CS 240: Data Structures and Data Management **Winter 2024**

Tutorial 09: Mar 18

1. **Quadtree**
   Suppose we are given n points in 2 dimensions, S. Let M be the largest distance between points and m be smallest distance between points. Suppose we also have that $\frac{M}{m} \in O(\sqrt{n})$. Then, prove that height of quadtree on such set is $O(\log n)$. To make the analysis easier, assume $(0, 0)$ contains in this set.

2. **Basics of Range Tree**
   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 primary tree for this range tree.

   (b) Draw the corresponding associate trees 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.

3. **Find Largest x in kd-tree**
   Given a 2D kd-tree with n points, design an algorithm that finds a point with largest x-coordinate. For simplicity, you may assume n is a power of 4.