CS 240: Data Structures and Data Management **Spring 2022**

Tutorial 9: July 11

1. Consider the following points being stored in a 2D range tree: $(2, 12)$, $(17, 77)$, $(23, 92)$, $(40, 47)$, $(55, 91)$, $(67, 27)$, $(89, 79)$, $(99, 53)$, $(10, 23)$, $(35, 7)$, $(61, 40)$, $(95, 56)$, $(22, 42)$, $(88, 15)$, $(42, 2)$.

a) Draw the x-BST for this range tree.

b) Draw the corresponding y-BSTs for the points $(88, 15)$, $(61, 40)$ and $(67, 27)$.

c) Perform a range-search with the query rectangle $[35, 90] \times [5, 30]$, indicating all boundary nodes and topmost inside nodes.

2. Suppose you have a set of n horizontal line segments in a plane, where line segment ℓ_i has coordinates (x_i, y_i) and (x'_i, y_i). Assume that all coordinates are integers.

For each of the range-search queries below, design a data structure and provide an algorithm to answer the queries in $O(\log^3 n + s)$ time, where s is the number of lines reported. Each range-search query is a rectangle of the form $[a, b] \times [c, d]$.

a) The algorithm reports all line segments that are entirely contained inside the query rectangle. For the example below, the algorithm would return ℓ_2, ℓ_5, ℓ_7 and ℓ_8.

b) The algorithm reports all line segments that intersect the query rectangle. For the example below, the algorithm reports all line segments **except** ℓ_4 and ℓ_9.