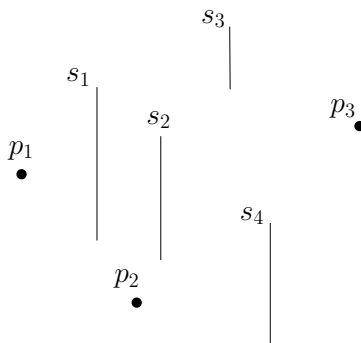


## CSCI5010 Exercise List 3

**Problem 1 (Range Max).** Let  $S$  be a set of  $n$  real numbers. Each number  $v \in S$  is associated with a real valued *weight*. Given a range  $[x, y]$ , a query returns an element in  $S \cap [x, y]$  with the maximum weight. For example, if  $S = \{(1, 15), (3, 7), (7, 12), (10, 9)\}$ , where each pair has the form  $(v, \text{weight}(v))$ . Then, a query with range  $[2, 15]$  returns  $(7, 12)$ . Design a data structure to answer such queries in  $O(\log n)$  time. Your structure should also support insertions and deletions in  $O(\log n)$  time.

**Problem 2 (Batched Line Dragging).** Let  $S$  be a set of  $n$  vertical line segments in  $\mathbb{R}^2$  (i.e., each segment has the form  $x \times [y_1, y_2]$ ). Also, let  $P$  be a set of  $m$  points in  $\mathbb{R}^2$ . For each segment  $s \in S$ , we want to output a pair  $(s, p)$  where  $p$  is the first point in  $P$  that is hit by  $s$  if  $s$  moves left; if  $p$  does not exist, output  $(s, \text{nil})$ . Describe an algorithm to do so in  $O(n \log n + m \log m)$  time. For example, in the following figure, you should output  $\{(s_1, p_1), (s_2, p_1), (s_3, \text{nil}), (s_4, p_2)\}$ . You may assume that  $P$  is in general position (i.e., no two points have the same x-coordinate or y-coordinate).



**Problem 3 (Rotating Sweep; Exercise 2.14 from textbook).** Let  $S$  be a set of  $n$  disjoint line segments in the plane, and let  $p$  be a point not on any of the line segments in  $S$ . We want to determine all line segments of  $S$  that  $p$  can see, that is, all line segments of  $S$  that contain some point  $q$  so the segment  $pq$  does not intersect any segment in  $S$  (except at  $q$ , of course). Give an  $O(n \log n)$  time algorithm to solve the problem. For example, in the following figure, you should output all segments but  $s_4$  and  $s_6$ .

