



Nearest Neighbour Interpolation

Week 30



Nearest neighbour interpolation

If each site is assigned a numerical value (such as the amount of rain that fell on a particular day or a level of pollutant) then the value of all points in each site's cell is assumed to equal that value.

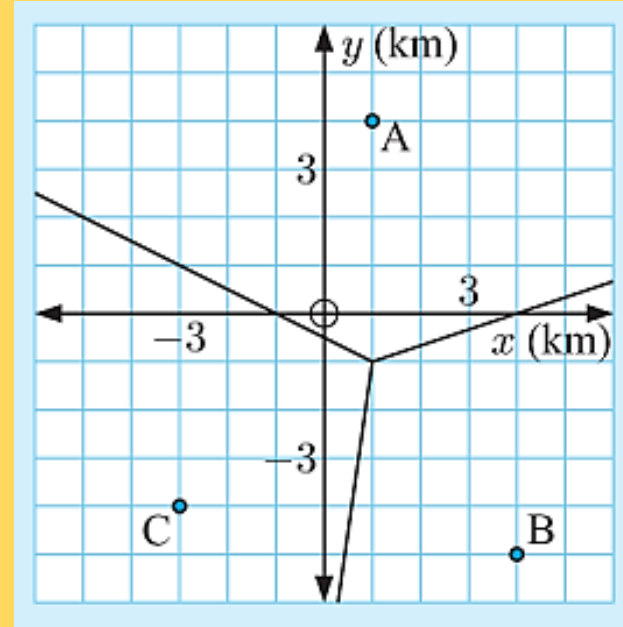
Example 1

Ted measured the rainfall in his city at three locations A, B, and C, marked on the map. The results are:

Location	Rainfall (mm)
A	12
B	7
C	15

Use nearest neighbour interpolation to estimate the rainfall at:

- a. $(-4,1)$ This point lies on cell C, so the estimated rainfall will be 15mm.
- b. $(-1,0)$
- c. $(1,-1)$



Example 2

Weather stations measure the temperature in a city at three locations, A, B, and C. Their measurements at 3PM are shown:

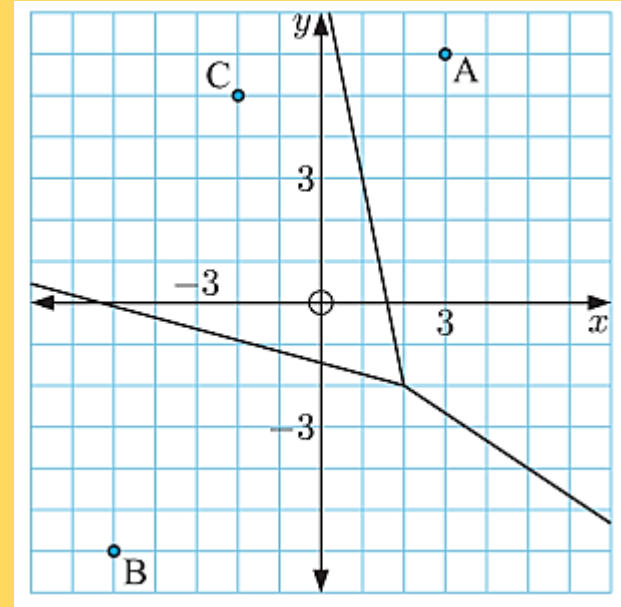
Use nearest neighbour interpolation to estimate the 3PM temperature at:

Location	Temperature (°C)
A	28.4
B	25.6
C	27.3

a. (1,0)

b. (2,-2)

c. (1,3)



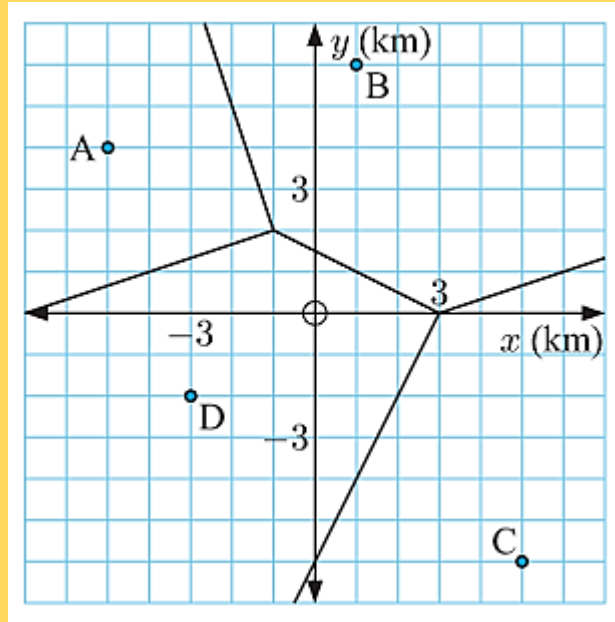
Example 3

On a snowy day, the snowfall was measured in four locations across a city.

