Be sure to read the instructions on the assignments section of the class web page.

Fast Interval Stabbing in Linear Space

Given a set of $n$ intervals $[a_1, b_1], [a_2, b_2], \ldots, [a_n, b_n]$ in one dimension, describe and analyze a static data structure that supports the following query operation:

- $\text{stab}(x)$: Return all intervals $[a_i, b_i]$ such that $a_i \leq x \leq b_i$.

Each call to $\text{stab}(x)$ should take time $O(\log n + k)$ where $k$ is the number of intervals returned by $\text{stab}(x)$. The total space used by your data structure should be $O(n)$ and the total preprocessing time needed to initialize your data structure should be $O(n \log n)$.

Technical Notes

- Your data structure should work in the comparison model. The $a_i$, $b_i$, and $x$ belong to an arbitrary partially ordered set $X$ and in $O(1)$ time you can compute the relative order of any two elements in $X$.

- By “return an interval” we mean output the index and endpoints of the interval, i.e., return the tuple $(i, a_i, b_i)$ for the interval $i$ which starts at $a_i$ and ends at $b_i$. 