Trees

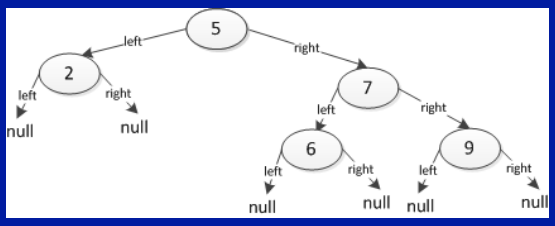
Snarf today's code

Today

- Binary Trees
- Recursion and Trees
- Binary Search Trees

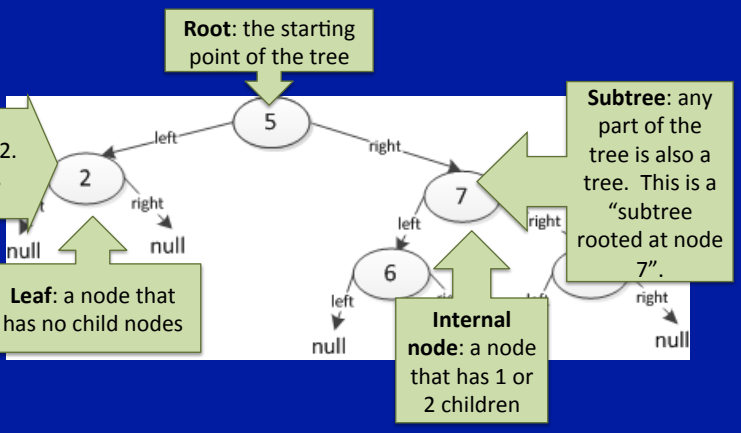
- By the end of class
  - You will be able to articulate what makes binary search trees so powerfully efficient – including understanding the runtime of the mysterious TreeSet

Binary Tree



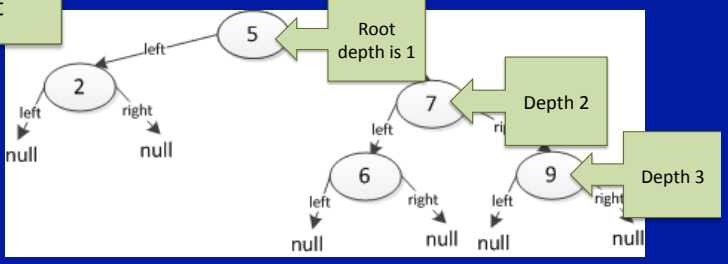

```
IntTreeNode root = null;

   public class IntTreeNode {
      public int myValue;
      public IntTreeNode myLeft; // holds smaller tree nodes
      public IntTreeNode myRight; // holds larger tree nodes

      public IntTreeNode(int val) { myValue = val; }
   }
```

