CSCI5610: Final Exam

**Problem 1 (10%).** Problem 3 of Lecture 10 (removing Assumption 1 for union-find).

**Problem 2 (20%).** Problem 4 of Lecture 15 (dynamic range count).

**Problem 3 (20%).** Problem 2 of Lecture 17 (high success probability for LSH).

**Problem 4 (20%).** Let $S$ be a set of $n$ strings $\sigma_1, \sigma_2, ..., \sigma_n$. Define $m = \sum_{i=1}^{n} |\sigma_i|$. Given a non-empty string $q$, a query reports the largest $i \in [1, n]$ such that $\sigma_i$ contains at least one occurrence of $q$. Design a data structure of $O(m)$ space that can answer any query in $O(|q|)$ time.

**Problem 5 (30%).** Let $P$ be a set of $n$ points in $\mathbb{R}^2$, each of which is associated with a real-valued weight. Given a two-sided rectangle $q = \langle -\infty, x \rangle \times \langle -\infty, y \rangle$, a query reports the maximum weight of the points in $q \cap P$. Design a data structure of $O(n)$ space that can answer any such query in $O(\log n)$ time.

In the above example, the weight of each point $p \in P$ is indicated next to $p$. The query with the search rectangle $q$ shown should return 32.