Jarvis March Algorithm

An algorithm to find convex hull

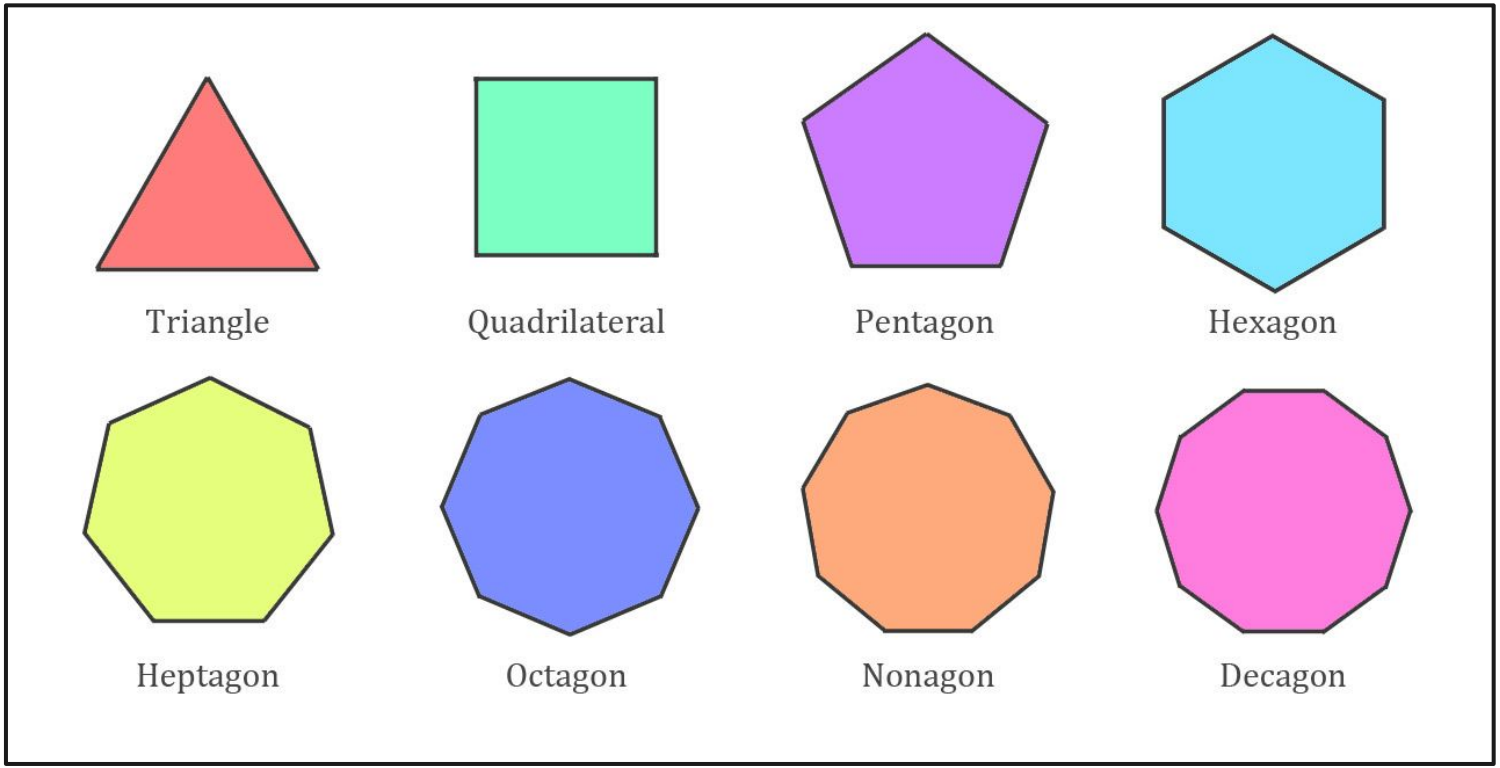
Akif Islam

Why it is called “Jarvis March”?

- the algorithm named after R. A. Jarvis, who published it in 1973
- “March” refers to the organized, uniformed way of walking

What is a Polygon (বহুভুজ) ?

- A polygon is a closed shape with straight sides. Rectangles, triangles, hexagons, and octagons are all examples of polygons.