Binary Tree



Binary Tree

Depth: distance of a node from the root

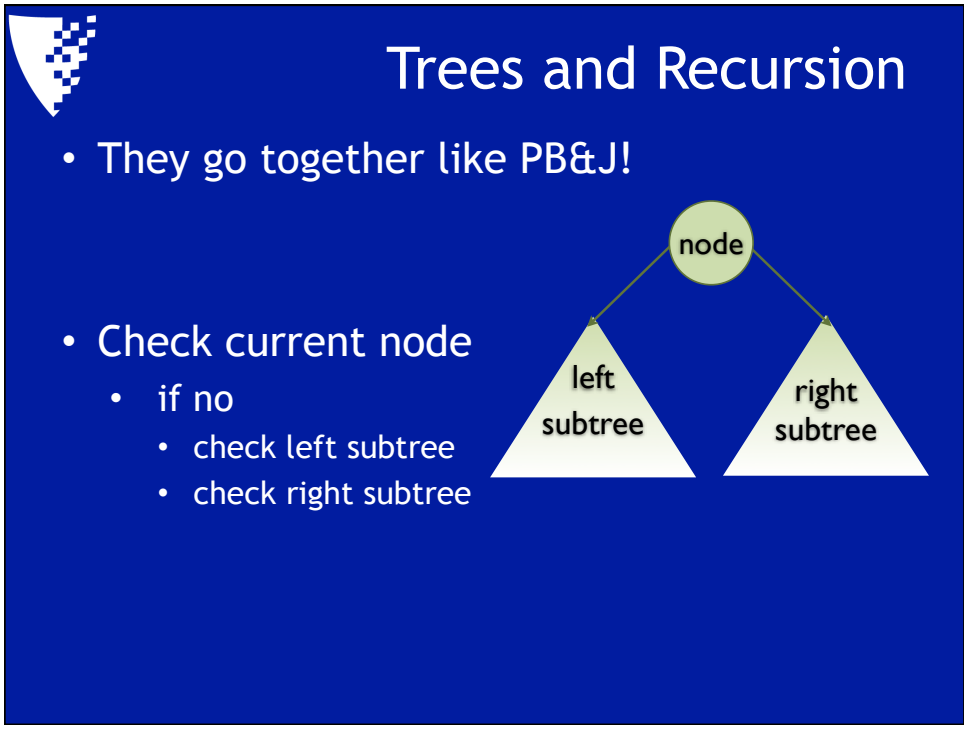


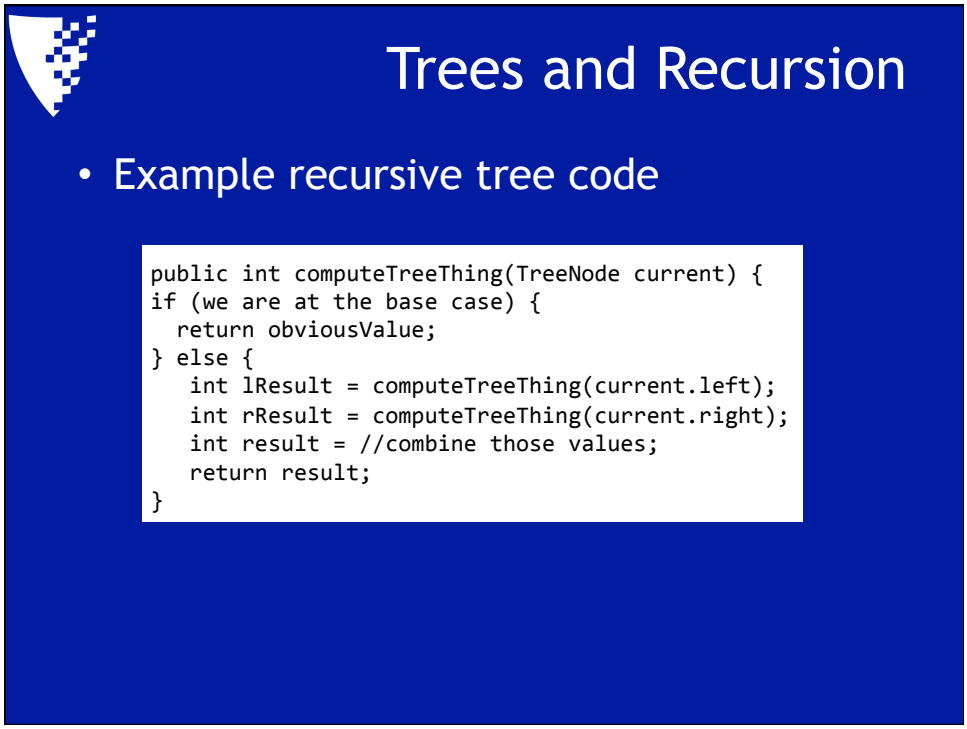
