

## COMP 4045 – Assignment 1

- Guarding the walls.* Construct a polygon  $P$  and a placement of guards such that the guards see every point of  $\partial P$ , but there is at least one point interior to  $P$  not seen by any guard.
  - Watchman route.* A watchman route is a closed walk in  $P$  such that every point of  $P$  is visible from some point of the walk. Construct a polygon  $P$  that may contain polygonal holes and a watchman route such that the watchman sees every point of  $\partial P$ , but there is at least one point interior to  $P$  not seen by the watchman.
- Prove or disprove.* The dual graph of the triangulation of a monotone polygon is always a chain, that is, any node in this graph has degree at most two.
- Prove that any polygon  $P$  with  $n$  vertices admits a triangulation, even if it has  $h$  polygonal holes. Prove that the number of triangles in the triangulation is  $n + 2h - 2$ .
- Compute the convex hull of a set of  $n$  points in the plane by using divide-and-conquer.
  - Let  $P_1$  and  $P_2$  be two disjoint convex polygons with  $n$  vertices in total. Give an  $O(n)$  time algorithm that computes the convex hull of  $P_1 \cup P_2$ . You may assume that  $P_1$  and  $P_2$  can be separated by a vertical line.
  - Use the algorithm from part a to develop an  $O(n \log n)$  time divide-and-conquer algorithm to compute the convex hull of a set of  $n$  points in the plane.
- Let  $S$  be a set of  $n$  disjoint line segments in the plane, and let  $p$  be a point not on any line segment of  $S$ . Determine all line segments of  $S$  that  $p$  can see, that is, all line segments of  $S$  that contain some point  $q$  so that the open segment  $\overline{pq}$  doesn't intersect any line segment of  $S$ . Give an  $O(n \log n)$  time algorithm that makes use of a rotating half-line with its endpoint at  $p$ .
- Let  $P$  be a non-convex polygon. Describe an algorithm that computes the convex hull of  $P$  in time  $O(n)$ . *Hint:* Use a variant of algorithm CONVEXHULL on page 6 where the vertices are not treated in lexicographical order, but in some other order.

**Due: 31st of March 2005 at 4pm.**