Problem 1. Let us consider the classic range search problem. Let $P$ be a set of $n$ points in 2d space. Given an axis-parallel rectangle $q$, a query reports all the points in $P \cap q$. We can store $P$ in a kd-tree, so that any query can be answered in $O(\sqrt{n} + k)$ time, where $k$ is the number of points reported. We also know that the kd-tree can be constructed in $O(n \lg n)$ time.

Use the logarithmic method to obtain a semi-dynamic structure that answers a query in $O(\sqrt{n} \lg n + k)$ time, and supports an insertion in $O(\lg^2 n)$ amortized time.

Problem 2. Improve your solution to the previous problem so that a query is answered in $O(\sqrt{n} + k)$ time (i.e., no deterioration compared to the static structure), whereas the insertion cost remains unchanged.

Problem 3. Give a FIFO structure to solve the range search problem with query cost $O(\sqrt{n} + k)$, and amortized update cost $O(\lg^2 n)$, where the meanings of $n$ and $k$ are the same as in the previous problems.