Treeviz

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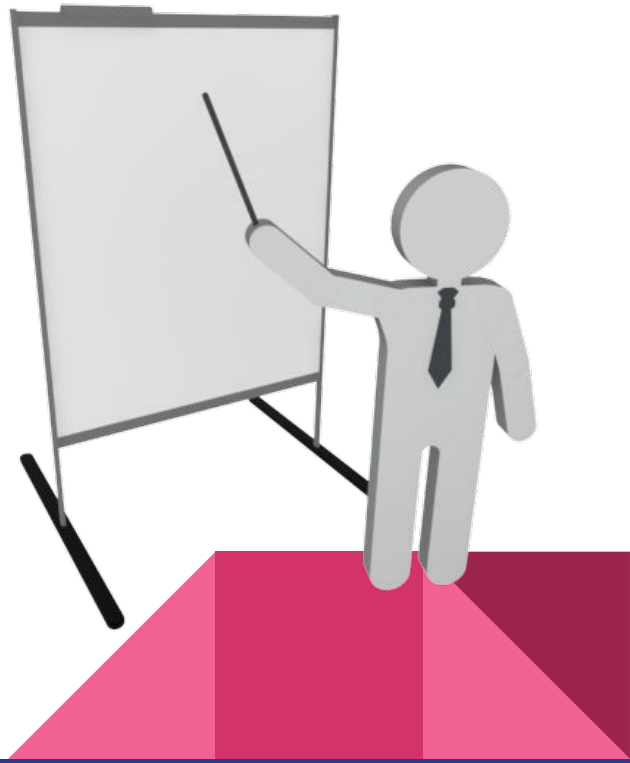
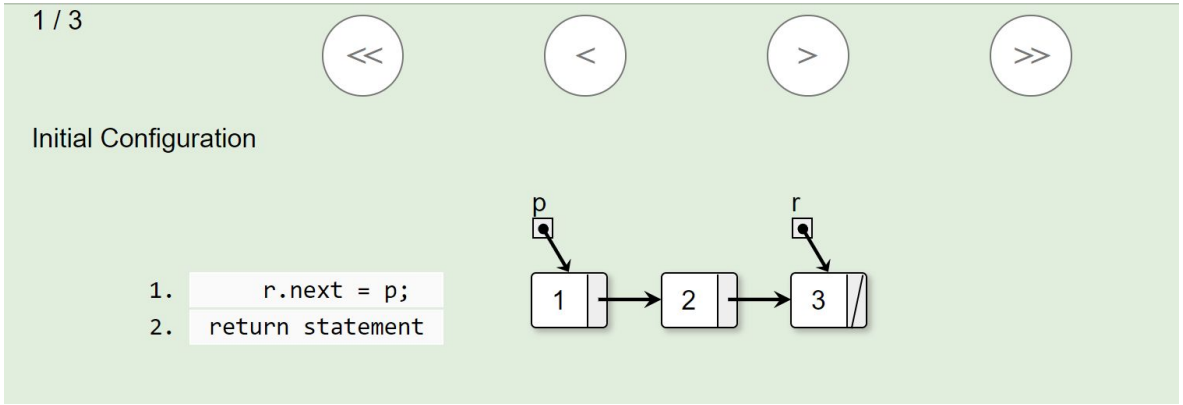
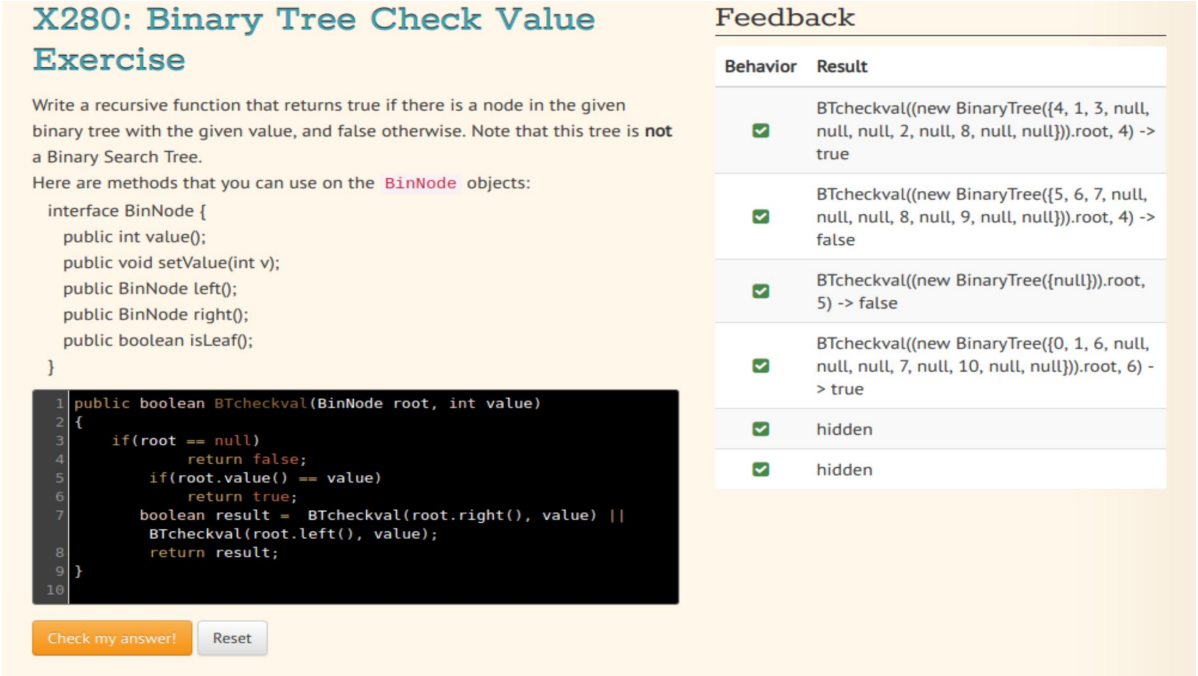


