COMP163 Homework Assignment 5
Due Thursday, November 13, 2025 at 11:59pm

Reading:

Continue reading in the yellow/blue book and possibly the red book to expand your understanding of computational geometry, as well as more particularly the topics of 3D (and higher) convex hulls, linear programming, and closest pairs.

Please also review my handwritten lecture notes:

`https://www.cs.tufts.edu/cs/163/notes05/CH_HD_handwritten.pdf`

Problems:

1. Point Inclusion in 2D: Given a set S of n unsorted points in R^2 and a query point q that is NOT in S, describe the most efficient procedure that you can devise for each of the following:

   (a) Determine whether q lies inside or outside the convex hull of S ($CH(S)$), without actually calculating the convex hull.

   (b) If q lies inside $CH(S)$ (but again, you have not calculated it), report points $x, y, z \in S$ such that triangle Δxyz contains q.

   (c) If q lies outside $CH(S)$ (but again, you have not calculated it), report a line that passes through a point of S such that q is on one side of the line and all of the points of S are either on the line or on the other side of the line.

   (d) If you have already calculated the $CH(S)$, how quickly can each of the preceding tasks be accomplished? How?

2. Point Inclusion in 3D: Given a set S of n unsorted points in R^3 and a point q that is NOT in S, describe a the most efficient procedure that you can devise to determine each of the following, analyse its complexity, and justify its correctness:

   (a) Determine whether q lies inside or outside the convex hull of S ($CH(S)$). without actually calculating the convex hull.

   (b) If q lies inside $CH(S)$ (but again, you have not calculated it), determine points $w, x, y, z \in S$ such that the tetrahedron $\Delta wxyz$ contains q.

   (c) If q lies outside $CH(S)$ (but again, you have not calculated it), report a plane that passes through a point of S such that q is on one side of the plane and all of the points of S are either on the plane or on the other side of the plane.

   (d) If you have already calculated the $CH(S)$, how quickly can each of the preceding tasks be accomplished? How? What if you do additional "preprocessing"?