Height: maximum depth of the tree

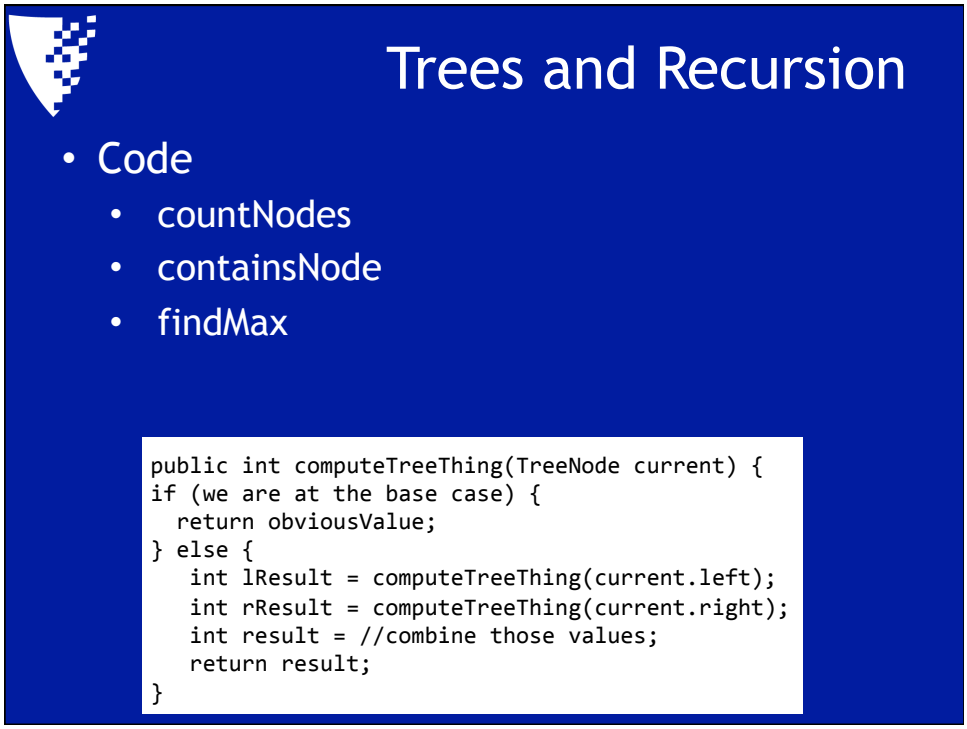
Today

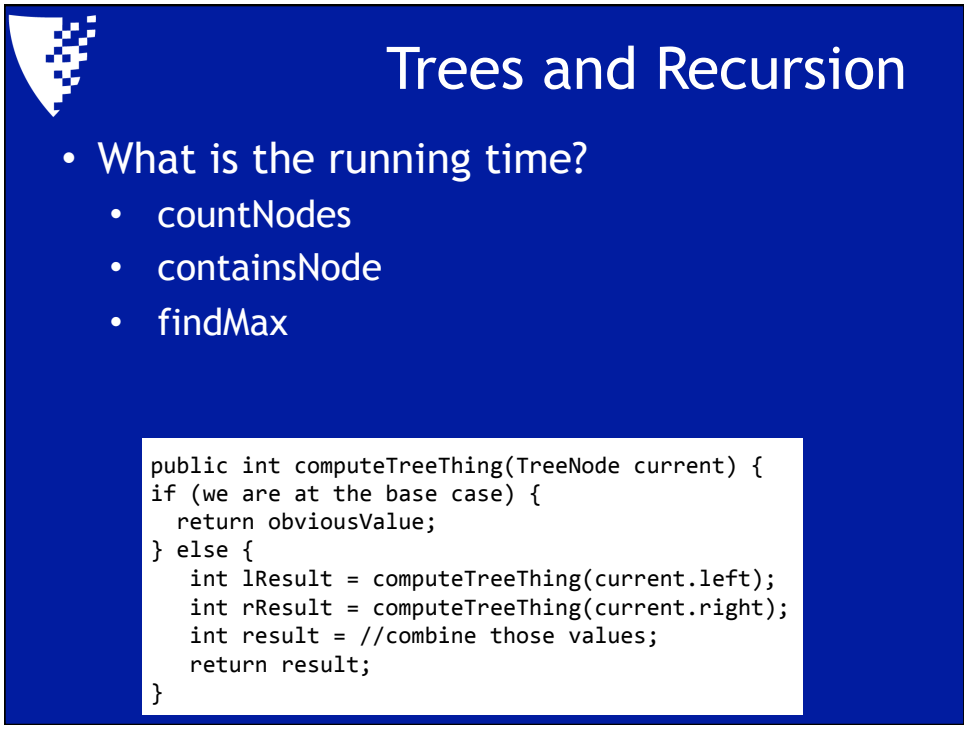
- Binary Trees
- Recursion and Trees
- Binary Search Trees