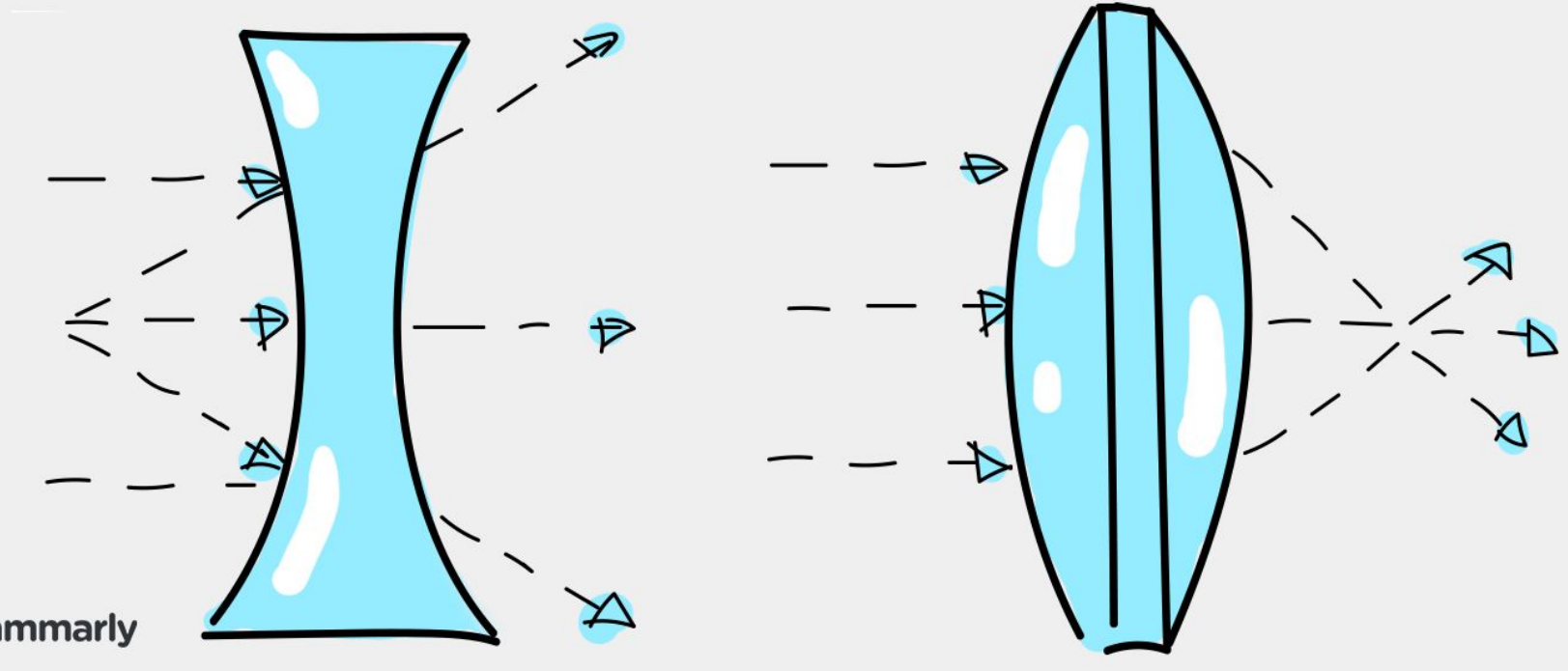

Triangle
Quadrilateral
Pentagon
Hexagon
Heptagon
Octagon
Nonagon
Decagon

What is Convex (উত্তল) ?

- curved or rounded outward like the exterior of a sphere or circle.

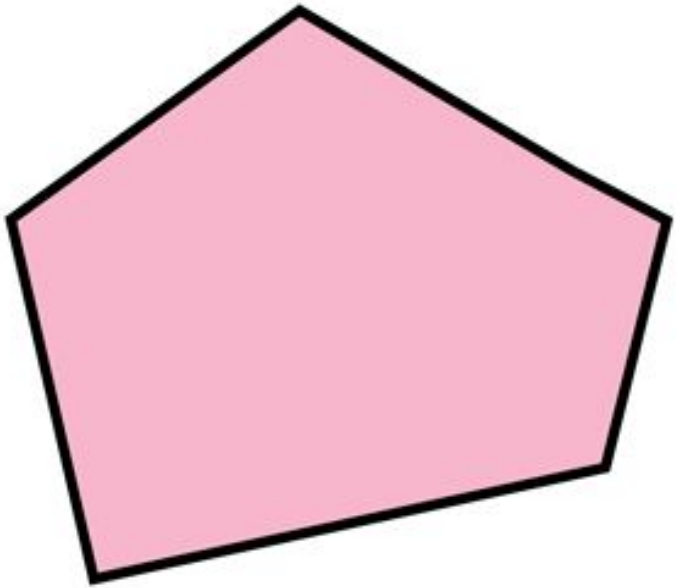
- (similarly, **‘Concave’** is the opposite of convex)

