CMPS 3130/6130 Computational Geometry – Spring 17

1/19/17

1. Homework

Due **1/26/17** before class

1. **Convex hulls for collinear points (10 points)**
   We have covered three different convex hull algorithms in class: Slow_CH, Giftwrapping_CH, and Incremental_CH. 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 correct convex hulls in this case.

   Also consider the case when all points are collinear.

2. **Line segment intersection (10 points)**
   Given two line segments $\overline{ab}$ and $\overline{cd}$ in the plane, where $a, b, c, d \in \mathbb{R}^2$. The goal is to test them for intersection.

   (a) (3 points) Let $a = \binom{6}{5}$, $b = \binom{14}{9}$, $c = \binom{7}{2}$, and $d = \binom{9}{10}$. Express each line segment as a convex combination, and use this representation to determine if $\overline{ab}$ and $\overline{cd}$ intersect, and if so, compute their intersection point.

   (b) (2 points) Do $\overline{eb}$ and $\overline{cd}$ intersect, where $e = \binom{10}{7}$? What is different compared to part (a)?

   (c) (5 points) Explain how you can use one or more orientation tests to test if two line segments intersect. *(Hint: Case analysis. Draw pictures of examples, and determine important configurations of a, b, c, d.)*

3. **Point location in a convex polygon (10 points)**
   Given a convex n-gon P in the plane, and a query point q, design an algorithm that can decide in $O(\log n)$ time whether $q \in P$ or not. If you find it easier you can preprocess P into a suitable data structure that enables efficient queries for q.

   Analyze your algorithm and make it as efficient as possible.