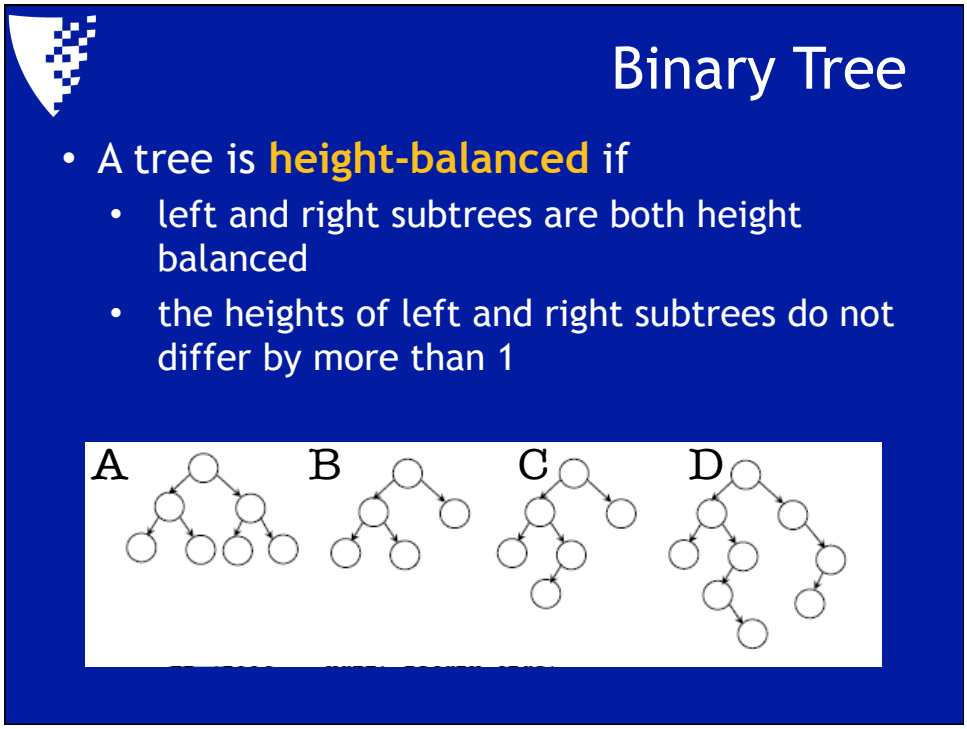
- By the end of class
  - You will be able to articulate what makes binary search trees so powerfully efficient – including understanding the runtime of the mysterious TreeSet