CONCAVE VS. CONVEX

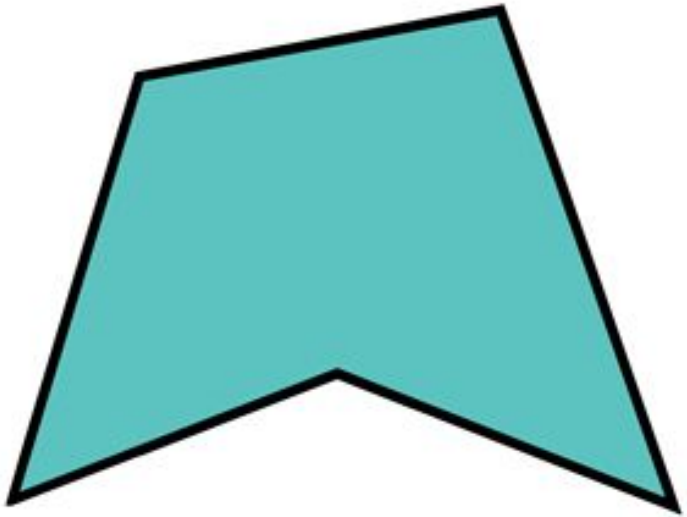


Convex and Concave Polygons

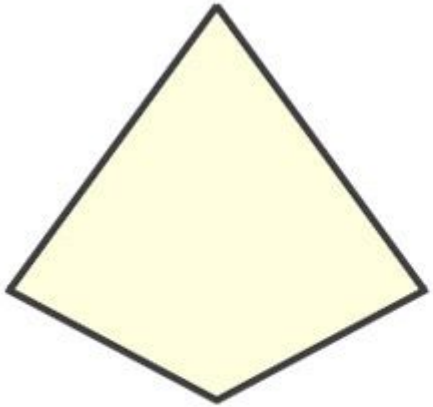
MATH MONKS



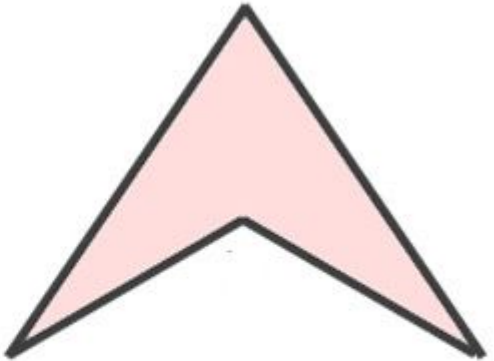
Convex



Concave



Convex



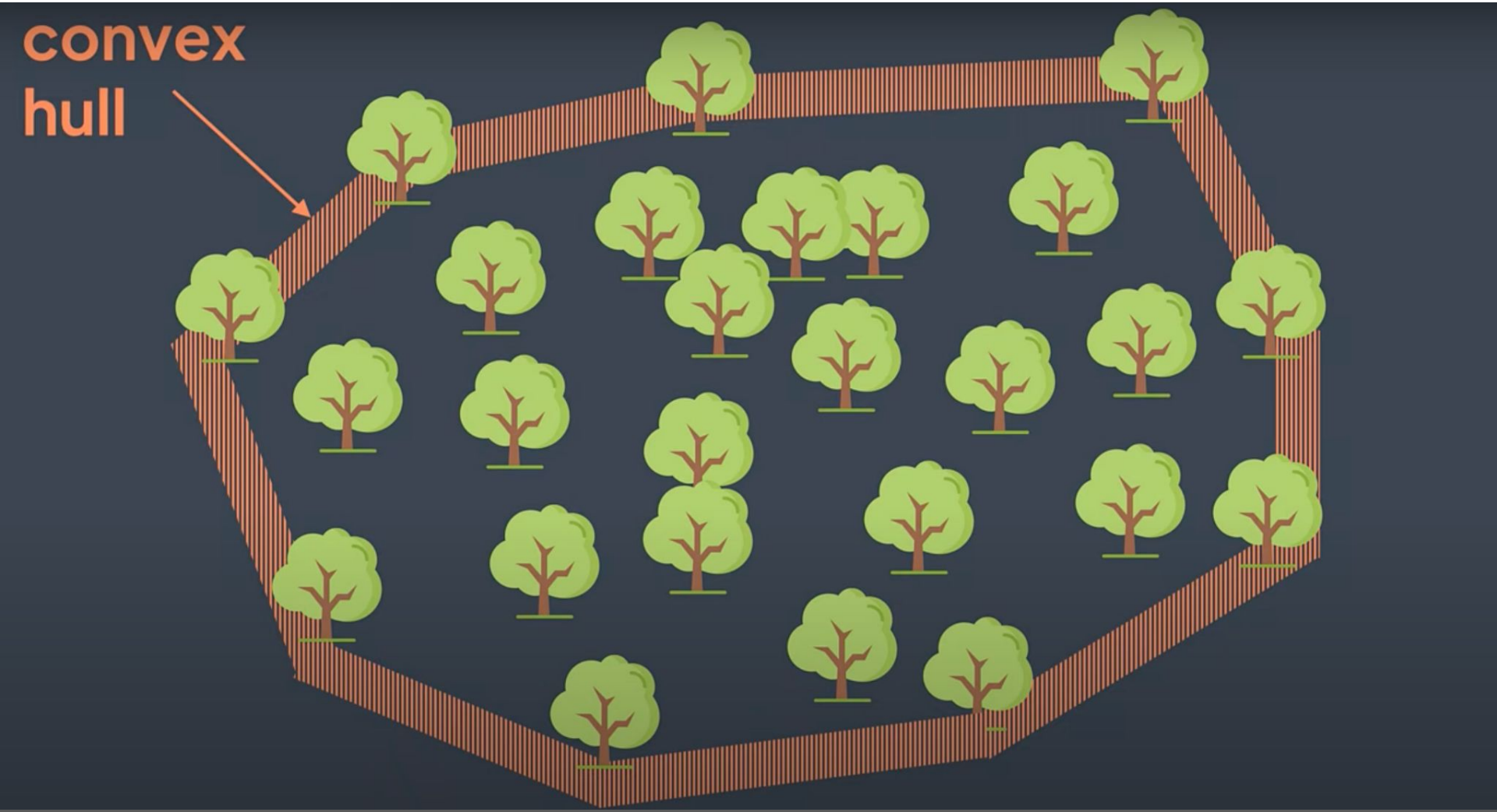
Concave

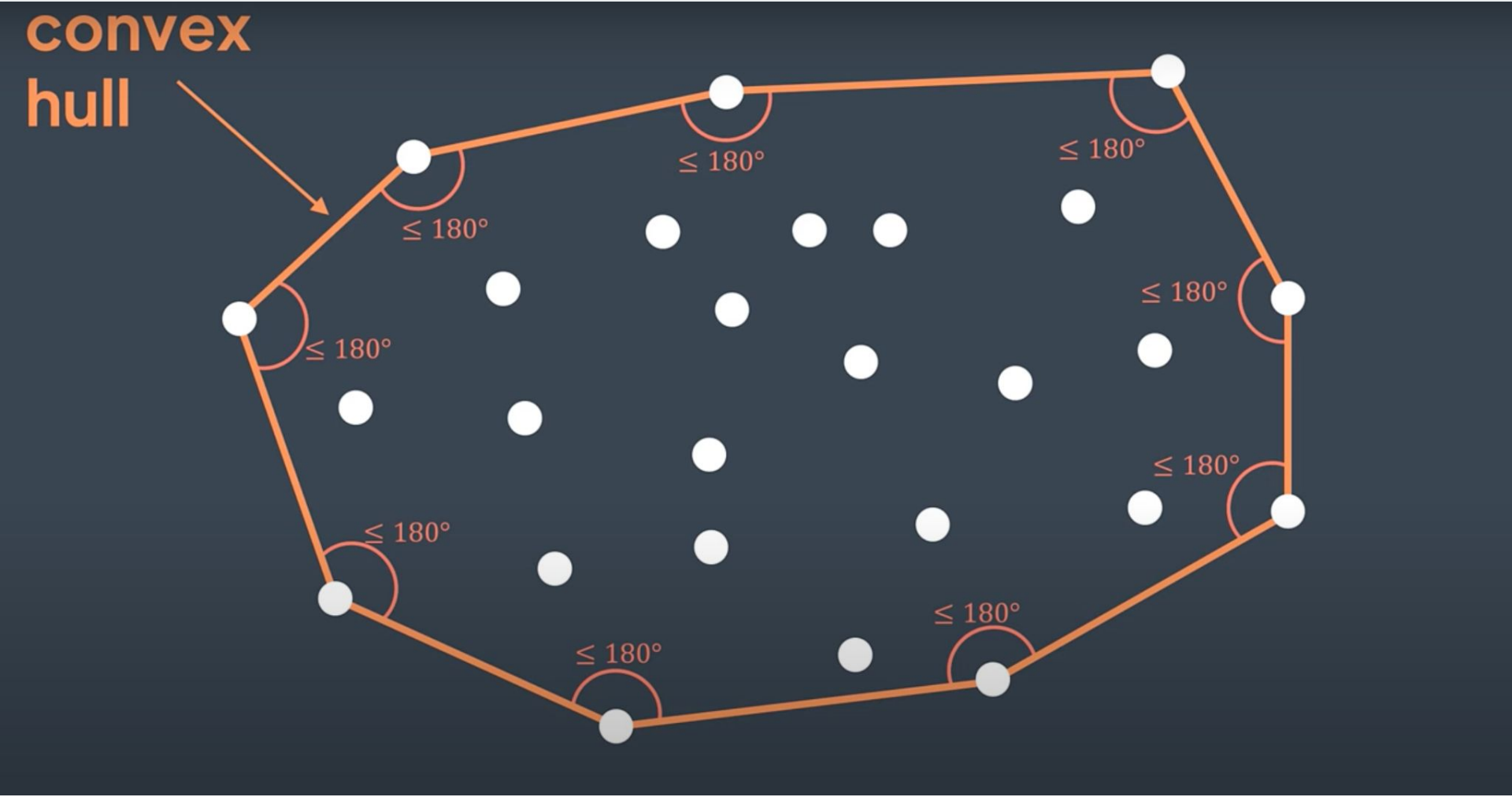
What is Convex Hull?

("Convex" means rounded, "hull" means the outer layer)

Smallest convex polygon containing a given set of points

Formally, we can describe it as the smallest convex polygon which encloses a set