

## Review I

Concerning the midterm of Wednesday 18 February, 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 first five chapters in the textbook, briefly summarized below:

1. planar convex hull algorithms;
2. line sweeping to intersect line segments, DCELs and the map overlay problem;
3. triangulations, partitioning into monotone pieces, and triangulating a monotone polygon;
4. divide & conquer for halfplane intersection, 2D LP: incremental, randomized, and with certificates;
5. orthogonal queries: 1D range query, building and searching kD trees, range 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
3. given pseudo code, prove correctness, analyze time and space cost

The homework problems are good examples of questions. It is usually always a good idea to draw a picture when solving a geometric problem. Below are some sample questions:

1. Suppose we are interested only in computing the lower hull of a set of points in the plane.
  - (a) Design an incremental algorithm to report the lowest vertex first.
  - (b) What are the advantages and disadvantages to presort the points on their second coordinate?
  - (c) To address robustness, give an example of a near degenerate input.
2. Discuss the robustness of the line segment intersection problem.
  - (a) Draw an example of a near degenerate input configuration.
  - (b) For a near degenerate input, describe the behavior of the algorithm. In case the algorithm makes a wrong decision, will the error propagate?
  - (c) How should the algorithm deal with near degenerate configurations?
3. Give an example of a floorplan of an art gallery, represented by a polygon of  $n$  vertices for which more than  $\lfloor \frac{n}{3} \rfloor$  cameras are needed for guarding the gallery.
4. Write detailed pseudo code to reduce a 2D linear programming problem into a one dimension problem, given the equation of a line on which to search for the optimum. In addition:
  - (a) Show the correctness of the reduction, ensuring all cases are covered.
  - (b) Prove that the cost of the reduction is linear in the number of halfplanes of the 2D LP problem.
5. Given two collection of point sets in the plane, each stored as a kd tree, consider the problem to build one kd tree to store all points of both sets.
  - (a) Draw two examples of this problem: what is the best and what is the worst case?
  - (b) Describe the outline of an algorithm for this problem. What is its cost?