# CSCI5010 Exercise List 10

Problem 1. A *polygonal subdivision* of $\mathbb{R}^2$ is a planar graph embedded in $\mathbb{R}^2$ where each face is a convex polygon. Let n be the number of faces. The figure below shows an example of $n = 7$ (where the rectangle represents $\mathbb{R}^2$). Explain how to build a structure that allows us to identify the face containing any query point. Your structure needs to consume $O(n)$ space in expectation, and answer any query in $O(\log n)$ time in expectation.
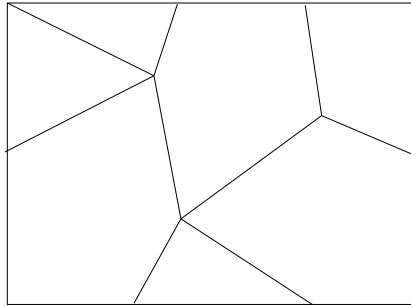
Problem 2. Let P be a convex polygon whose vertices are given in an array in clockwise order. Shoot a ray r from a point inside P. Describe an algorithm to find the edge of P crossed by r in $O(\log n)$ time, where n is the number of vertices of P. For example, in the figure below, you should return the edge AB.
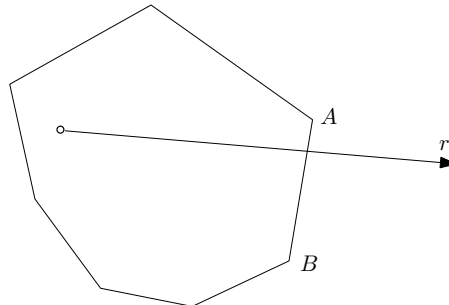
Problem 3. Given a polygonal subdivision of $\mathbb{R}^2$, explain how to build a structure to answer queries of the following form: given a query segment q, find all the faces of the subdivision that have a non-empty intersection with q. For example, in the figure below, q intersects with 3 faces. Your structure needs to consume $O(n)$ space in expectation, where n is the number of faces in the subdivision. It must answer any query in $O(k \log n)$ time in expectation, where k is the number of faces reported.