of points such that each point in the set lies within the polygon or on its perimeter.

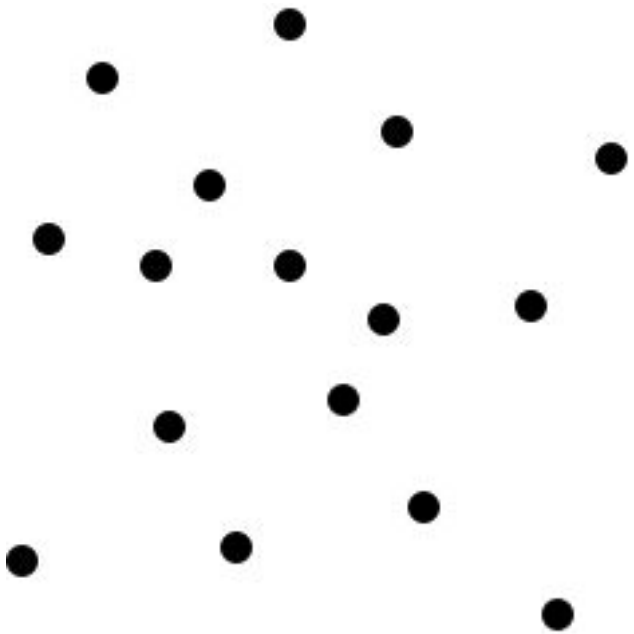

convex
hull


convex
hull
≤ 180°
≤ 180°
≤ 180°
≤ 180°
≤ 180°
≤ 180°
≤ 180°
≤ 180°
≤ 180°

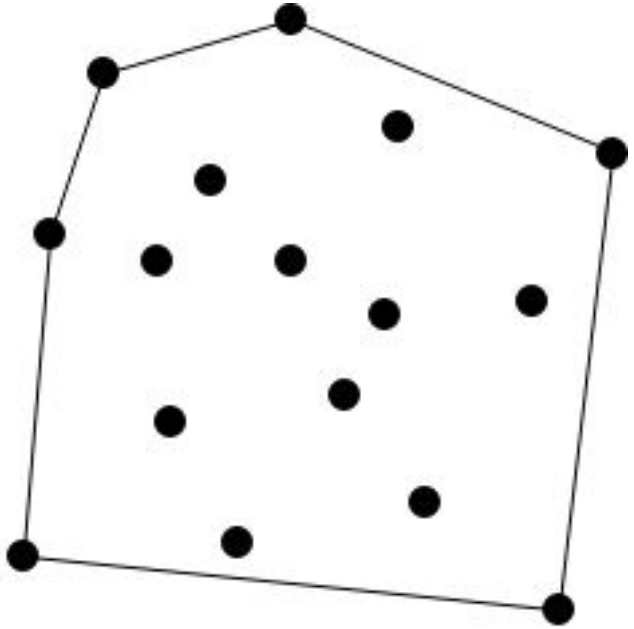
Why we will study this algorithm?

to detect the corner points of a convex hull from a given set of data points.

Convex Hull is useful in many areas including computer visualization, pathfinding, geographical information system, visual pattern matching, etc.



