CMSC 132: OBJECT-ORIENTED PROGRAMMING II

Polymorphic Lists & Trees

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Polymorphic Binary Search Trees

- Second approach to implement BST
- What do we mean by polymorphic?
- Implement two subtypes of Tree
    - EmptyTree
    - NonEmptyTree
- Use EmptyTree to represent the empty tree
    - Rather than null
- Invoke methods on tree nodes
    - Without checking for null (IMPORTANT!)

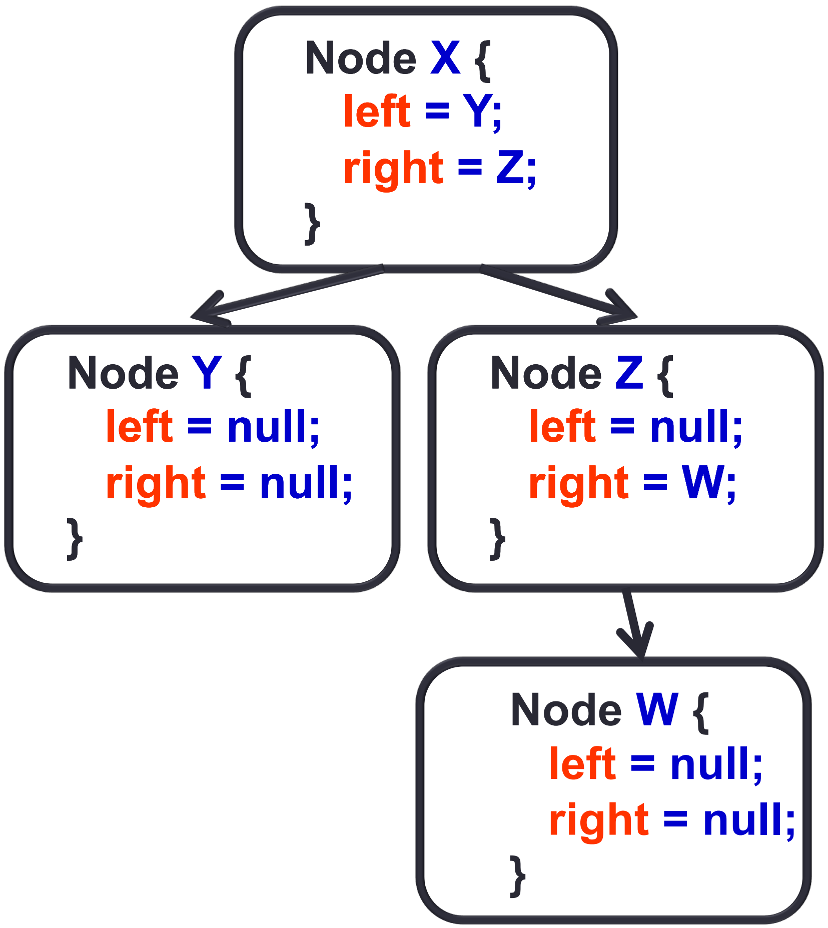
Polymorphic Binary Tree Implementation

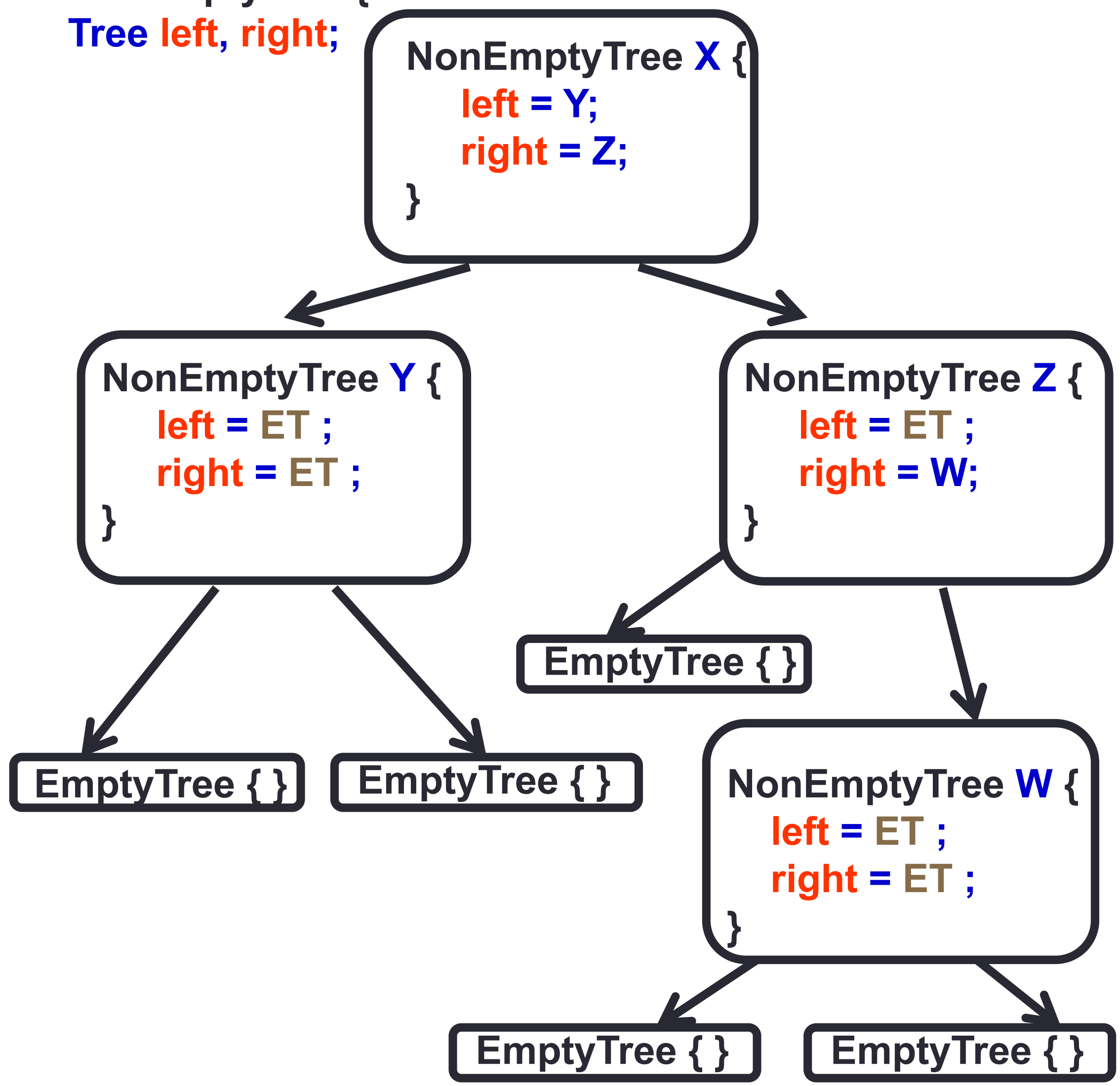
```
Interface Tree {
   Tree insert ( Value data1 ) { … }
}
Class EmptyTree implements Tree {