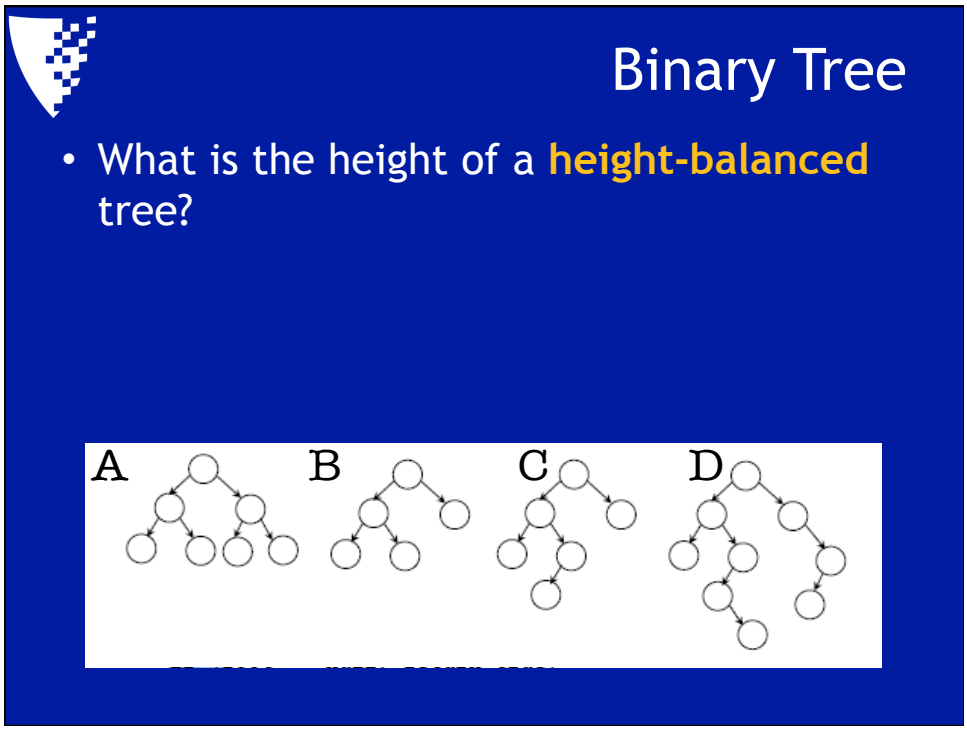

Trees and Recursion
• They go together like PB&J!
• Check current node
• if no
• check left subtree
• check right subtree
node
left subtree
right subtree

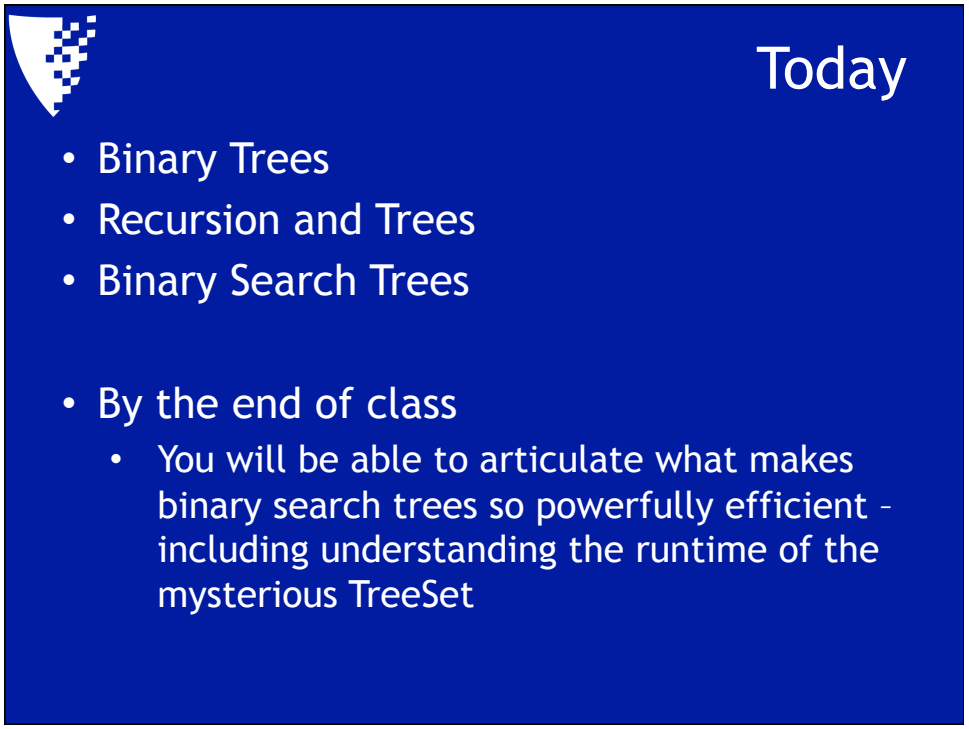

Trees and Recursion
• Example recursive tree code
public int computeTreeThing(TreeNode current) {
if (we are at the base case) {
return obviousValue;
} else {
int lResult = computeTreeThing(current.left);
int rResult = computeTreeThing(current.right);
int result = //combine those values;
return result;
}

