

Quadtrees, KD-Trees, Range trees and Skip Lists

Monday, March 11, 2013

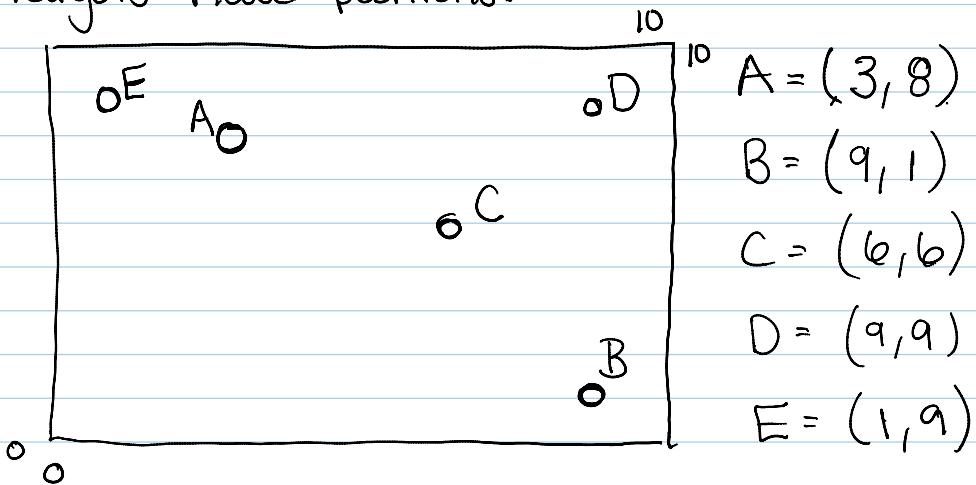
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- Quadtrees : Kd-trees are typically used to store multidimensional data
 - reduce search time
 - used in computer graphics to improve performance of ray tracing from $O(n)$ to $O(\log n) \rightarrow$ which is a big deal since n may be greater than 1×10^9

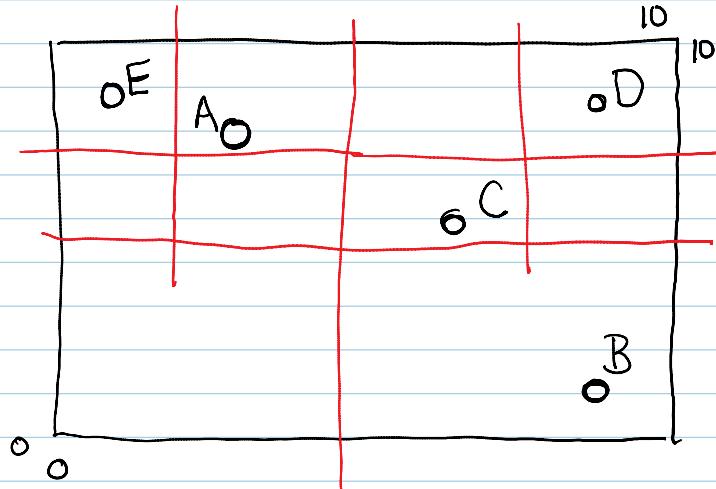
Example 1 :

Suppose you have an archery range with K targets. An archer fires a shot into the field, what target (if any) did he hit.

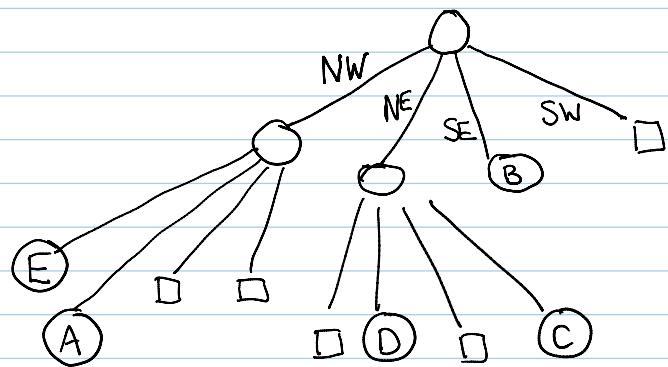
The targets have positions:



