CS133
Computational Geometry
Search Problems
Range Search Problem

- Given a set $P$ of points and a rectangular query range $q$, find all the points in $P$ that are enclosed in $q$
Range Search Applications

- Google Maps: Find restaurants in the visible window

- Database applications: Find all employees in the age range [25,35] with salary [80,000, 150,000]
Naïve Range Search

- Scan all the points and compare to q
- Running time = $O(n)$
- Is this optimal?
- Can we do better?
Single-dimensional Ranges

Find all elements in the range [15, 55]
Single-dimensional Ranges

Find all elements in the range $[15, 55]$
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k-d tree

- A tree index for a set of k-dimensional points
- Extends BST to k-dimensions
- Each node $n_i$ stores a point and splits the other points into two subsets
K-d tree Structure
K-d tree Construction

» Build Kd Tree(P, levels)
  » if |P| = 0 then return null
  » \( a = \text{levels} \% k \)
  » Find the median \( p_m \) of P along the axis \( a \)
  » left = Build Kd Tree(\( \{ p \in P | p \leq p_m \} \), levels-1)
  » right = Build Kd Tree(\( \{ p \in P | p > p_m \} \), levels-1)
  » Return New Node(\( p_m \), left, right)
Range Search

Search(node, q)
- if \( q \) contains(node.value)
  - Report node.value
- if \( q \leq node.value \)
  - Search(node.left, q)
- if \( q > node.value \)
  - Search(node.right, q)