# Tutorial 4

20BCE10077
Fiza Siddiqui

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## Q (1)

Find convex hull Points using Graham Scan method & Javis March method.

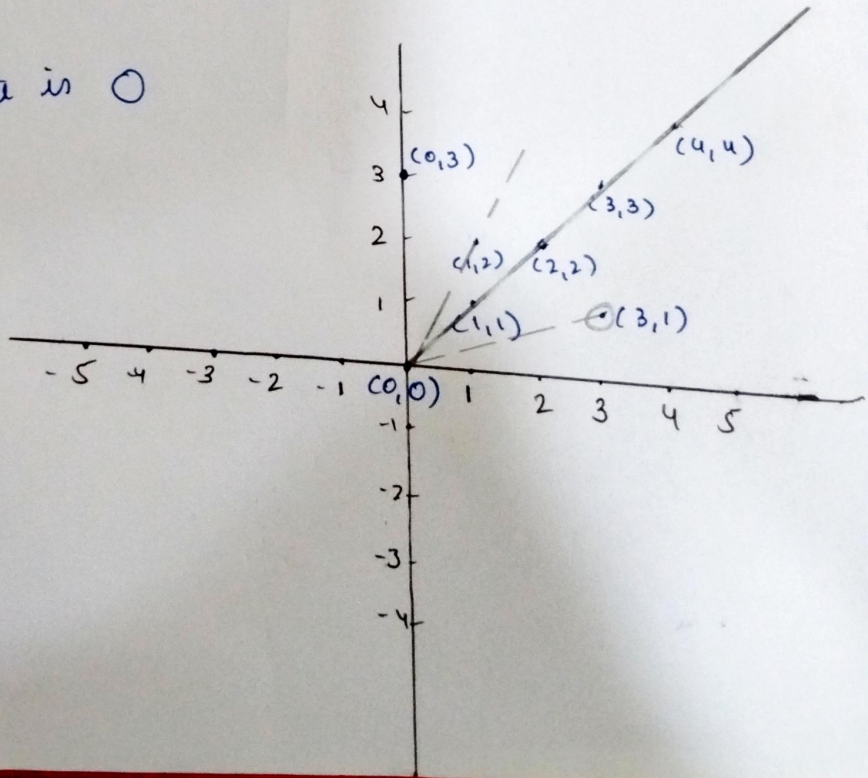
i) {0,3}, {1,1}, {2,2}, {4,4}, {0,0}, {1,2}, {3,1}, {3,3}

## Solution:

By Graham Scan Method:

Smallest y coordinate is 0

$\therefore P_0 = (0,0)$



Sorted list based on polar angle:

$\Rightarrow (0,0), (3,1), (1,1), (2,2), (3,3), (4,4), (1,2), (0,3)$

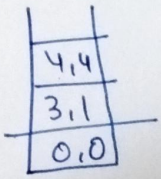
Now, we can see that;

$(1,1), (2,2), (3,3), (4,4)$ are collineal & farthest is $(4,4)$

$\therefore$ Rest all are discarded.

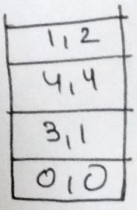
$\therefore$ list

$(0,0), (3,1), (4,4), (1,2), (0,3)$
$P_0 \quad P_1 \quad P_2 \quad P_3 \quad P_4$




Considering $(3,1)$ & $(4,4)$. The next point is $(1,2)$.
Clearly from point $(3,1)$ & $4,4)$ ; $(1,2)$ turn left.

$\therefore$ Therefore, $(1,2)$ is pushed in stack.




Vector $(3,1)$ to $(4,4)$

$\overrightarrow{P_0 P_1} = (-1, -3)$

Vector $(0,0)$ to $(1,2)$

$\overrightarrow{P_2 P_3} = (1,2)$

Therefore, $\vec{P_0P_1} \times \vec{P_2P_3} = \begin{vmatrix} -1 & 1 \\ 3 & 2 \end{vmatrix}$

$= 1 > 0$ (greater than zero)

Now from points (4,4) & (1,2), the point (0,3) turns right.

∴ Pop (1,2) from stack.

