

## 77) Convex hull

CODE:

```
def convex_hull(points):
    points = sorted(points)

    def cross(o, a, b):
        return (a[0] - o[0]) * (b[1] - o[1]) - (a[1] - o[1]) * (b[0] - o[0])

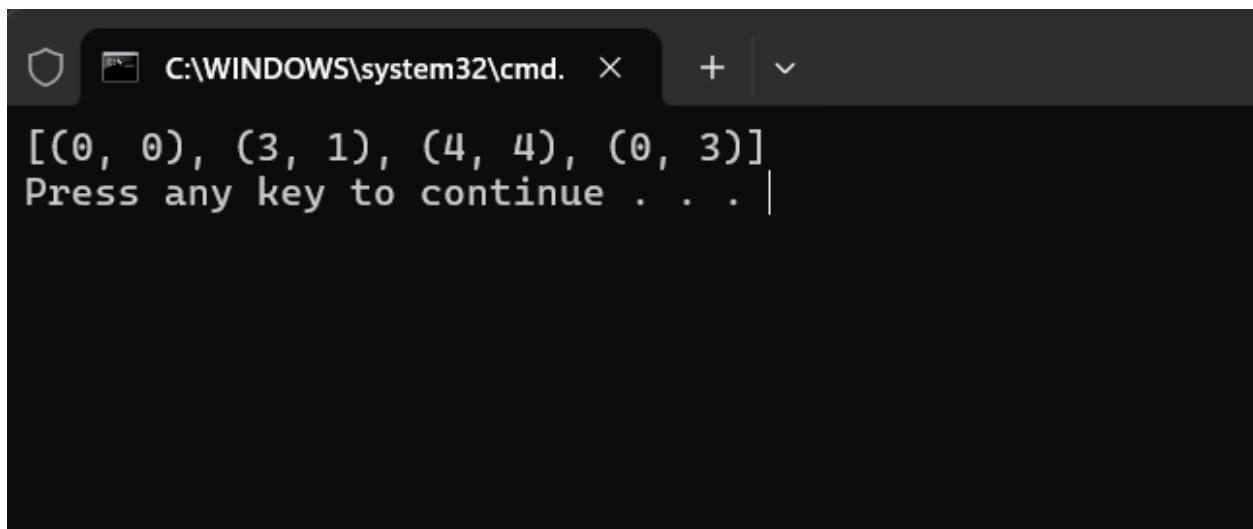
    lower = []
    for p in points:
        while len(lower) >= 2 and cross(lower[-2], lower[-1], p) <= 0:
            lower.pop()
        lower.append(p)

    upper = []
    for p in reversed(points):
        while len(upper) >= 2 and cross(upper[-2], upper[-1], p) <= 0:
            upper.pop()
        upper.append(p)

    return lower[:-1] + upper[:-1]

points = [(0, 3), (1, 1), (2, 2), (4, 4), (0, 0), (1, 2), (3, 1)]
hull = convex_hull(points)
print(hull)
```

OUTPUT:

A screenshot of a Windows command prompt window. The title bar shows the path 'C:\WINDOWS\system32\cmd.' with a close button and window control icons. The command prompt displays the output of the program: '[(0, 0), (3, 1), (4, 4), (0, 3)]' followed by the prompt 'Press any key to continue . . . |'.

```
C:\WINDOWS\system32\cmd.
[(0, 0), (3, 1), (4, 4), (0, 3)]
Press any key to continue . . . |
```

TIME COMPLEXITY :  $O(n \log n)$