(a)



(b)

Algorithm

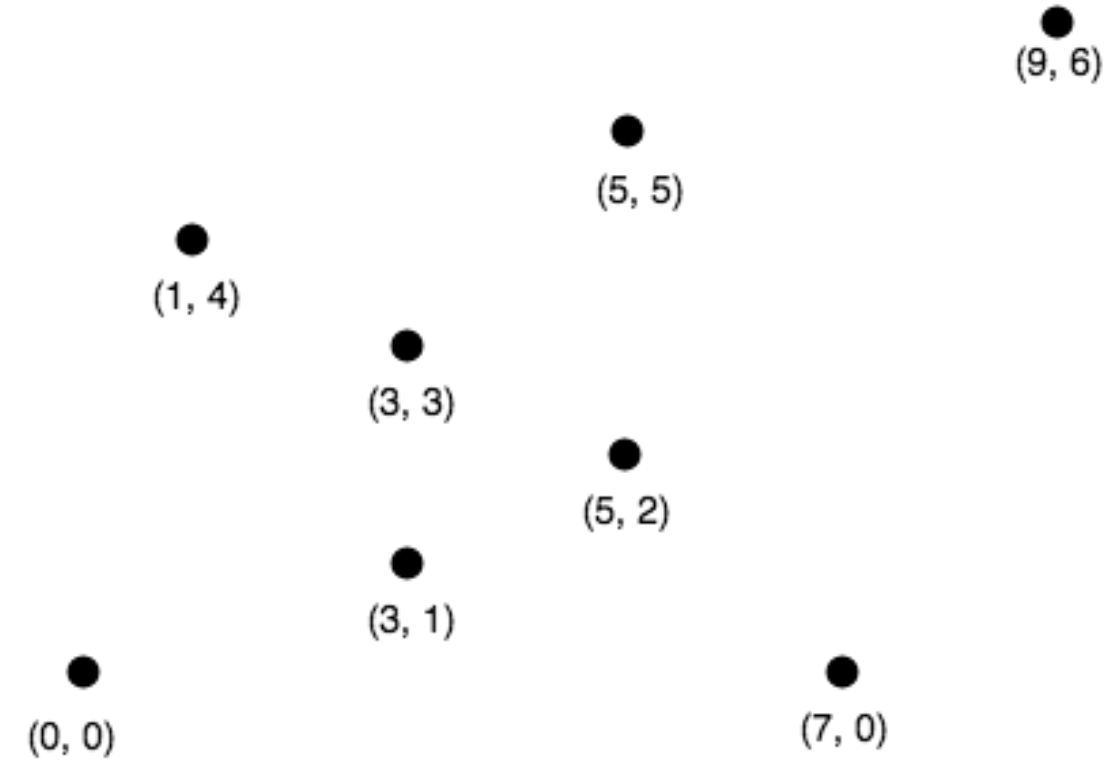
- Jarvis's march algorithm uses a process called **gift wrapping** to find the convex hull. It is one of the simplest algorithms for computing convex hull.

- The working of Jarvis's march resembles the working of selection sort.

- In selection sort, in each pass, we find the smallest number and add it to the sorted list. Similarly, **in Jarvis's march, we find the leftmost point and add it to the convex hull vertices in each pass.**