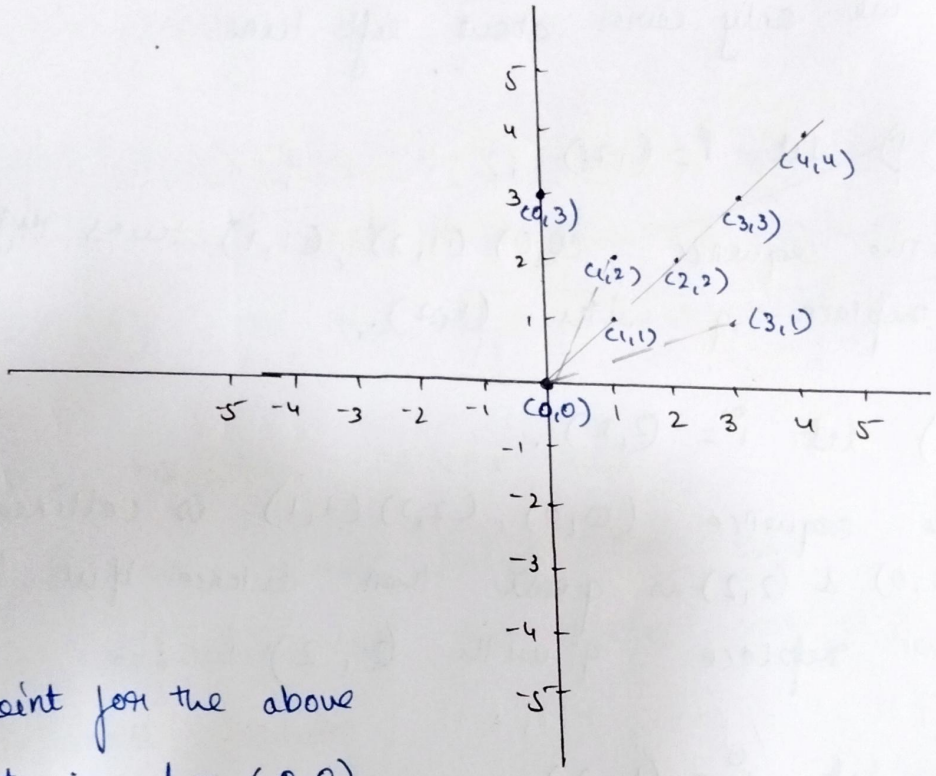
Now, (0,3) is the last point. Hence we push it in stack & stop.

∴ convex hull points

(0,0), (3,1), (4,4), (0,3).

# By Jarvis March method

(0,3) (1,1) (2,2) (4,4) , (0,0) , (1,2) , (3,1) , (3,3)




The leftmost point for the above set of points is $L = (0,0)$

- Now, we insert the point (0,0) into the convex hull vertices.

Now, we have to find the left most point from $L = (0,0)$

1) Let $q$ be the point (1,1)
2) all other points except L & q are i°

$(l, i, q)$

3.) let $i = (3,1)$.

→ The sequence $(0,0), (3,1), (1,1)$ turns left.
we only care about left turns.

4) let $i = (1,2)$

→ The sequence $(0,0)(1,2), (1,1)$ turns right. we replace $q$ with $(1,2)$.

4) let $i = (2,2)$.

The sequence $(0,0), (2,2)(1,1)$ is collinear. In this case $(0,0)$ & $(2,2)$ is greater than distance b/w $(0,0)$ & $(3,3)$ so we replace $q$ with $(2,2)$

5) let $i = (1,2)$

The sequence $(0,0)(1,2)(2,2)$ turns right. we replace $q$ by point $(1,2)$

6) let $i = (0,3)$

the sequence $(0,0)(0,3)(1,2)$ turns right, we replace $q$ by point $(0,3)$.

7) $i = 3,3$

The sequence $(0,0)(3,3)(0,3)$ turns left, so we move on.

8) ~~$i = 4,4$~~ finally let $i = (4,4)$

The sequence $(0,0)(4,4)(0,3)$ turns left. So we do nothing. We went through all points & now $q = (0,3)$ is the left most point.

- We add $(0,3)$ to the convex hull.

→ Now we find the leftmost point from the point $(0,3)$. repeating all the steps we get $(4,4)$ as leftmost point.

→ Using the same procedure, we find the ~~left~~ leftmost Point from $(4,4)$ & get ~~$(1,1)$~~ $(3,1)$ as the leftmost point.

- Now from $(3,1)$ the leftmost point is $(0,0)$ which is already included in convex hull so we stop.

So the convex hull points are :

$\Rightarrow (0,0), (0,3), (4,4), (3,1), (0,0)$.