CS 225

#24: BTrees

October 23, 2017

Motivation

Can we always fit our data in main memory?

Where else do we keep our data?

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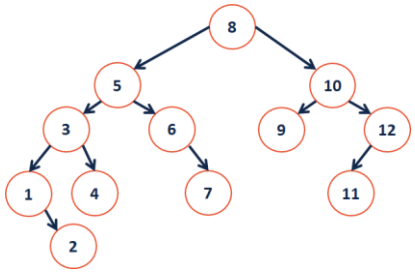
-

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!

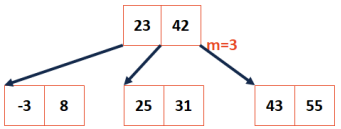
A **BTree of order m** is an m-way tree where:

1. All keys within a node are ordered.
2. All leaves contain no more than **m-1** nodes.

BTree Insert, using m=5

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

Example #2:

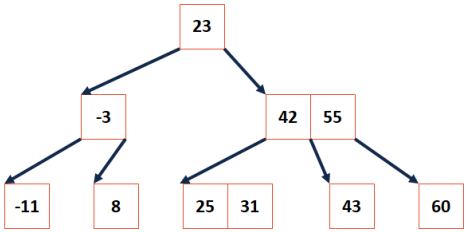


BTree Properties

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.

BTree Search



BTree.cpp (partial)

```
1  bool Btree::_exists(BTreeNode & node, const K & key) {
2
3    unsigned i;
4    for (i=0; i<node.keys_ct_ && key<node.keys_[i]; i++) { }
5
6    if ( i < node.keys_ct_ && key == node.keys_[i] ) {
7      return true;
8    }
9
10   if ( node.isLeaf() ) {
11     return false;
12   } else {
13     BTreeNode nextChild = node._fetchChild(i);
14     return _exists(nextChild, key);
15   }
16 }
```

BTree Analysis

The height of the BTree determines maximum number of _____ possible in search data.

...and the height of our structure:

Therefore, the number of seeks is no more than: _____.

...suppose we want to prove this!

BTree Setup

In our AVL Analysis, we saw finding an upper bound on the height (given **n**) is the same as finding a lower bound on the nodes (given **h**).

Goal: We want to find a relationship for BTrees between the number of keys (**n**) and the height (**h**).

CS 225 – Things To Be Doing:

1. Exam #7 is live!
2. MP4 due tonight
3. New lab coming Wednesday!
4. Daily POTDs