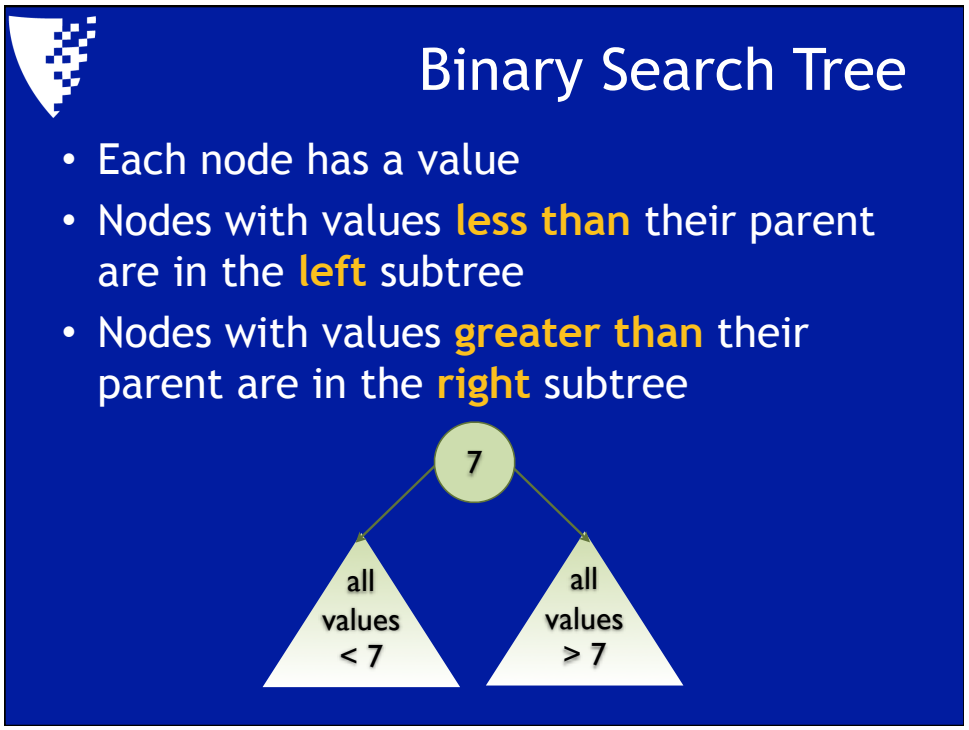

Trees and Recursion
• Code
• countNodes
• containsNode
• findMax
public int computeTreeThing(TreeNode current) {
if (we are at the base case) {
return obviousValue;
} else {
int lResult = computeTreeThing(current.left);
int rResult = computeTreeThing(current.right);
int result = //combine those values;
return result;
}


Trees and Recursion
• What is the running time?
• countNodes
• containsNode
• findMax
public int computeTreeThing(TreeNode current) {
if (we are at the base case) {
return obviousValue;
} else {
int lResult = computeTreeThing(current.left);
int rResult = computeTreeThing(current.right);
int result = //combine those values;
return result;
}


Binary Tree
• A tree is height-balanced if
• left and right subtrees are both height balanced
• the heights of left and right subtrees do not differ by more than 1
A
B
C
D

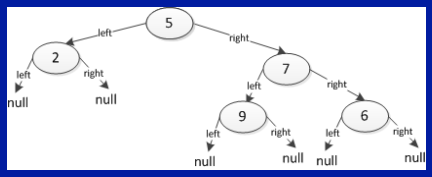

Binary Tree
• What is the height of a height-balanced tree?
A
B
C
D


Today
• Binary Trees
• Recursion and Trees
• Binary Search Trees
• By the end of class
• You will be able to articulate what makes binary search trees so powerfully efficient – including understanding the runtime of the mysterious TreeSet

