Review II

Concerning the midterm of Monday 6 April, please observe the following policies:

1. The exam is open book and open notes. No computers or calculators are allowed.
2. You may skip the midterm exam. Skipping the exam means that you do not show up on the day of the exam. In that case, more weight will be placed on the projects and/or final exam.

The exam covers the chapters six to ten in the textbook, briefly summarized below:

1. point location, trapezoidal maps;
2. Voronoi diagrams and sweep line algorithms;
3. duality and arrangements of lines;
4. edge flips and Delaunay triangulations;
5. windowing with interval, priority and segment trees.

For each topic, we have three types of questions:

1. understand a concept, an idea for an algorithm or data structure;
2. formulate an algorithm in pseudo code or list the stages of a method;
3. given pseudo code, prove correctness, analyze time and space cost.

The homework problems are good examples of questions. A picture says more than a thousand words and holds often the key to the solution of a geometric problem. Below are some sample questions:

1. Let $T(S)$ be a trapezoidal map of a subdivision S be given along with its search structure $\mathcal{D}$. Suppose we want to refine $T(S)$ into a triangulation.
   (a) Outline an algorithm to refine $T(S)$ by adding new internal vertices.
   (b) If no new internal vertices may be added, how would you then refine $T(S)$?
2. Consider as given three points p_1, p_2, p_3 that are not collinear in the plane, and another point q.
   (a) Describe an algorithm to decide whether q lies inside the disk whose boundary circle passes through p_1, p_2, and p_3.
   (b) Discuss the robustness of your algorithm (or any algorithm to solve the problem). What happens in case the points p_1, p_2, and p_3 are almost collinear?
3. We discussed an incremental algorithm to construct a doubly-connected edge list to store an arrangement of lines. Does the order in which we add the lines matter for the complexity of this algorithm? Justify your answer.
4. Consider a convex polygon P with no interior points.
   (a) Derive an upper bound on the number of triangulations of P.
   (b) Give an algorithm to enumerate all triangulations of P.
5. Suppose we want a window query on a map using a circle instead of a rectangle as the window.
   (a) State a precise formulation of the problem, using an input/output specification for such a query. Relate how you could solve the problem approximately using rectangular query windows.
   (b) Develop an idea to directly solve the circular query problem.