AMS 345/CSE 355 (Spring, 2008) Joe Mitchell

COMPUTATIONAL GEOMETRY
Homework Set # 4

Due at the beginning of class on Wednesday, March 12, 2008.

Recommended Reading: O'Rourke, Chapter 3 (sections 3.1–3.8).

Reminders: *The Midterm Exam will be March 26th, 3:50-5:10PM in the usual class room. It will cover material from homeworks 1–4.*

In all of the exercises, be sure to give at least a brief explanation or justification for each claim that you make.

(1). [20 points] O'Rourke, problem 5, section 3.2.3, page 68.

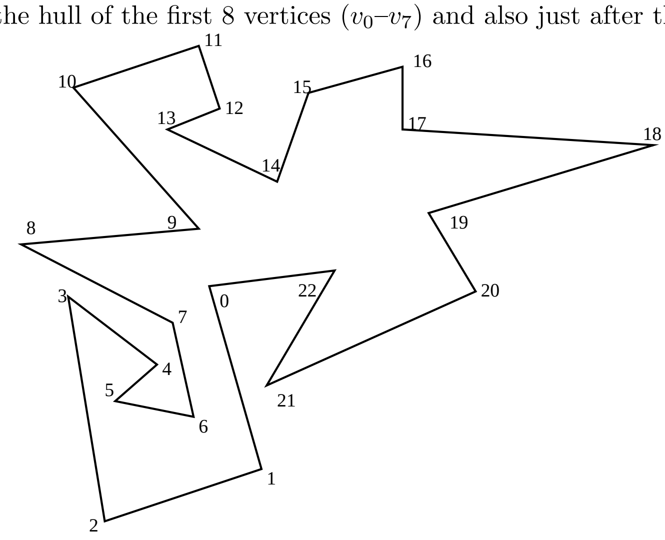
(2). [15 points] O'Rourke, problem 4, section 3.4.1, page 72.

(3). [10 points] O'Rourke, problem 2, section 3.5.7, page 86.

(4). [15 points] O'Rourke, problem 1, section 3.9.2, page 96.
Optional (for extra credit): Do also problem 2, section 3.9.2.

(5). [20 points] Let S be the set of points $\{$(8,5), (8,1), (2,2), (-1,5), (2,6), (3,4), (10,4), (-3,2), (-3,4), (-3,1), (2,-2), (-1,-2), (2,0), (-2,2)$\}$. When the Graham Scan code of Section 3.5 is run on this data, what is the sorting (as in Table 3.1) and what is the history of the stack (as in the example on page 86)? Plot the points and the resulting convex hull.

(6). [20 points] Assume that we execute Melkman's convex hull algorithm on the vertices of P in the order v_0, v_1, v_2, v_3, etc. (In the figure, I label v_i with "i".) Show the deque, indicating the "top" d_t and "bottom" d_b at the instant just after having computed the hull of the first 8 vertices (v_0–v_7) and also just after the first 9 vertices (v_0–v_8).



OPTIONAL CHALLENGE PROBLEM: (I will often ask "research" questions, some of which I have not yet solved myself, but I want to provoke you to try to solve. You can obtain an (unspecified) number of extra credit points for seriously attempting (and ideally solving!) these questions. They have no particular due date, but must be turned in by the last day of class if you want to get credit.)

Modify the code of O'Rourke's implementation of Graham's convex hull algorithm so that it uses a sorting of the points by x-coordinate (instead of by angle about the rightmost lowest point). Run experiments on random data to determine which method is faster in practice, say, on uniformly distributed points in a square.