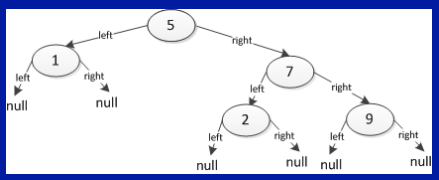

Binary Search Tree
• Each node has a value
• Nodes with values less than their parent are in the left subtree
• Nodes with values greater than their parent are in the right subtree
7
all values < 7
all values > 7

Binary Search Tree

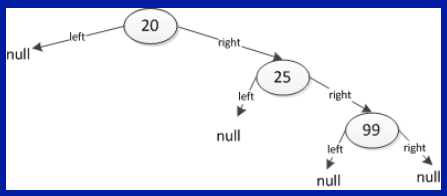
A



B

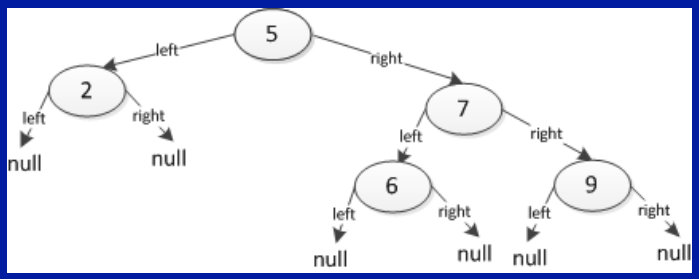


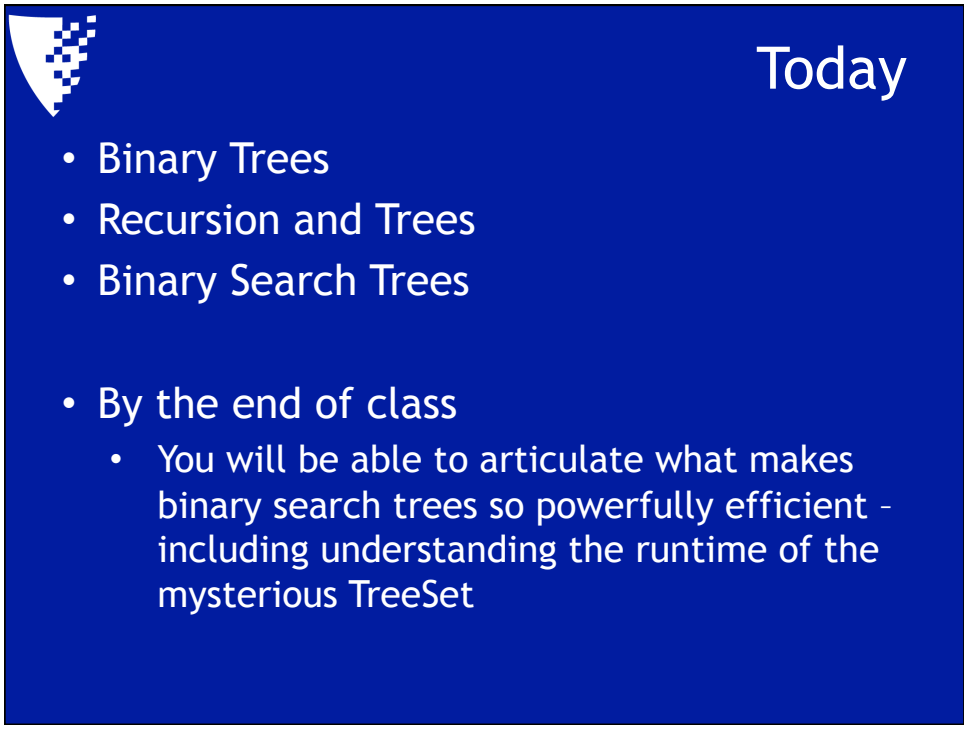
C



Binary Search Tree

- What is the maximum time to:
  - Insert a node?
  - Find a node?




Today
• Binary Trees
• Recursion and Trees
• Binary Search Trees
• By the end of class
• You will be able to articulate what makes binary search trees so powerfully efficient – including understanding the runtime of the mysterious TreeSet