Exercises:

1. [*CLRS*] Devise an algorithm to determine whether any three points in a set of n points are collinear. You may work out algorithms with the following time complexities: $O(n^3)$ and $O(n^2 \lg n)$. Implement both versions of the algorithm and test their correctness.

2. [*CLRS*] Given a point $p_0 = (x_0, y_0)$, the *right horizontal ray* from p_0 is the set of points $\{p_i = (x_i, y_i) | x_i \geqslant x_0 \text{ and } y_i = y_0\}$,that is, it is the set of points due right to p_0 along with p_0 itself. Show how to determine whether a given right horizontal ray from p_0 intersects a line segment $\overline{p_1 p_2}$ in $O(1)$ time by reducing the problem to that of determining whether two line segments intersect. Write the pseudocode of the corresponding algorithm.

3. [*Point in polygon.*] Consider a *convex polygon* and a point defined in the plane (two dimensions). One way to determine whether a point p_0 is in the interior of a simple, convex, polygon P is to look at any ray from p_0 and check that the ray intersects the boundary of P an odd number of times but that p_0 itself is not on the boundary of P. Show how to compute in $\Theta(n)$ time whether a point p_0 is in the interior of an n-vertex polygon P. You may also implement your algorithm and test it thoroughly. (Hint: Use the previous exercise. Make sure your algorithm is correct when the ray intersects the polygon boundary at a vertex and when the ray overlaps a side of the polygon.)