   Tree insert ( Value data1 ) { … }
}
Class NonEmptyTree implements Tree {
    Value data;
    Tree left, right; // Either Empty or NonEmpty
    Tree insert ( Value data1 ) { … }
}
```

Standard vs. Polymorphic Binary Tree

```
Class Node {
        Node left, right;
}
```

```
Class EmptyTree {}
Class NonEmptyTree {
        Tree left, right;
}
```





Singleton Design Pattern

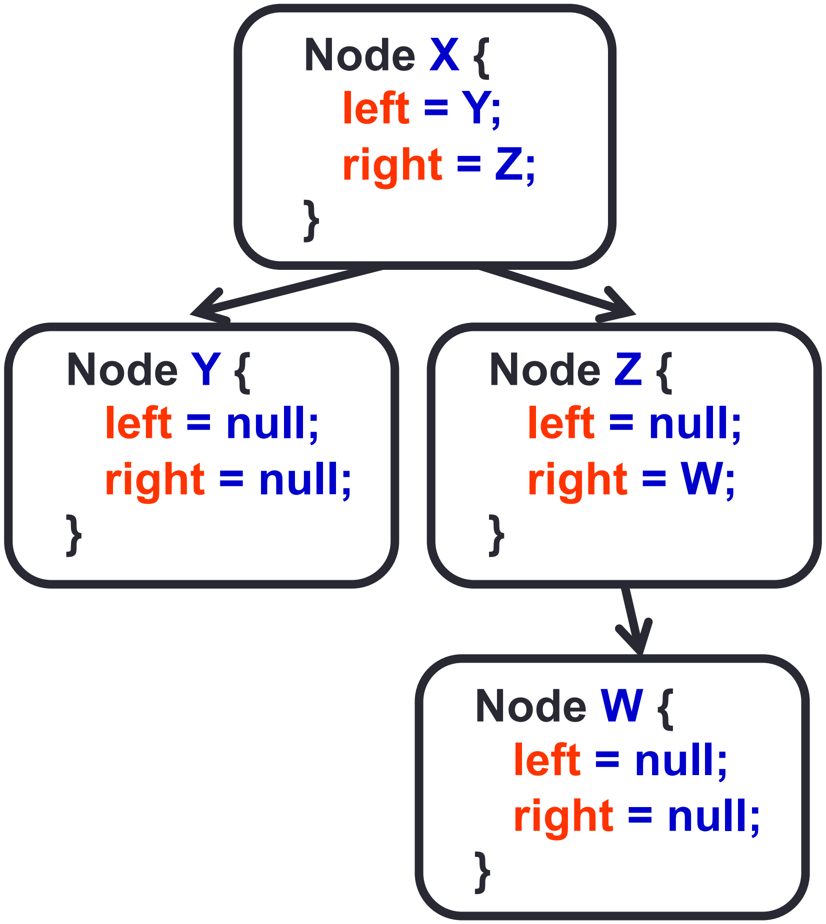
- Definition
  - One instance of a class or value accessible globally
- Where to use & benefits
  - Ensure unique instance by defining class final
  - Access to the instance only via methods provided
- EmptyTree class will be a singleton class

