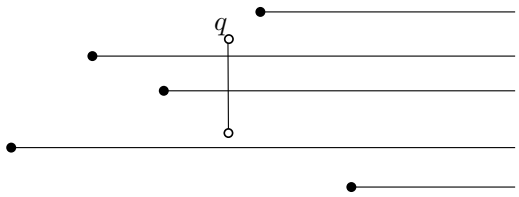
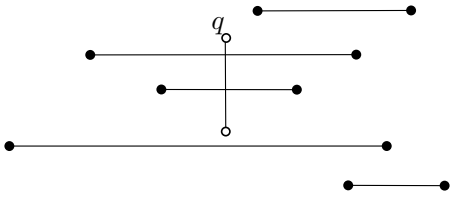
CSCI5010 Exercise List 9

Problem 1 (Segment-Ray Intersection). Let S be a set of horizontal rays in $\mathbb{R}^2$, where each ray has the form $[x, \infty) \times y$. Given a vertical segment $q = x \times [y_1, y_2]$, a query reports all the rays in S intersecting q (e.g., in the figure below, the query reports two rays). Preprocess S into a data structure of $O(n)$ space such that a query can be answered in $O(\log n + k)$ time, where k is the number of rays reported.



Problem 2 (Segment-Segment Intersection). Let S be a set of horizontal segments in $\mathbb{R}^2$, where each segment has the form $[x_1, x_2] \times y$. Given a vertical segment $q = x \times [y_1, y_2]$, a query reports all the segments in S intersecting q (e.g., in the figure below, the query reports two segments). Preprocess S into a data structure of $O(n)$ space such that a query can be answered in $O(\log^2 n + k)$ time, where k is the number of segments reported. (Hint: combine an interval tree and priority search trees.)



Problem 3 (Ray Shooting). Let S be a set of horizontal segments in $\mathbb{R}^2$, where each segment has the form $[x_1, x_2] \times y$. Given a point q, a query reports the first segment of S that will be hit if we shoot a ray upwards from q (e.g., in the figure below, the query reports s). Preprocess S into a data structure of $O(n)$ space such that a query can be answered in $O(\log n)$ time. (Hint: convert the problem into a point location problem.)