Data Structures I :
Binary search trees

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Disclaimer: Keep alcohol out of the hands of minors.

- 45 ml of Vodka
- 90 ml of tomato juice
- 15 ml of lemon juice
- tabasco, salt and pepper

https://www.youtube.com/watch?v=EoQuVnKhxaM

A binary tree is a tree data structure in which each node has at most two children, which are referred to as the left child and the right child.

1. Applications
2. Some Algorithms
   - Number of elements
   - Maximum Height
   - Tree traversal
     - https://www.youtube.com/watch?v=gm8DUJJhmY4
     - https://www.youtube.com/watch?v=9RHO6jU--GU

Sorted binary tree or binary search tree (BST) is a node-based binary tree data structure where the datum in each node is larger than the data in all nodes in that node's left subtree and smaller than the data in all nodes in that node's right sub-tree.

- Databases (e.g., MySQL, DB2, SQL server)
- Filesystems (e.g., NTFS, EXT4, HFS)

Animation:
https:
//www.cs.usfca.edu/~galles/visualization/BST.html
Simulation
http://visualgo.net/bst.html

Operations:

1. Insert
2. Search
3. Delete

- http://www.csanimated.com/animation.php?t=Binary_search_tree
- http://visualgo.net/bst.html

Figure: Taken from Inc. [Inc13]

- Lookup, insertion, and deletion all take $O(n)$ time in the worst case, where $n$ is the number of nodes in the tree prior to the operation.

- AVL is a self-balancing binary search tree.
- In an AVL tree, the heights of the two child subtrees of any node differ by at most one
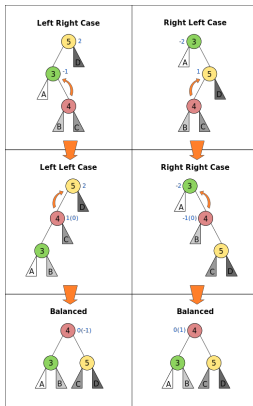    - If at any time they differ by more than one, rebalancing is done to restore this property.

```
http://www.qmatica.com/DataStructures/Trees/AVL/
AVLTree.html
```

# Balancing AVL trees



Figure: Balancing AVL trees. Taken from Wikipedia.

Figure: Taken from Inc. [Inc13]

- Lookup, insertion, and deletion all take $O(log\ n)$ time in both the average and worst cases, where $n$ is the number of nodes in the tree prior to the operation.

- The B-tree is a generalization of a binary search tree in that a node can have more than two children.
- B trees are commonly used in databases and filesystems; they use a hierarchical index to minimize the number of disk reads.

```
http://www.csanimated.com/animation.php?t=B-tree
```
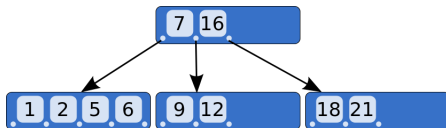
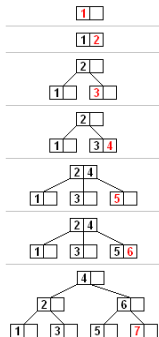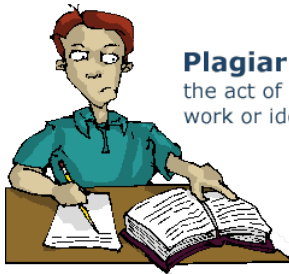Figure: Example of a B tree. Taken from Wikipedia

Figure: Insertion operation for B trees. Taken from Wikipedia

Figure: Taken from Inc. [Inc13]

- A B-tree is a tree data structure that keeps data sorted and allows searches, sequential access, insertions, and deletions in $O(log\ n)$
- Unlike self-balancing binary search trees, the B-tree is optimized for systems that read and write large blocks of data.

- Please learn how to reference images, trademarks, videos and fragments of code.
- Avoid plagiarism



Figure: Figure about plagiarism, University of Malta [Uni09]

📄 Inc.

Questions Figure — Small Business Ideas and Resources for Entrepreneurs, 2013.

[Online; accessed 29-November-2013].

📄 University of Malta.

Plagarism — The act of presenting another's work or ideas as your own, 2009.

[Online; accessed 29-November-2013].

- Binary search trees
  - `http://visualgo.net/bst.html`