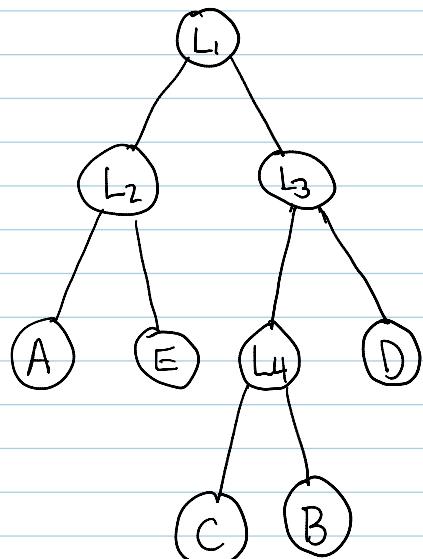
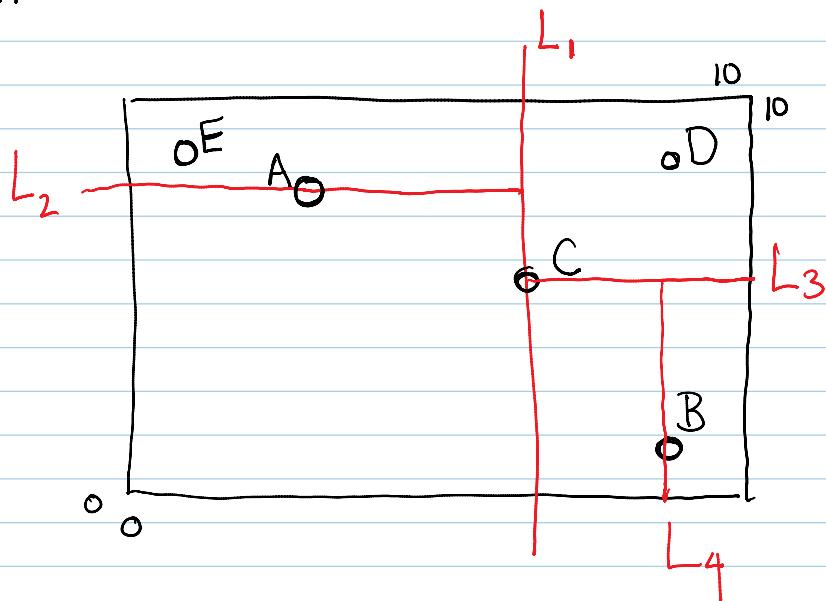
a) Create a quad tree of the range, show divisions on the graph.



□



b) Create a kd-tree of the range, and show the splits on the graph.



c) Why would you use a kd-tree over a quadtree?

- a quad tree can have a height much greater than the number of points in the tree!

e.g. $(0,0), (100,100), (1,1)$ create a quad tree with $h=7$

So if the data is not uniformly distributed, you could get very tall trees.

