CSE 326: Data Structures
Search Trees (Conclusions)

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Announcements (2/9/09)

- Project 2B due Wednesday night.
- Midterms will be graded this week, returned to you in section.
- Homework 4 due Friday, beginning of class.

Which Search Tree To Use?

- We’ve talked about: BST, AVL, Splay, B+
- Suppose your data doesn’t fit in memory? B+
- Else, suppose your keys (input/find/del) are:
  - Random? Best: BST
    Worst: Splay
  - Sorted? Best: Splay
    Worst: BST
  - Sorted insert, random access?
    Best: AVL
    Worst: BST

But wait… there’s more!

- Here are a couple more popular ones (briefly)
Red-Black Trees

Structure property:
- Every node is “colored” either red or black.
- The root is black.
- If a node is red, its children are black. (A leaf can be red.)
- For each node, all paths down to null pointer must contain the same number of black nodes.

Notes:
- Uses the standard rotations, plus some coloring operations, to maintain structure.
- Worst case find, insert, delete: $O(\log n)$
- Has nice top-down, non-recursive implementation.
- Java uses top-down red-black trees (TreeMap)

Treaps

Order property:
- Each node has a randomly assigned priority value, in addition to its key value.
- Tree has both BST and heap order!

Notes:
- Insert:
  - insert as leaf
  - assign random priority
  - percolate up with rotations.
- Delete:
  - set priority to infinity
  - percolate down with rotations
  - once it’s a leaf, delete.
- Average case insert, delete, find: $O(\log n)$.
- Relatively easy to implement

Orange = low priority value, Yellow = high priority value
There are many more sorted Dictionary ADTs:
- AA trees
- Scapegoat trees
- Skip lists
- ...

Experimental evaluation

Pfaff [1] tried out 20 different BSTs on several common systems applications.

Findings:
- Random inputs:
  - BSTs perform best (low overhead)
- Mostly random inputs, occasional ordering:
  - Red-Black trees best
- Ordered inputs, random finds
  - AVL trees best
- Ordered inputs, ordered or clustered finds:
  - Splay trees best (though not best for interactive situations)

Special queries

The BSTs we’ve discussed were only required to support the Dictionary ADT: find, insert, delete.

But, other operations that leverage the sorted data can also be efficient on BSTs:
- findMax
- findMin
- findMedian
- findRange (i.e., keys within a certain range)
- printSorted

Bibliography