

CS 485/584: Spatial Computing
Fall 2024

Assignment 4: Spatial Index Structures

Submit all assignments until **Wednesday, October 9th at 2:30pm**

Assignment 4-1 *Quad-Trees* (4)

Insert the following points (in this order) into an initially empty Quad-tree:

$$A = (0, 0), B = (10, 10), C = (8, 2), D = (9, 3), E = (2, 2), \\ F = (6, 2), G = (2, 10), H = (7, 3), I = (5, 5), J = (7, 4)$$

The maximum page capacity of this *Quad*-tree is 4.

- Draw the current your *Quad*-tree after each split.

Assignment 4-2 *kd-Trees* (4)

Insert the following points (in this order) into an initially empty *kd*-tree:

$$A = (0, 0), B = (10, 10), C = (8, 2), D = (9, 3), E = (2, 2), \\ F = (6, 2), G = (2, 10), H = (7, 3), I = (5, 5), J = (7, 4)$$

The maximum page capacity of this *kd*-tree is 4.

- Draw the current your *kd*-tree after each split.

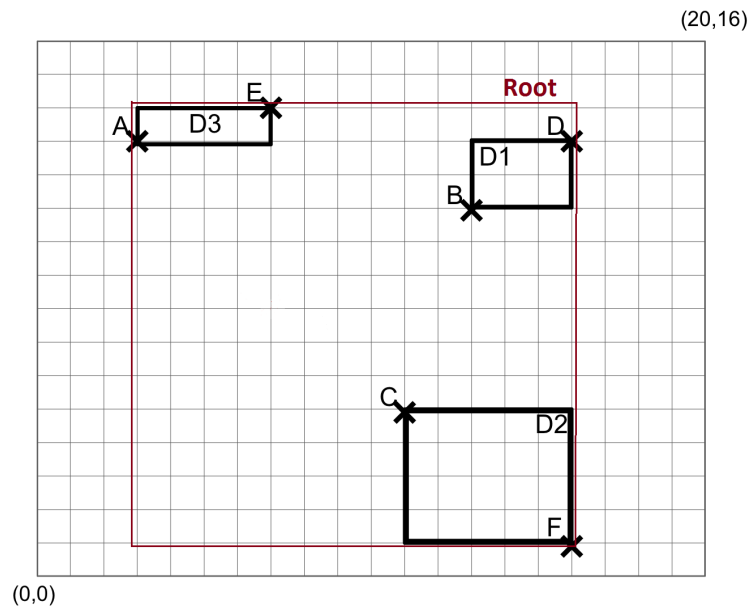


Figure 1: An *R-Tree*.

Assignment 4-3 *R-Trees* (6)

Insert the following points into the *R-tree* depicted in Figure 1: $G = (14, 3)$, $H = (7, 11)$, $I = (9, 12)$, $J = (5, 13)$, and $K = (11, 8)$. The maximum page capacity is 3, the minimal number entries per page (except for the root) is $k = 1$. For a point p that does not fall into any region, extend the region which requires the least increase in area to include p . As split-strategy, use the *linear split* as introduced in the lecture. Always choose a partitioning which minimizes the overlap and use the total area of partitions to break ties.

Redraw your *R-Tree* after each insertion.

Hint: The capacity of a node is 3. Thus, a page overflows if it has more than three entries (which can be points or rectangles). I'm echoing that because in previous questions (such as 4-1 and 4-2 on the previous page) we used a capacity of 4.

Assignment 4-4 *Quad-Tree Insertion* (6 Points [CS 584 Only])

Implement the insertion method for a *Quad-Tree*. Your insertion method should allow to build an initially empty *Quad-Tree* through iterative insertion.

Hint: You may assume that the data space is $[0, 100] \times [0, 100]$, thus no points may have negative coordinates or coordinates greater than 100.

Hint 2: You may give your *Quad-Tree* nodes additional attributes to help you navigate the tree. For example, nodes storing their spatial region may be useful.