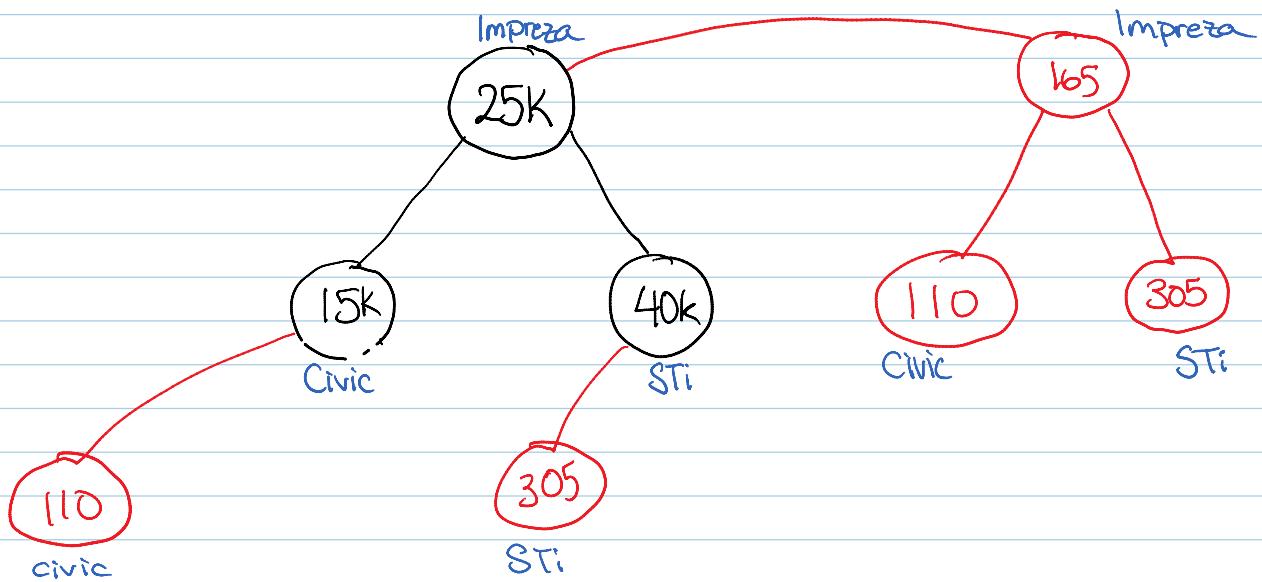
- A kd-tree of the same pts would have $h=3$ (search is $O(\log n)$) instead of $O(n^{th})$.

Range Trees

- also used to store multi-dimensional data

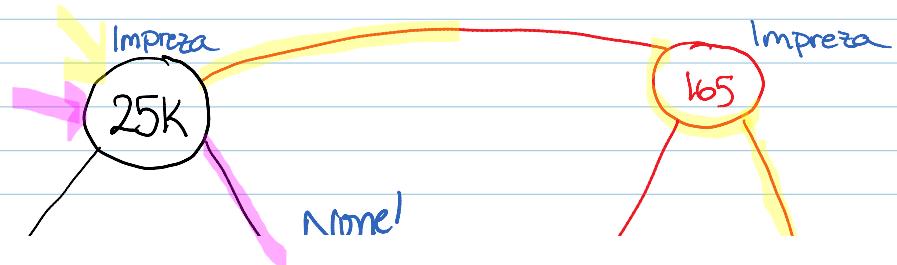
Example

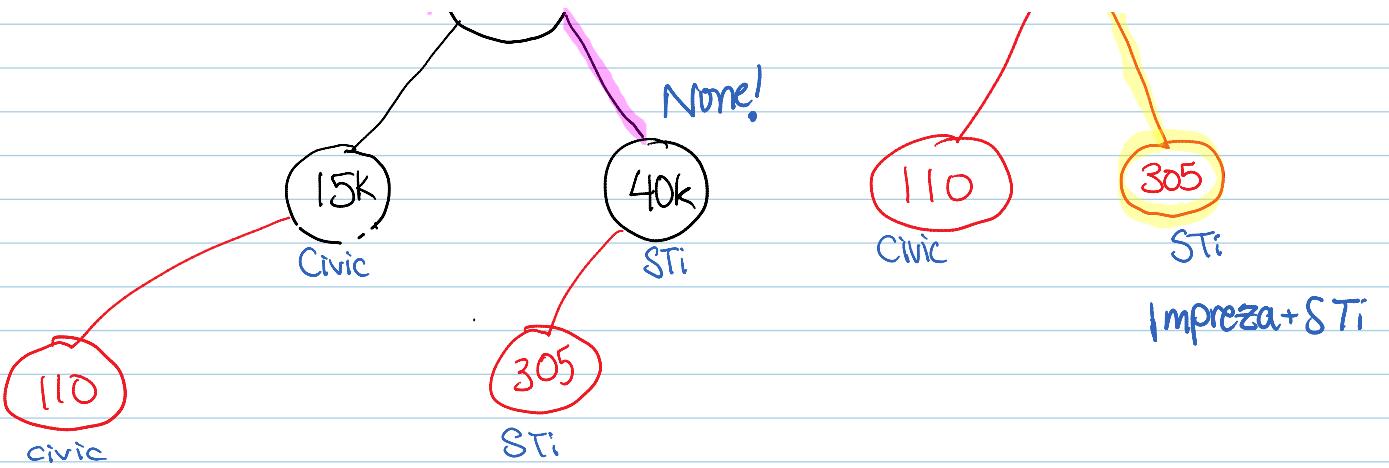
Suppose you are trying to choose a new car based on price and horsepower.