Estimate the snowfall received at:

- a. $(-1, -4)$
- b. $(1, 1)$
- c. $(-1, 2)$

Location	Snowfall (in.)
A	7
B	5.5
C	12.2
D	9.3





Therefore,

Nearest neighbour interpolation is a simple method of interpolation. To *estimate* the value of a variable at any point, we use the variable's value at the *nearest* known data point.



The Largest Empty Circle Problem

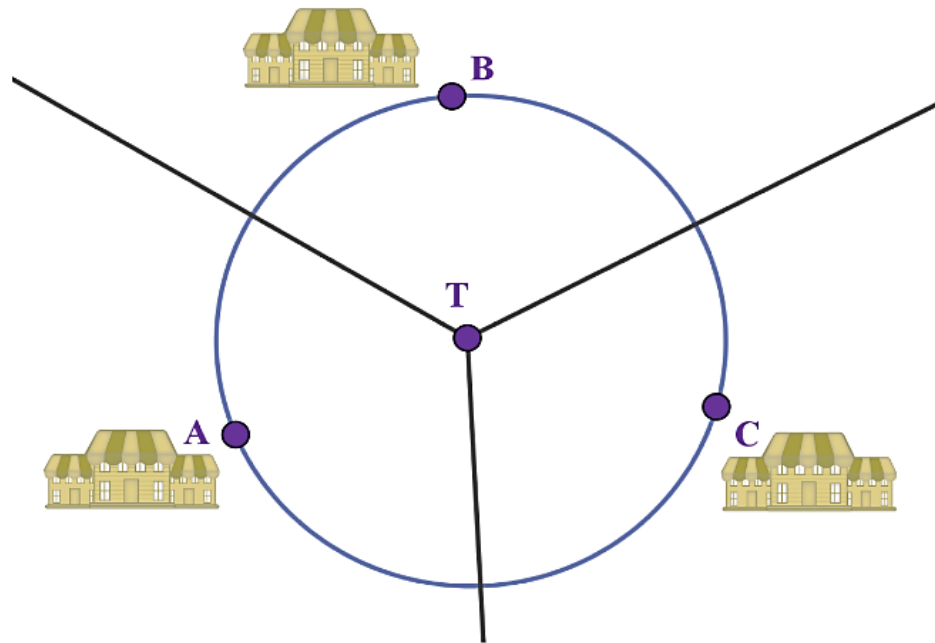


Bantar Gebang

- One of the world's largest landfills, more than 200 football fields in size, accepting as much as 7,000 tons of waste a day from Jakarta, Indonesia's capital.



In the past, most toxic waste ended up in rivers, lakes or the sea, or it was buried underground where it contaminated underground water and the soil. In the past few decades, countries have enacted regulations on how to handle toxic waste. One common method of handling toxic waste is to bury it in sealed containers. The diagram shows an area with three towns. If you had to dump toxic waste in that area, where would you do so?



The Largest Empty Circle Problem



- This problem is sometimes called the **toxic waste dump problem**.
- It can be formulated as finding the **optimal position** for a toxic waste dump.
- The optimal position for the circle's centre will occur at one of the vertices of the Voronoi diagram, with the **greatest distance** from its nearest site.

How do we find the largest circle?

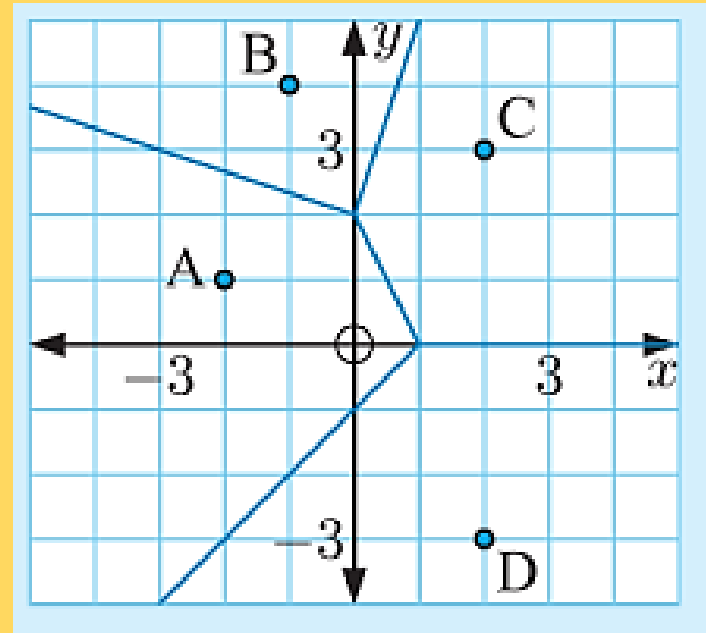


- For each **vertex** in the Voronoi diagram:
 - determine the **sites** from which it is equidistant.
 - find the **distance** from the vertex to any of those sites.
- The vertex with the **greatest distance** to the nearest site is the centre of the largest circle.
- The distance from that vertex to the nearest site is the **radius** of the largest circle.

