CMPS 3130 Computational Geometry – Spring 20

1/16/20

1. Homework (undergrad)

Due **1/23/20** before class

1. **Convex polygons and upper/lower tangents (6 points)**
   Give an example of two convex polygons $P, Q \subseteq \mathbb{R}^2$ whose upper and lower tangents do not touch a point in P or Q with minimum or maximum y-coordinate.

2. **Convex hulls for collinear points (9 points)**
   Out of the five convex hull algorithms (in the plane), pick three algorithms. For each of these algorithms describe what happens if more than two points are collinear (i.e., lie on the same line), and suggest what changes should be made to the algorithms to compute the convex hulls correctly in this case. [Note: If more than two points are collinear then there potentially multiple correct outputs for the cyclic list representing the boundary of the convex hull, because several subsets of collinear points can correctly describe a line segment on the boundary of the convex hull.]

   Also consider the case when all points are collinear.

3. **Binary search (10 points)**
   Assume you have an orientation test available which can determine in constant time whether three points make a left turn (i.e., the third point lies on the left of the oriented line described by the first two points) or a right turn. Now, let a point q and a convex polygon $P = \{p_1, \ldots, p_n\}$ in the plane be given, where the points of P are stored cyclically in an array in counter-clockwise order around P. Give pseudo-code to determine an upper tangent from q to P in $O(\log n)$ time, and analyze its runtime. *(Hint: It helps to annotate your code with pictures.)*