Binary Search Balanced Trees

HEIGHT

$\Theta(\lg n)$ for n items

Constant

search
insert
delete
read/write
max/min

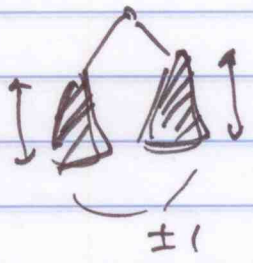
} $\Theta(\text{height})$

"Perfect" binary tree (min EPL)

↳ height $\lceil \lg n \rceil$

Examples

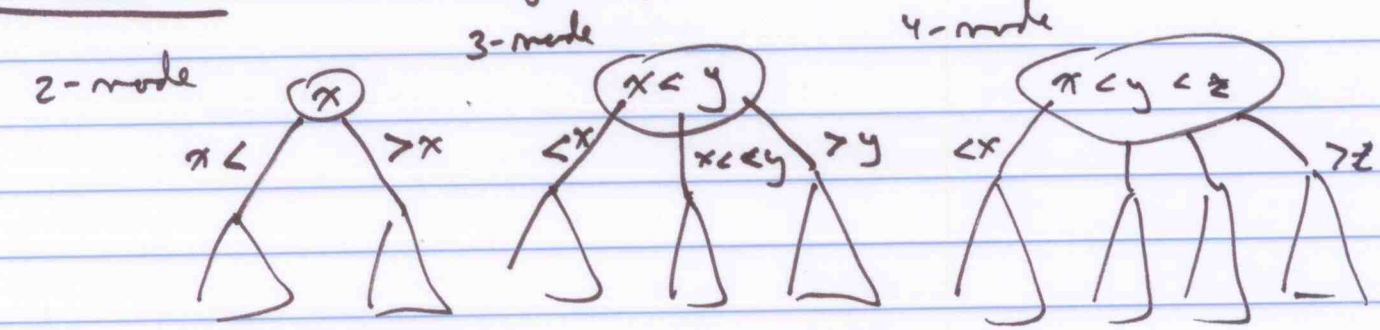
Height-Balanced (AVL)
Weight-Balanced (BB)
3-2 (2-3)
B-trees (extend memory)
⋮



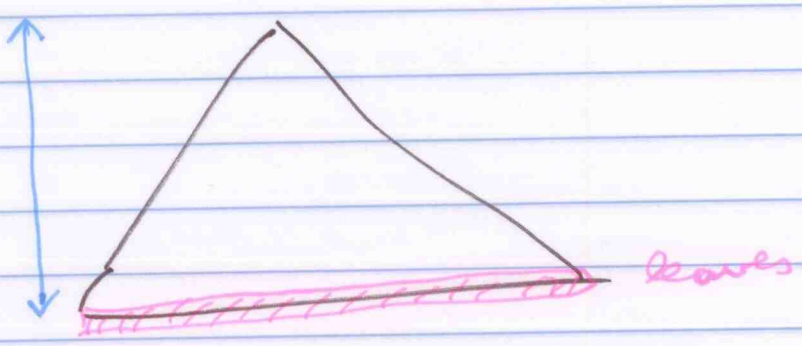
SEEK

Red-Black

2-3-4 Trees (RB in disguise)



All leaves are at same depth from root



n items

TALLEST only 2-nodes

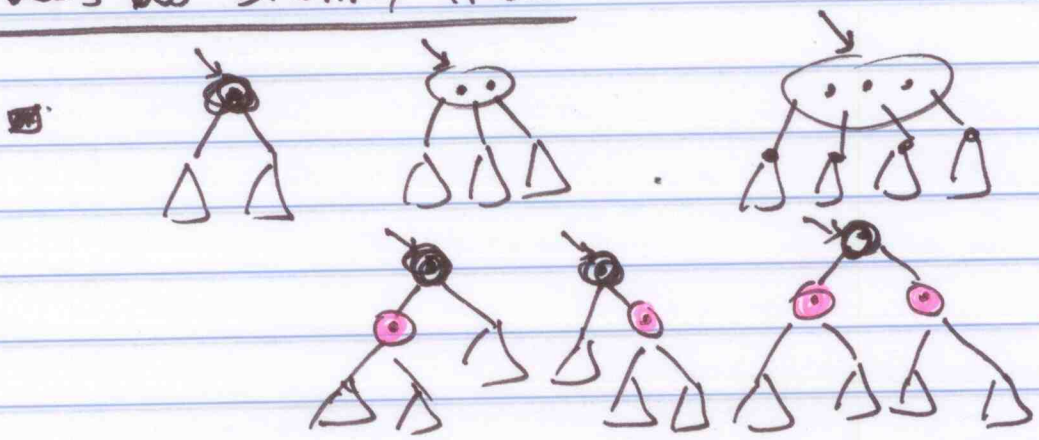
$\lg n$

SHORTEST only 4-nodes

$\log_4 n = \frac{1}{2} \lg n$

$\frac{1}{2} \lg n \le \text{height} \le \lg n \Rightarrow$ search $\Theta(\lg n)$

2-3-4 Trees & BINARY TREES



Red/Black Trees

1) No two red nodes in a row (parent + child)
2) Root black
3) Every node is red or black
4) Leaves are black
5) Paths from root to any leaf have the same number of BLACK nodes

] Black height

$\frac{1}{2}\lg n \leq$ Black height $\leq \lg n$

height(RB tree) $\leq$ 2 black height

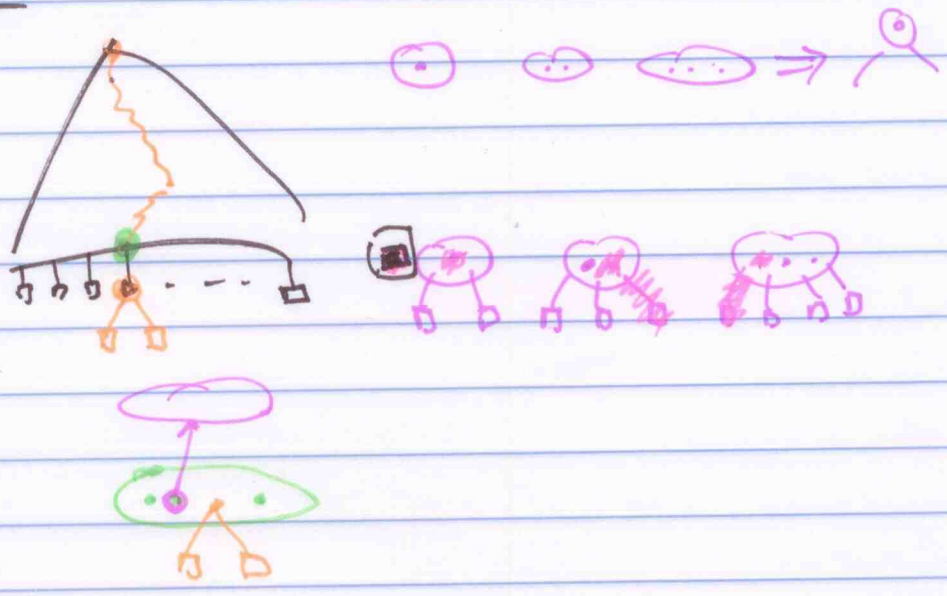
$\leq 2\lg n$

Search, max, min, succ, pred

$\Theta(\lg n)$

Insert/Delete

Insertion in 2-3-4 tree



Rotation