CS 225

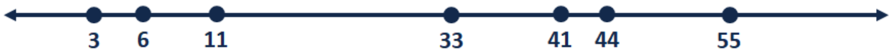
#22: BTrees Intro

October 19, 2020 · *G Carl Evans*

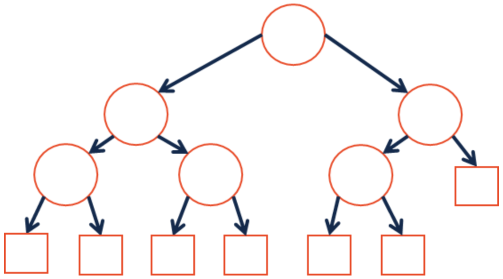
Range-based Searches:

Q: Consider points in 1D: $p = \{p_1, p_2, \ldots, p_n\}$.

...what points fall in [11, 42]?



Tree Construction:

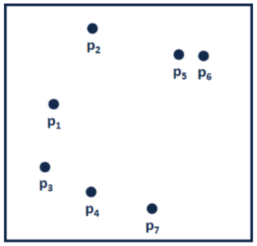


Range-based Searches:

Running Time:

Extending to k-dimensions:

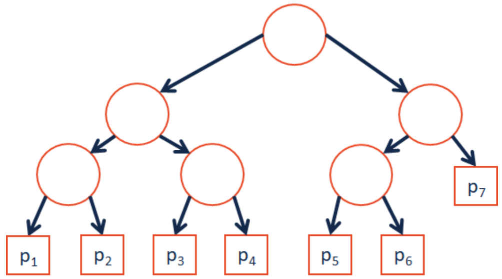
Consider points in 2D: $\mathbf{p = \{p_1, p_2, \ldots, p_n\}}$:



...what points are inside a range (rectangle)?

...what is the nearest point to a query point **q**?

Tree Construction:



BTree Motivation

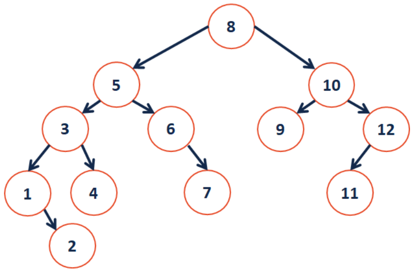
Can we always fit our data in main memory?

Where else do we keep our data?

-

vs. CPU: 3 GHz == 3m ops / __________ * ____ cores

AVL Operations on Disk:



How deep do AVL trees get?

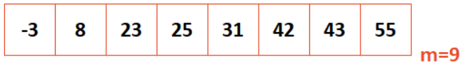
BTree Motivations

Knowing that we have long seek times for data, we want to build a data structure with two (related) properties:

1.

2.

BTree$_m$



Goal: Build a tree that uses ____________________ /node!

...optimize the algorithm for your platform!

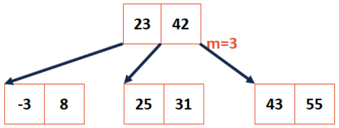
A **BTree of order m** is an m-way tree where:

1. All keys within a node are ordered.

BTree Insert, using m=5

...when a BTree node reaches **m** keys:

BTree Insert, m=3:



Great interactive visualization of BTrees:

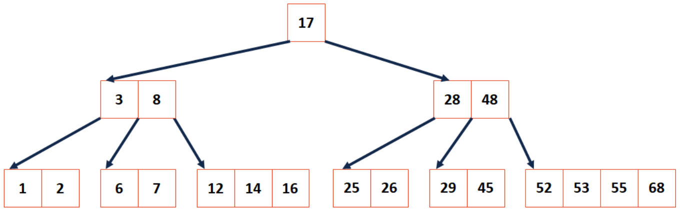
https://www.cs.usfca.edu/~galles/visualization/BTree.html

BTree Properties

For a BTree of order **m**:

1. All keys within a node are ordered.
2. All leaves contain no more than **m-1** nodes.
3. All internal nodes have exactly **one more key than children**.
4. Root nodes can be a leaf or have **[2, m]** children.
5. All non-root, internal nodes have **[ceil(m/2), m]** children.
6. All leaves are on the same level.

Example BTree



What properties do we know about this BTree?

CS 225 – Things To Be Doing:

1. mp_traveral final deadline Today
2. Daily POTDs are ongoing!