Algorithm

1. From the given set of points P, we find a point with minimum x-coordinates (or leftmost point with reference to the x-axis). Let's call this point l. Since this point is guaranteed to be in the convex hull, we add this point to the list of convex hull vertices.
2. From l, find the leftmost point. For this, we do the following. We select the vertex following l and call it q. We check if q is in the leftmost position from l. We add q to the list of convex hull vertices.
3. Now q becomes l and we repeat the step (2).
4. Repeat step (2) and (3) until we reach the point where we started.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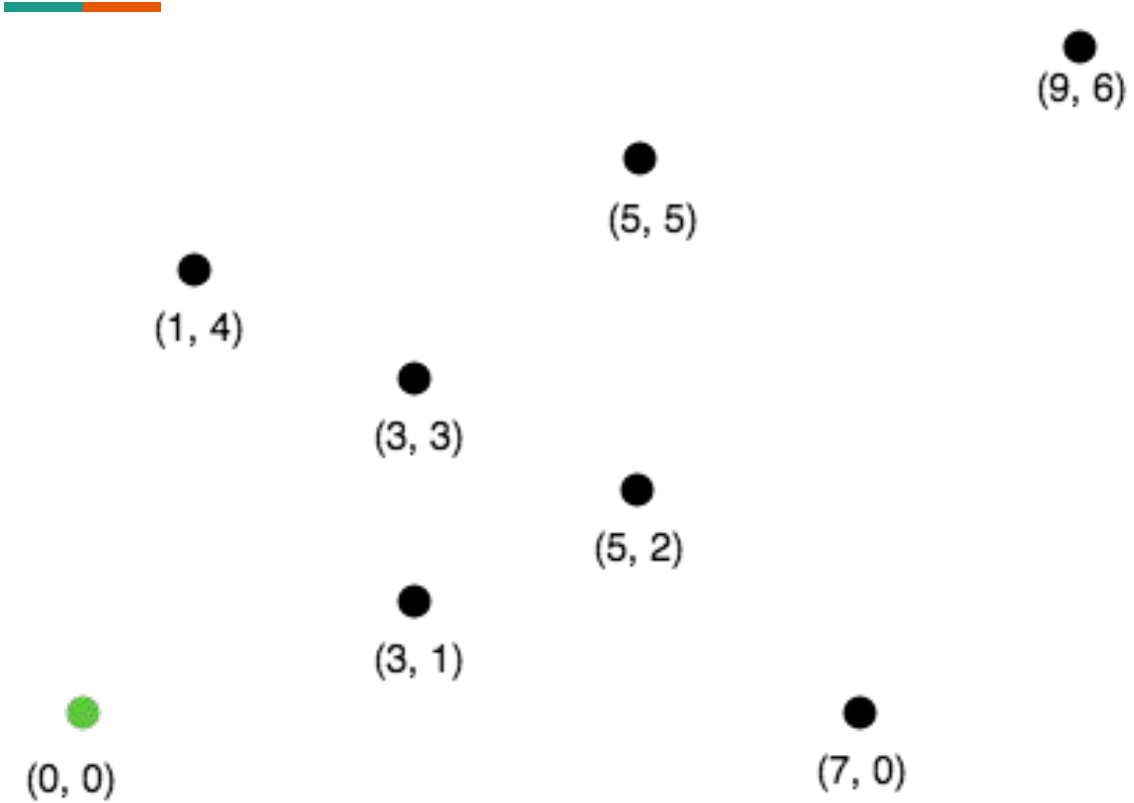
(5, 5)
(1, 4)
(3, 3)
(5, 2)
(3, 1)
(0, 0)
(7, 0)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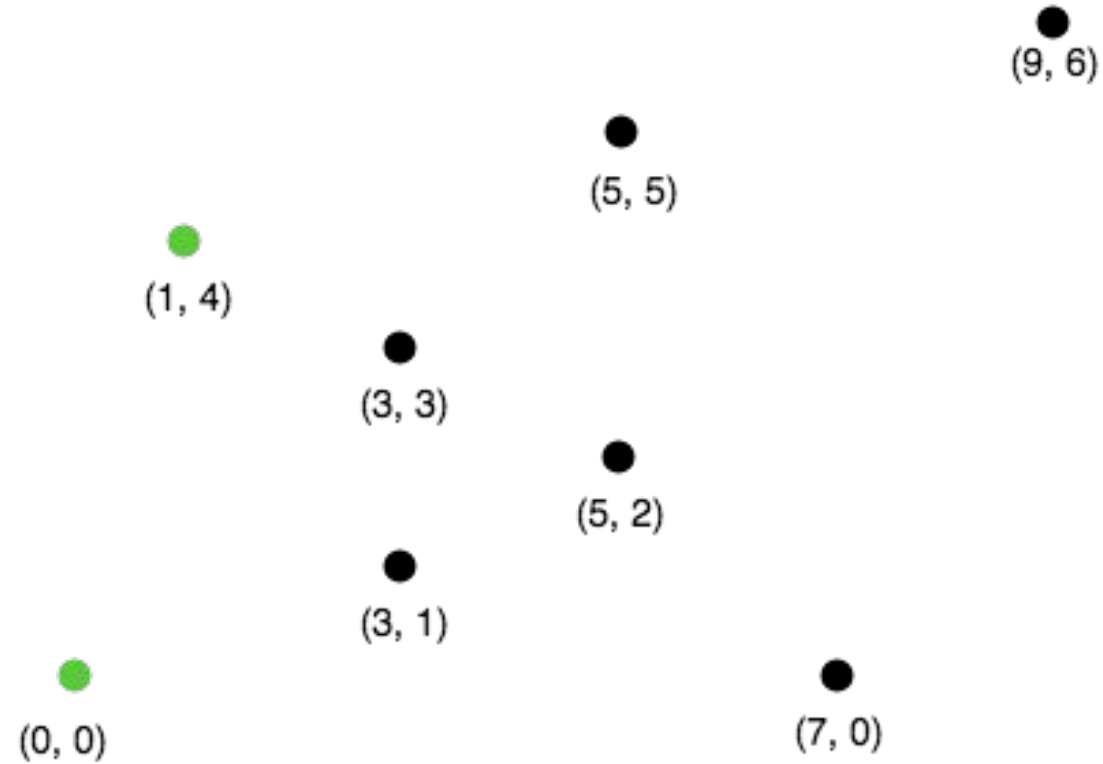
(7, 0)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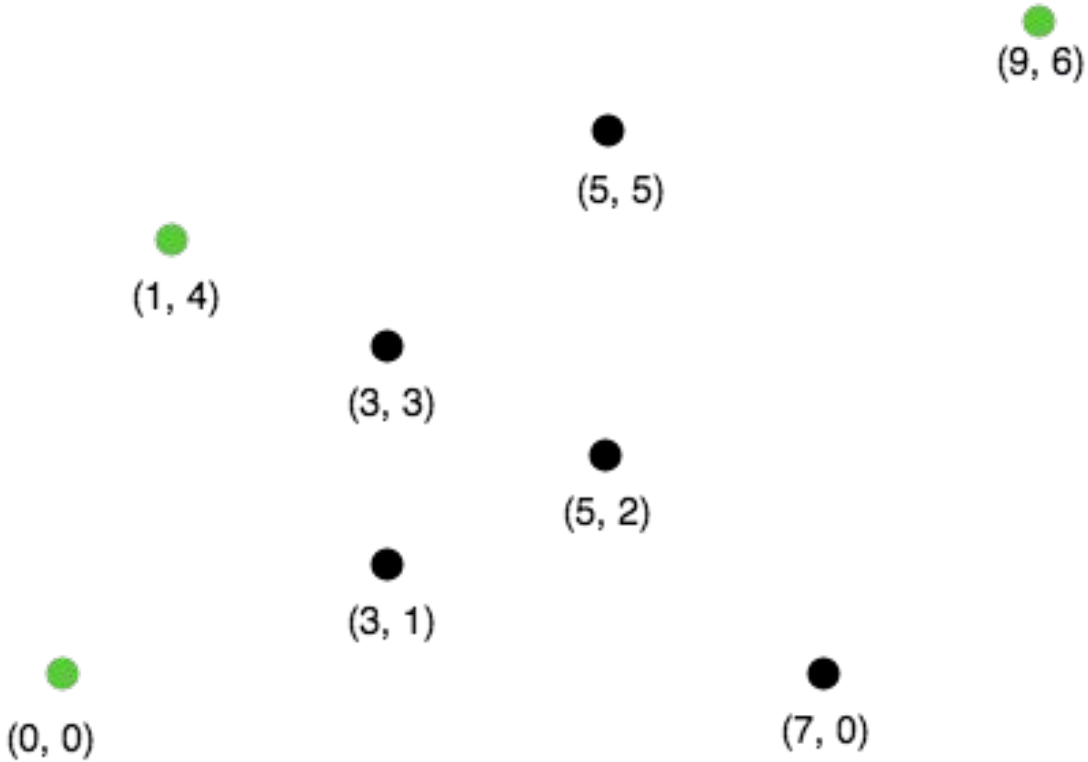
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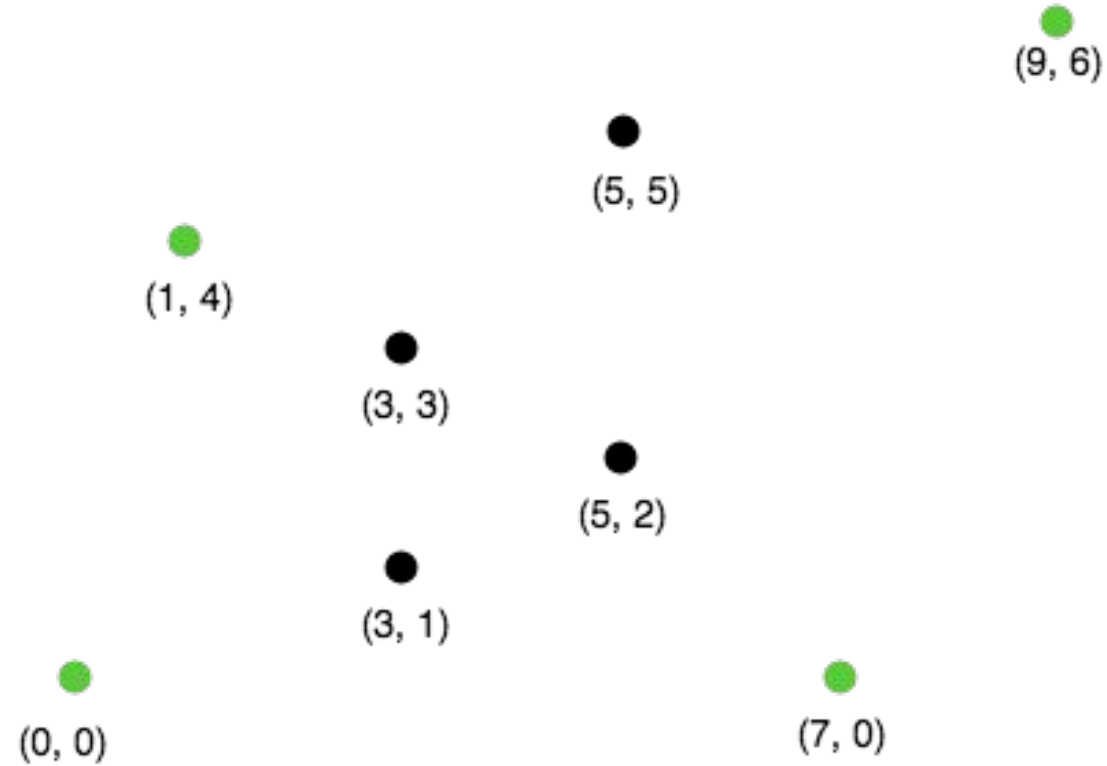
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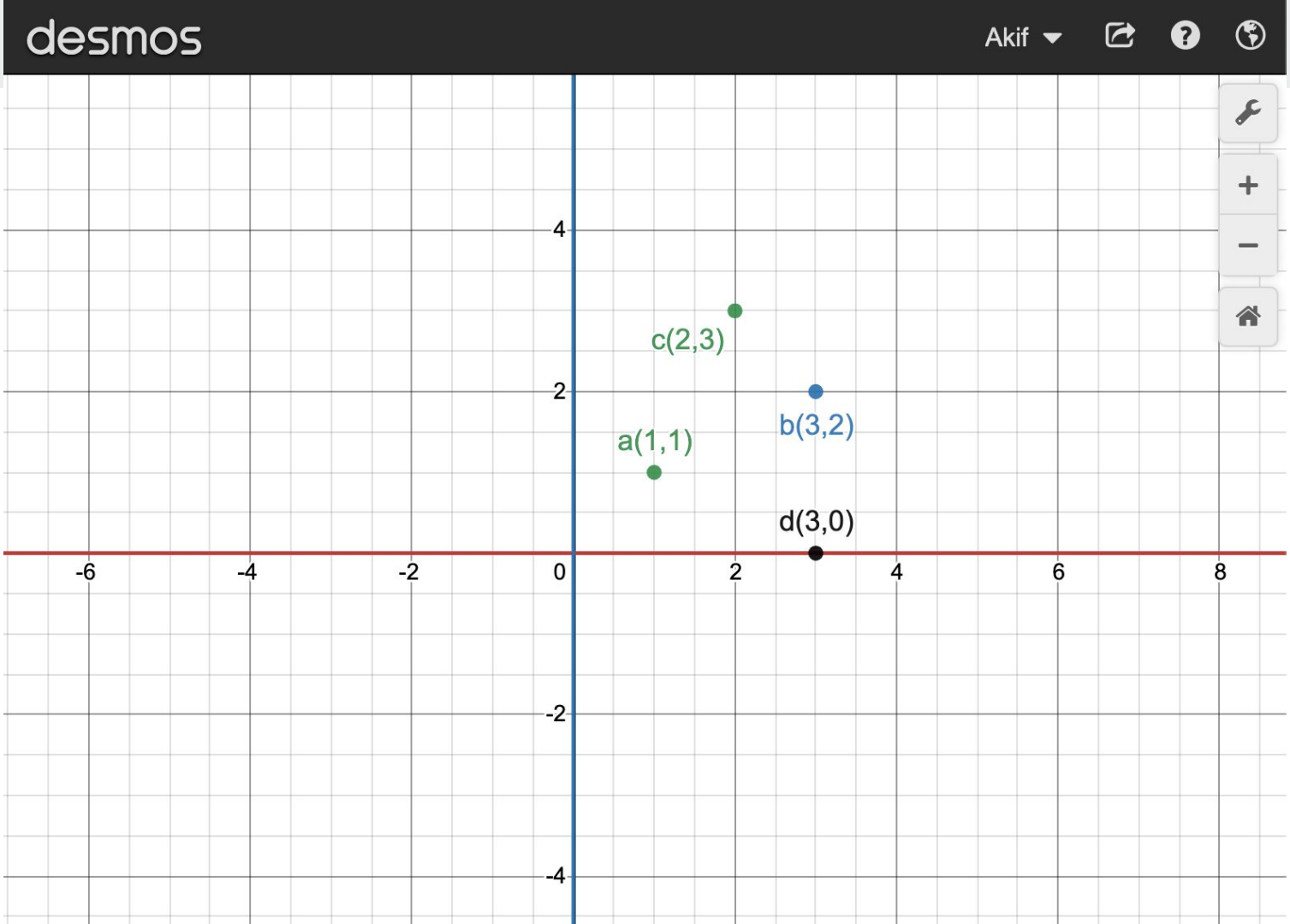
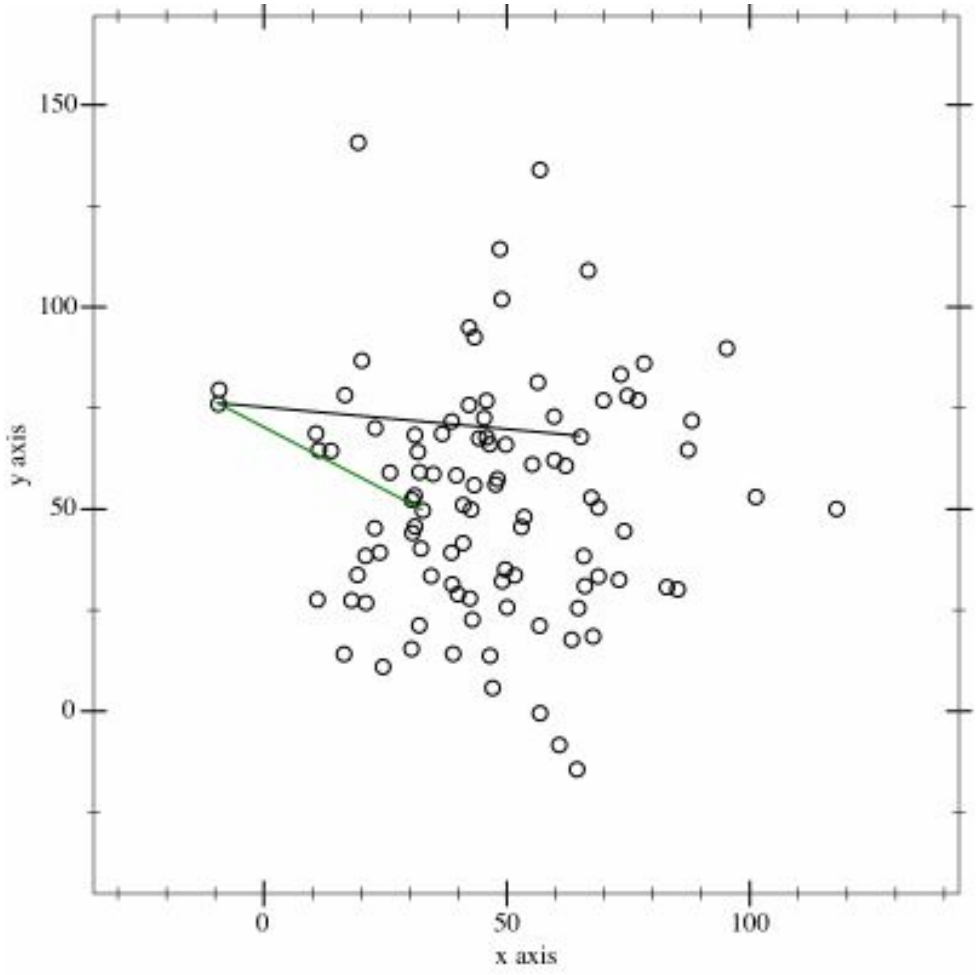

desmos
Akif
c(2,3)
b(3,2)
a(1,1)
d(3,0)
4
2
-2
-4
-6
-4
-2
0
2
4
6
8


150
100
50
0
y axis
0
50
100
x axis

Time Complexity

The algorithm spends O(n) time on each convex hull vertex. If there are h convex hull vertices, the total time complexity of the algorithm would be

$$O(n * h)$$

Since **h is the number of points in the boundary**, **n is the total points**. this algorithm is also called output sensitive algorithm since the complexity also depends on the number of output.

For Practise

https://leetcode.com/problems/erect-the-fence/

Reference

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7.

Thank you.