Example 1

The Voronoi diagram for the sites $A(-2,1)$, $B(-1,4)$, $C(2,3)$, and $D(2,-3)$ is shown.

Find the largest empty circle for these sites.



Example 1 (Continuation)

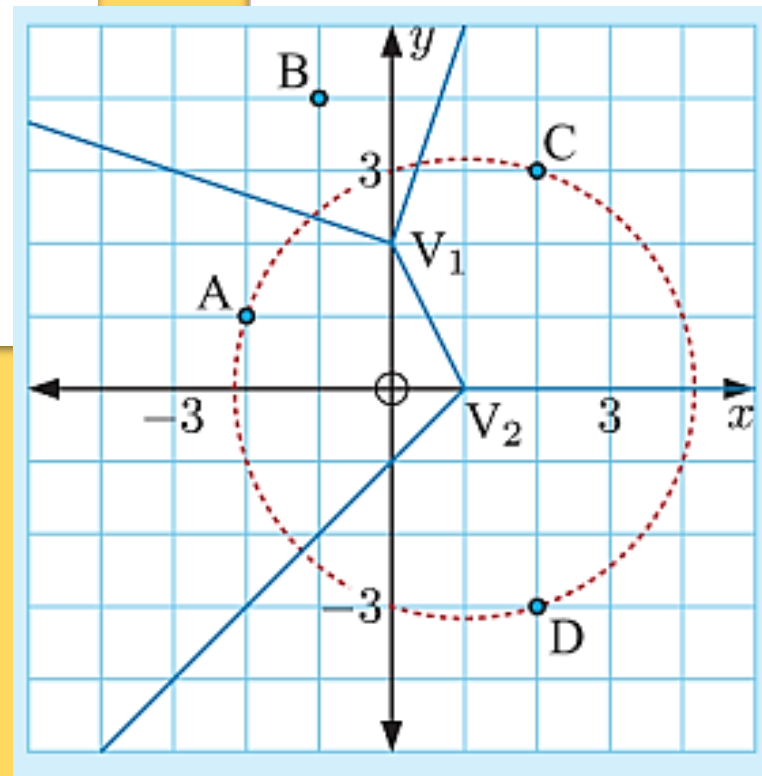
The Voronoi diagram has vertices V_1 (0,2) and V_2 (1,0).

V_1 is equidistant from A, B, and C.

$$\begin{aligned} V_1A &= \sqrt{(-2-0)^2 + (1-2)^2} \\ &= \sqrt{(-2)^2 + (-1)^2} \\ &= \sqrt{5} \text{ units} \end{aligned}$$

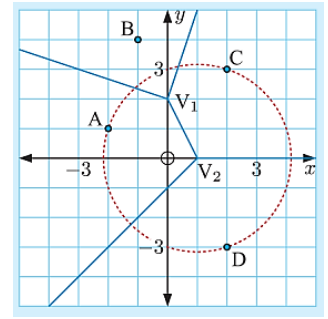
V_2 is equidistant from A, C, and D.

$$\begin{aligned} V_2A &= \sqrt{(-2-1)^2 + (1-0)^2} \\ &= \sqrt{(-3)^2 + 1^2} \\ &= \sqrt{10} \text{ units} \end{aligned}$$



So, the largest empty circle has centre V_2 (1,0) and radius $\sqrt{10}$ units.

Conceptual Questions:



- Explain why another site (town) **cannot** be inside the largest circle, assuming that no new sites are added.
- **Where is the point** that give the solution to the toxic waste problem?
- Why are **vertices** of a Voronoi diagram the only points that give the solution to the toxic waste problem?

**Your Turn: Check ManageBac
(week 30)**

International-mindedness

Voronoi diagrams were used in the analysis of the 1854 cholera epidemic in London, in which physician John Snow determined a strong correlation of deaths with proximity to a particular (and infected) water pump on Broad Street.

<https://plus.maths.org/content/uncovering-cause-cholera>



Thank You

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