a) Find all cars with horsepower > 150

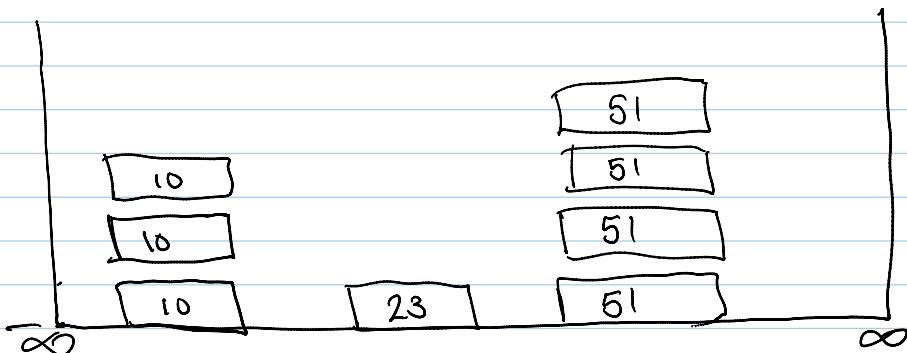
b) Find all cars with horsepower > 150 and cost $< 30k$.





Search is just like a binary tree, but each node may have an associated tree.

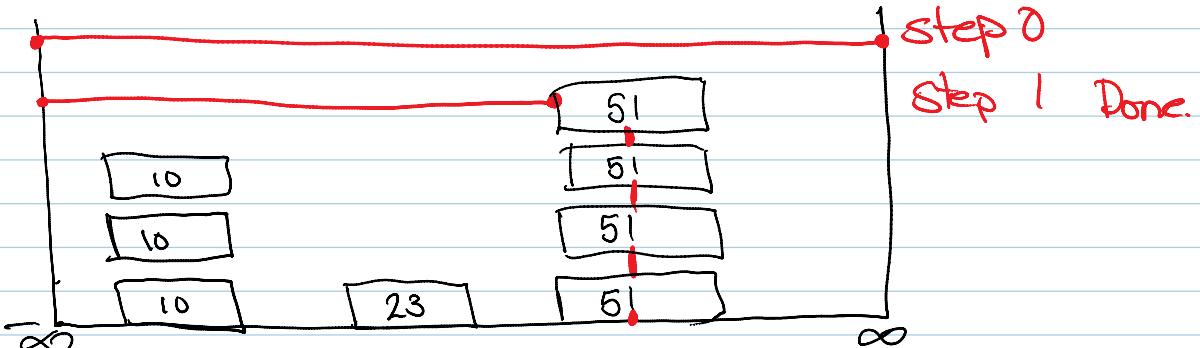
Skip Lists



A list where elements have a height.
Height could be:

- random
- increasing
- alternating
- related to frequency,
etc.

Find 51:



Find 7:

