

# CMSC 132: OBJECT-ORIENTED PROGRAMMING II

## Polymorphic Lists & Trees

---

# 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 ) { ... }  
}
```

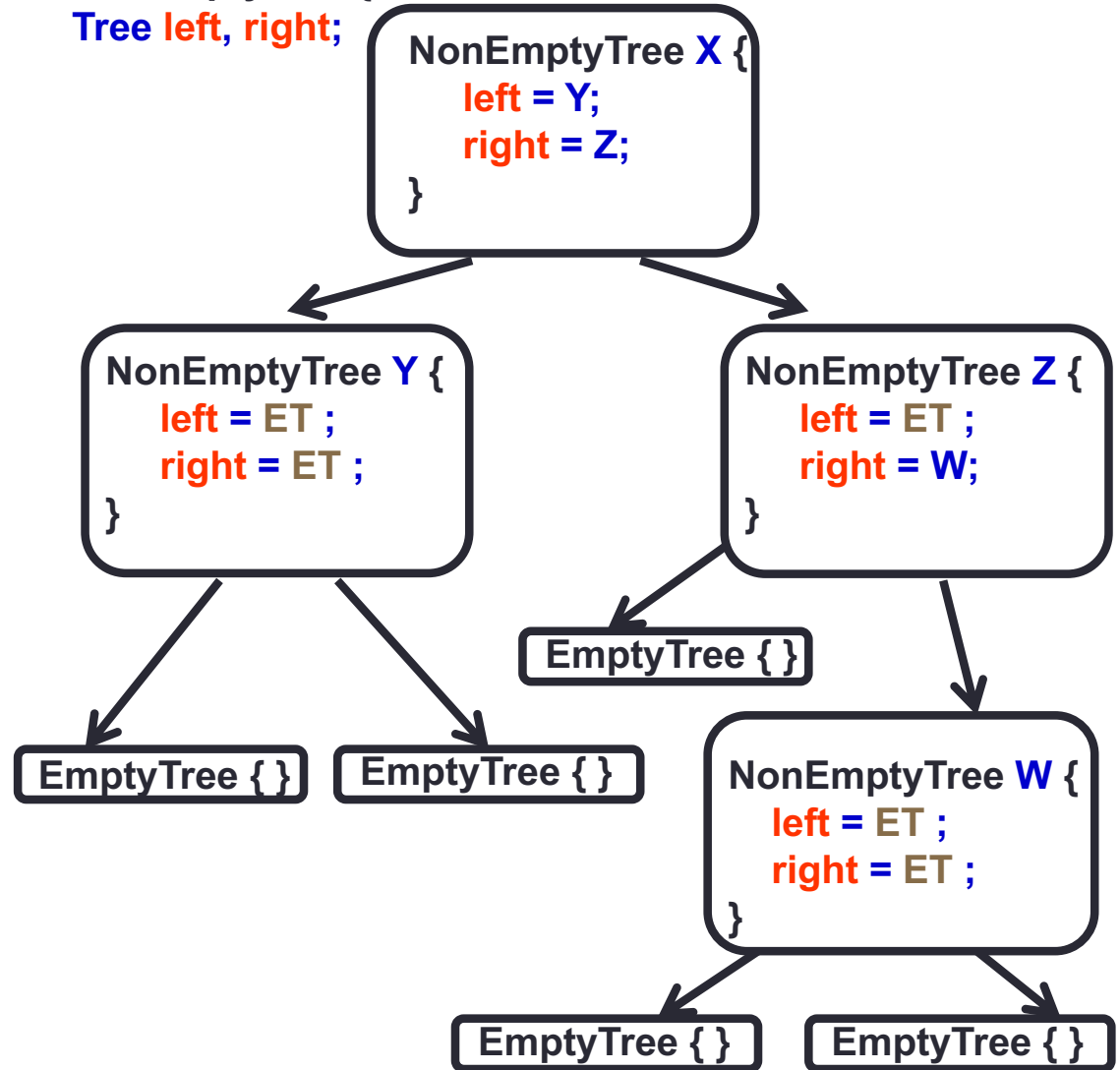
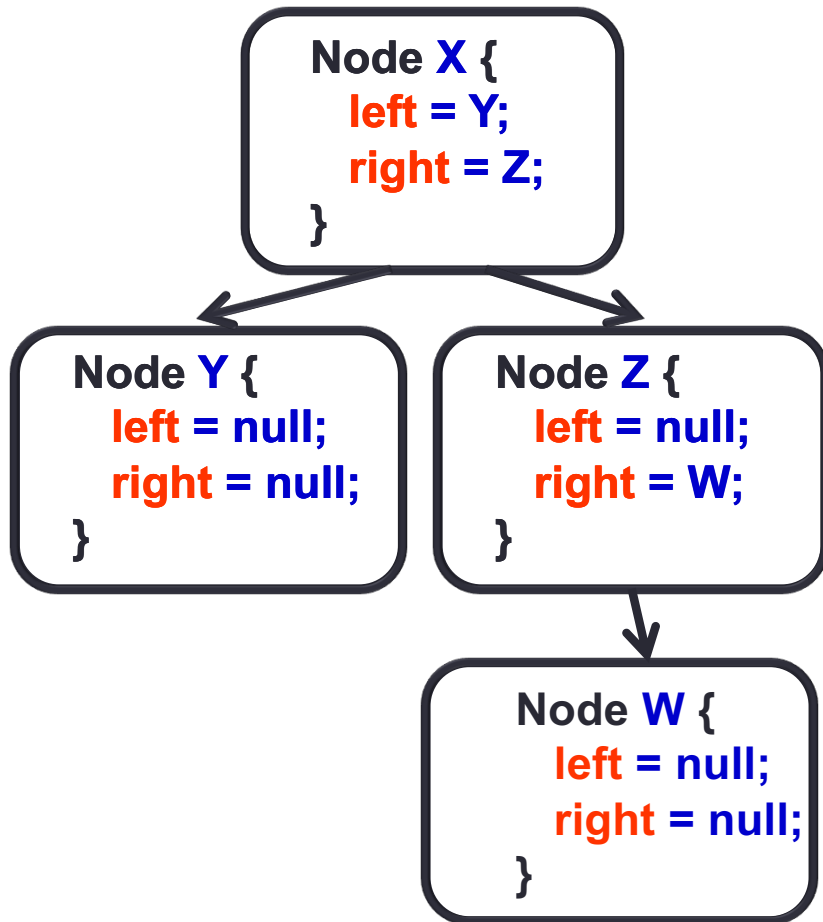
```
Class EmptyTree implements Tree {  
    Tree insert ( Value data1 ) { ... }  
}
```

```
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

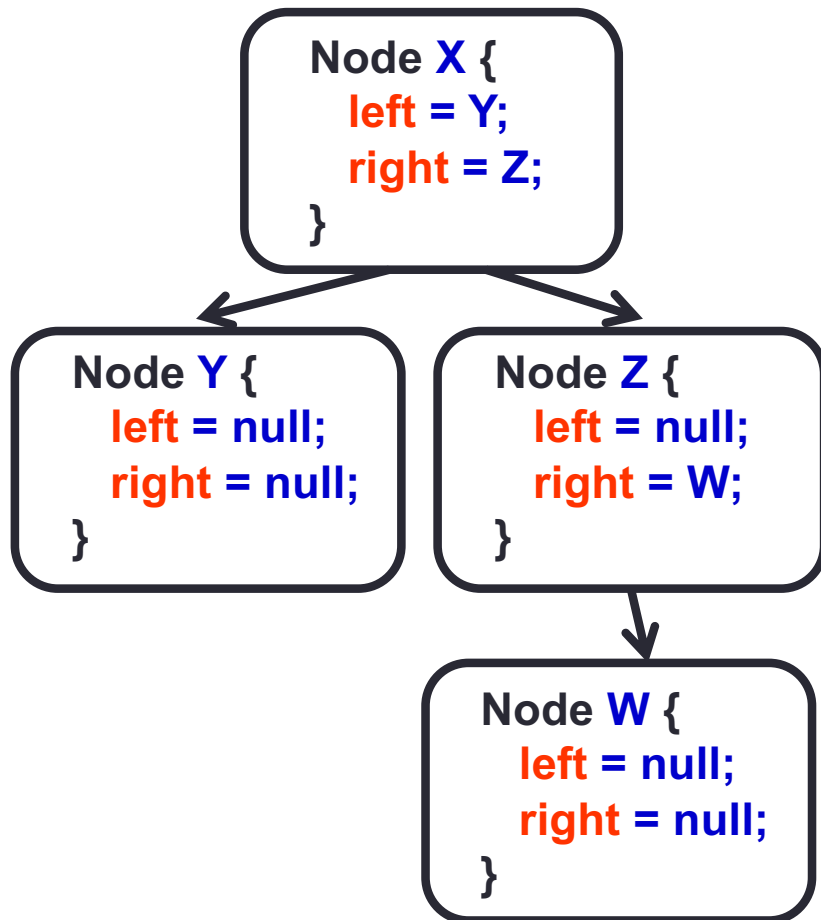
- Definition
  - One instance of a class or value accessible globally
- Where to use & benefits
  - Ensure unique instance by defining class final
  - Access to the instance only via methods provided
- EmptyTree class will be a singleton class

# Singleton Example

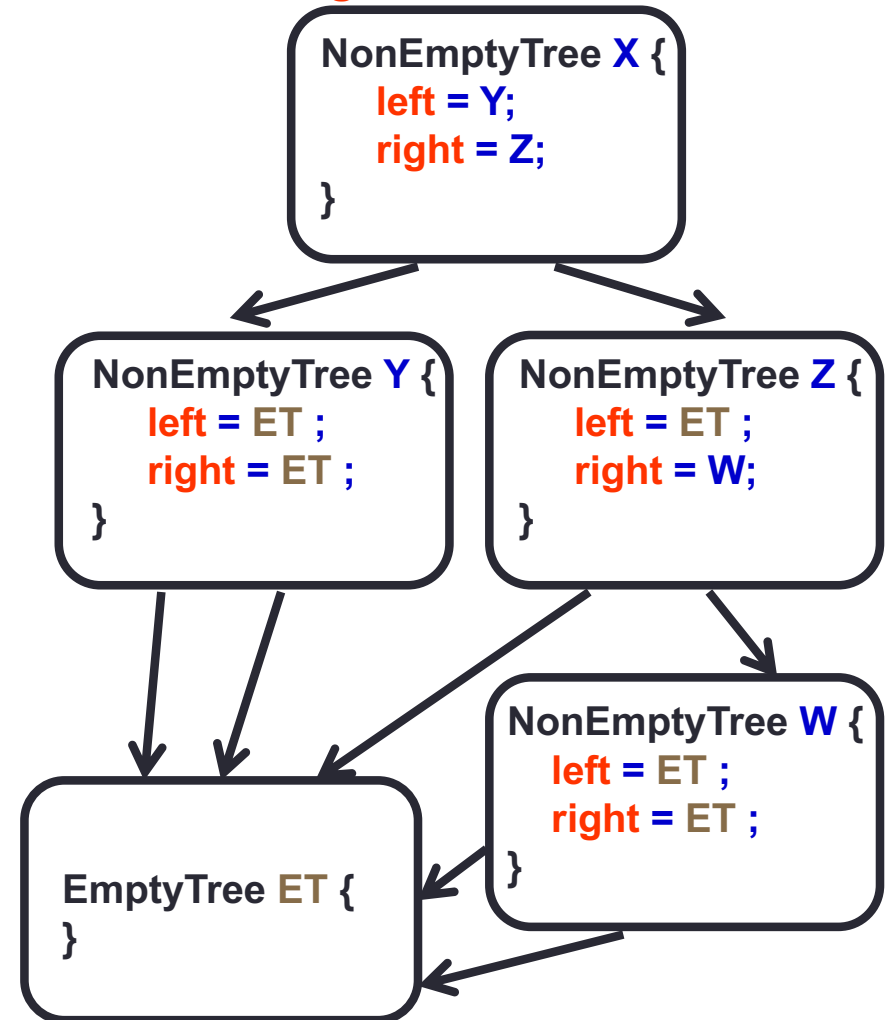
```
public final class MySingleton {  
    // declare the unique instance of the class  
    private static MySingleton uniq = new MySingleton();  
    // private constructor only accessed from this class  
    private MySingleton() { ... }  
    // return reference to unique instance of class  
   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

# Using Singleton EmptyTree

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



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



# Polymorphic List Implementation

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



# Polymorphic Tree

- Let's see the different operations for a polymorphic tree