Singleton Example

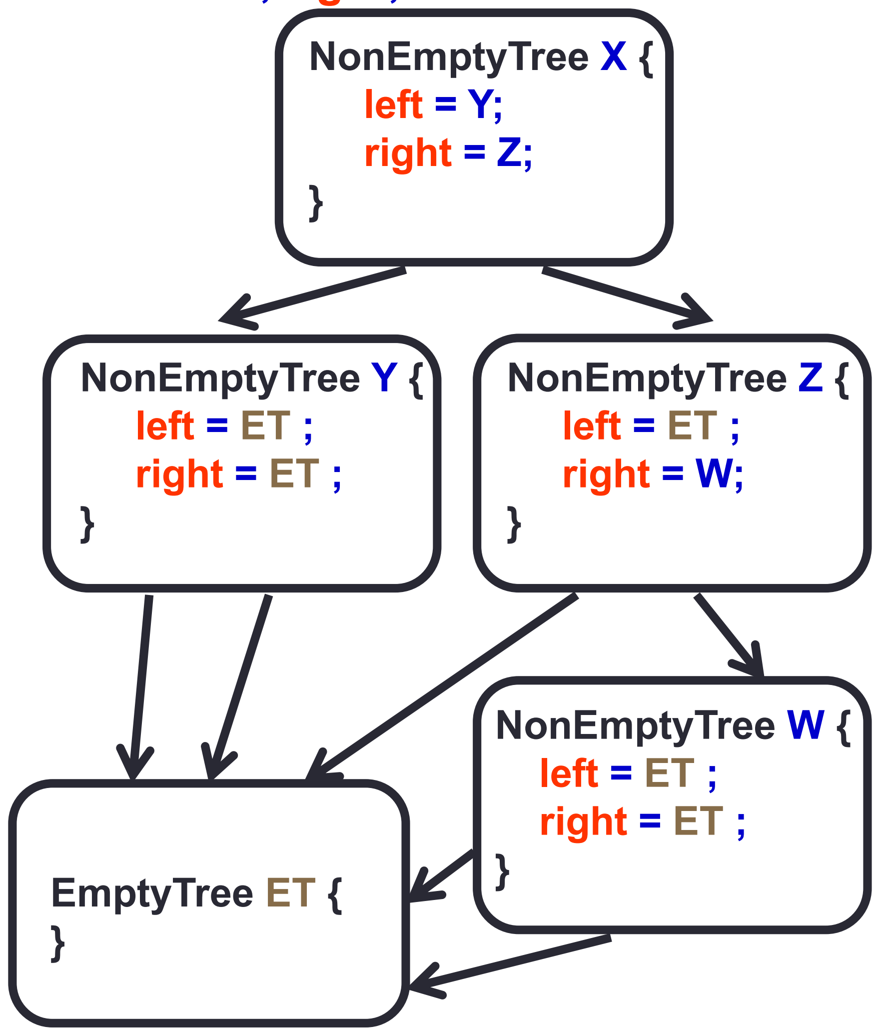
```
public final class MySingleton {
    // declare the unique instance of the class
    private static MySingleton uniq = new MySingleton();
    // private constructor only accessed from this class
    private MySingleton() { … }
    // return reference to unique instance of class
    public static MySingleton getInstance() {
        return uniq;
    }
}
```

Using Singleton EmptyTree

```
Class Node {
        Node left, right;
}
```




```
Class EmptyTree {}
Class NonEmptyTree {
        Tree left, right;
}
```



BST– Deletion (PseudoCode for project)

- Algorithm
    1. Perform search for value X
    2. If X is a leaf, delete X
    3. Else // must delete internal node

       a) Replace with largest value Y on left subtree

       OR smallest value Z on right subtree

       b) Delete replacement value (Y or Z) from subtree
- Observation
    - O(log(n)) operation for balanced tree
    - Deletions may unbalance tree

Polymorphic List Implementation

- Let's see a polymorphic list implementation
- See code distribution: LecturePolymorphicListCode.zip