B-Trees 🌳

Balanced Binary Search Tree

- H = O(Log(N)). Insert, remove, and search all have complexity of O(log(n)) = O(Log_2(N))
- Each Node has a maximum of 2 children

C-ary Tree in Tree

- $N = C^0 + C^1 + \ldots + C^H$
- $N = \frac{C^{H+1} - 1}{C - 1} \approx C^H$
- So $H \approx log_{\in}(H) = \frac{Log_2(N)}{Log_2(C)}$
- If we increase the max number of children from 2 to C and maintain a balanced tree, the height is reduced by $(Log_2(C))$

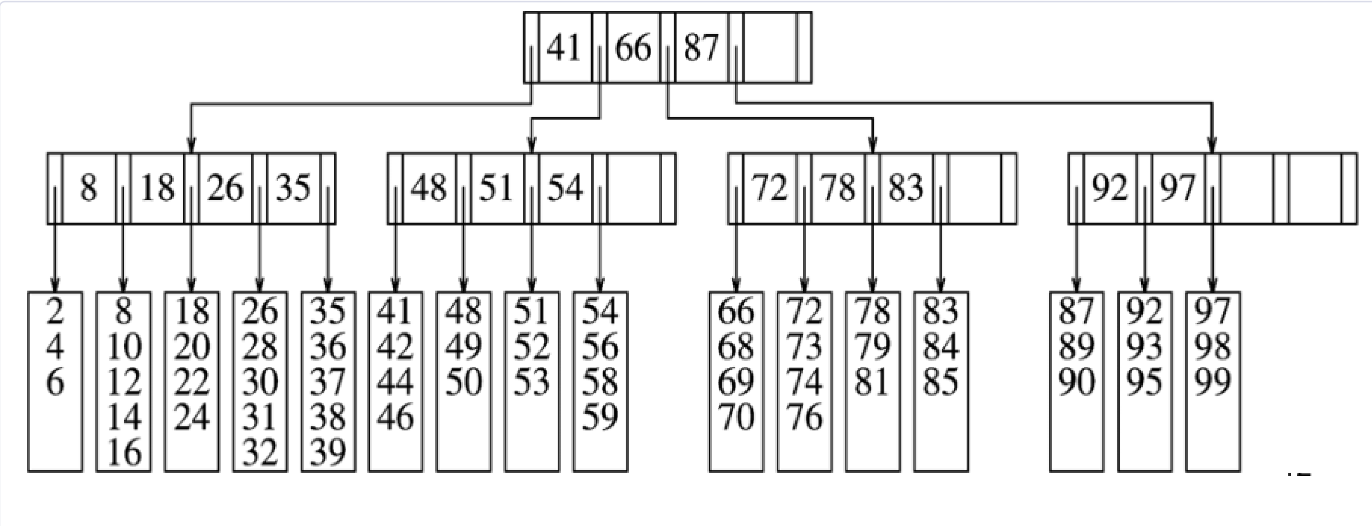
M-ary Trees

- Allow up to M children for each node
  - Instead of 2 max for binary trees
- A complete M-ary tree of N nodes has a depth of $log_M N$
- Each node has (M-1) keys to decide which branch follows
- Larger M, smaller tree depth
- **Balancing M-ary**
  1. Restrict the tree shape like in AVL
  2. Restrict the number of children each node can have
- B-Tree takes the second approach, easier to implement

Balanced Trees (B-Tree)

- B-Tree is an M-ary search tree with restrictions
  1. Data items stored at the leafs
  2. Non-lead nodes store up to M-1 Keys to guide search
  3. The root can be a leaf or have between 2 to M children
  4. Non lead Nodes except the root have between ceil M/2 and M children
  5. All leaves are at the same depth, have between ceil(L/2) and L data items

- Keys in each node are sorted. The i'th key in a node is the smallest data in the i+1 subtree



Deletion

- Do a search to find the leaf node to delete
- If the lead still has at least L/2 data entries, done
- Else, merge the data with neighboring leaf to ensure L/2 data entries