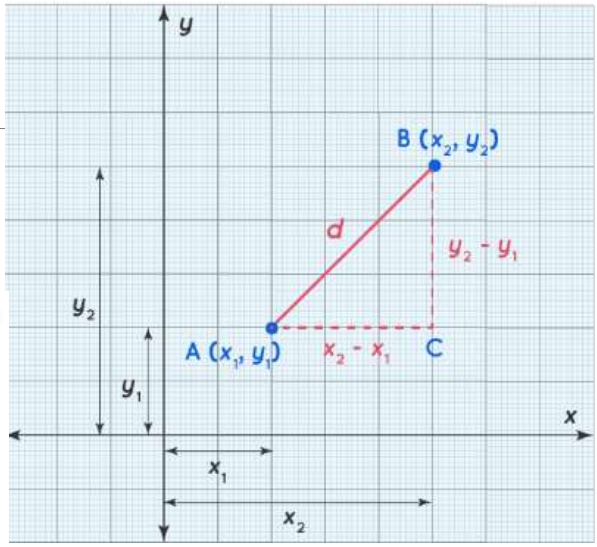
$AB^2 = AC^2 + BC^2$

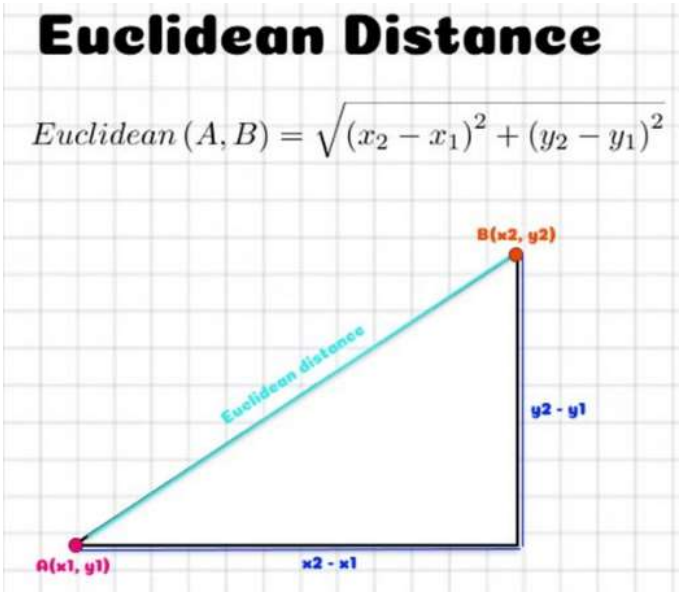
$d^2 = (x_2 - x_1)^2 + (y_2 - y_1)^2$

Taking the square root on both sides,

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

Hence the Euclidean distance formula is derived.





Examples Using Euclidean Distance Formula

Example 1: Find the distance between points P(3, 2) and Q(4, 1).

Solution:

Given:

P(3, 2) = (x1,y1)(x1,y1)

Q(4, 1) = (x2,y2)(x2,y2)

Using Euclidean distance formula,

$d = \sqrt{[(x22 - x11)^2 + (y22 - y11)^2]}$

$PQ = \sqrt{[(4 - 3)^2 + (1 - 2)^2]}$

$PQ = \sqrt{[(1)^2 + (-1)^2]}$

$PQ = \sqrt{2}$ units.

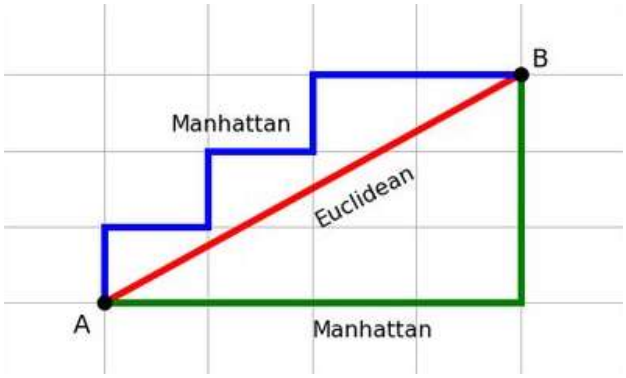
Answer: The Euclidean distance between points A(3, 2) and B(4, 1) is $\sqrt{2}$ units.

Examples Using Euclidean Distance Formula

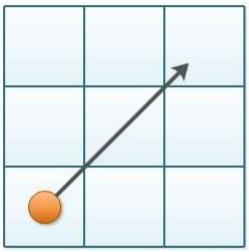
X	Y	Euclidean Distance (3,5)
7	6	$\sqrt{(7-3)^2+(6-5)^2} = \sqrt{(4)^2+(1)^2} = \sqrt{17} = 4.12$
6	6	$\sqrt{(6-3)^2+(6-5)^2} = \sqrt{(3)^2+(1)^2} = \sqrt{10} = 3.16$
6	5	$\sqrt{(6-3)^2+(5-5)^2} = \sqrt{(3)^2+(0)^2} = \sqrt{9} = 3$
1	3	$\sqrt{(1-3)^2+(3-5)^2} = \sqrt{(-2)^2+(-2)^2} = \sqrt{8} = 2.82$
2	4	$\sqrt{(2-3)^2+(4-5)^2} = \sqrt{(-1)^2+(-1)^2} = \sqrt{2} = 1.41$
2	2	$\sqrt{(2-3)^2+(2-5)^2} = \sqrt{(-1)^2+(-3)^2} = \sqrt{10} = 3.16$

perhitungan jarak dengan euclidean distance

Manhattan Distance (city block distance)

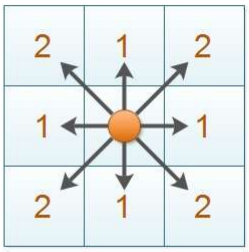


Euclidean Distance



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

Manhattan Distance



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

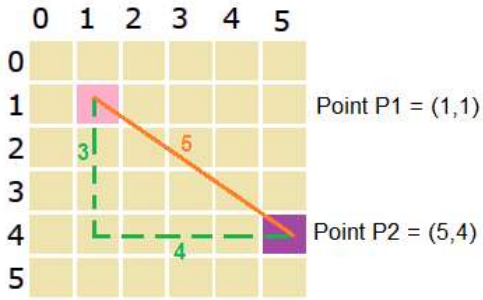
Applications of Manhattan distance

Manhattan distance is frequently used in:

1. **Regression analysis**: It is used in linear regression to find a straight line that fits a given set of points
2. **Compressed sensing**: In solving an underdetermined system of linear equations, the regularisation term for the parameter vector is expressed in terms of Manhattan distance. This approach appears in the signal recovery framework called compressed sensing
3. **Frequency distribution**: It is used to assess the differences in discrete frequency distributions

City block distance is generally calculated between 2-coordinates of a paired objec
It is the summation of absolute difference between 2-coordinates. The city block distance of 2-points *a* and *b* with *k* dimension is mathematically calculated using below formula:

$$d_{ij} = \sum_{i=1}^{k} |a_i - b_i|$$



Euclidean distance = $\sqrt{(5-1)^2 + (4-1)^2} = 5$

Manhattan distance = $|5-1| + |4-1| = 7$