Brief Overview

- Create visualization of student code from CodeWorkout exercises to help students find bugs more easily and increase understanding of data structures



Project Walkthrough



X280: Binary Tree Check Value Exercise

Write a recursive function that returns true if there is a node in the given binary tree with the given value, and false otherwise. Note that this tree is **not** a Binary Search Tree.

Here are methods that you can use on the `BinNode` objects:

```
interface BinNode {
  public int value();
  public void setValue(int v);
  public BinNode left();
  public BinNode right();
  public boolean isLeaf();
}
```

```
1  public boolean BTcheckval(BinNode root, int value)
2  {
3      if(root == null)
4              return false;
5          if(root.value() == value)
6              return true;
7         boolean result =  BTcheckval(root.right(), value) ||
           BTcheckval(root.left(), value);
8          return result;
9  }
10
```

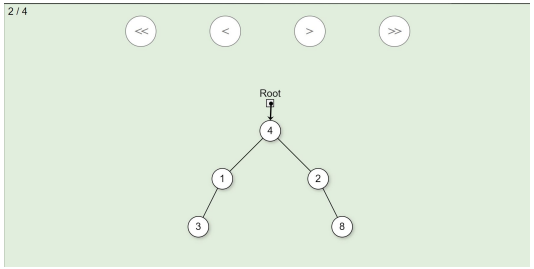
Check my answer! Reset

Feedback

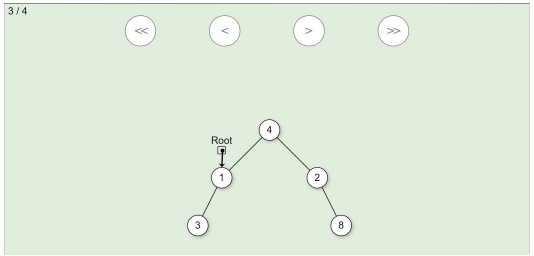
Behavior	Result
✓	BTcheckval((new BinaryTree({4, 1, 3, null, null, null, 2, null, 8, null, null})).root, 4) -> true
✓	BTcheckval((new BinaryTree({5, 6, 7, null, null, null, 8, null, 9, null, null})).root, 4) -> false
✓	BTcheckval((new BinaryTree({null})).root, 5) -> false
✓	BTcheckval((new BinaryTree({0, 1, 6, null, null, null, 7, null, 10, null, null})).root, 6) -> true
✓	hidden
✓	hidden

https://opendsa-server.cs.vt.edu/ODSA/Books/Everything/html/BinaryTreeInfFlw.html

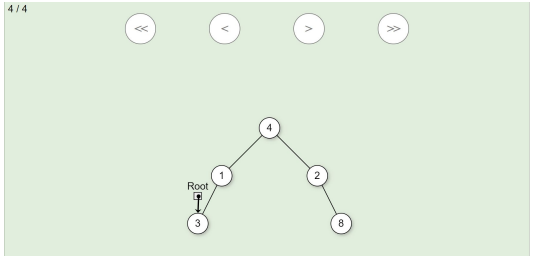
Project Walkthrough (cont.)



Pointing to root node, value of 4



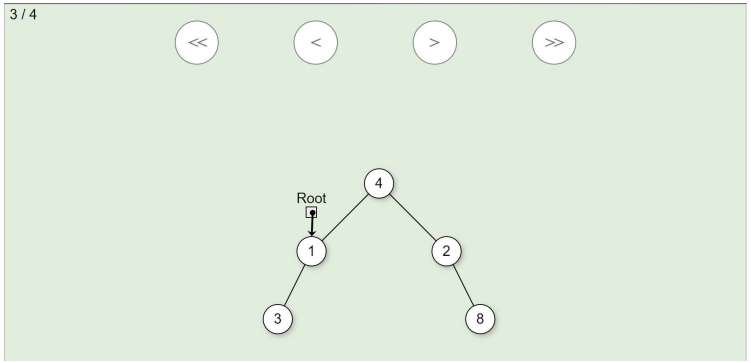
Pointing to first left child, value 1

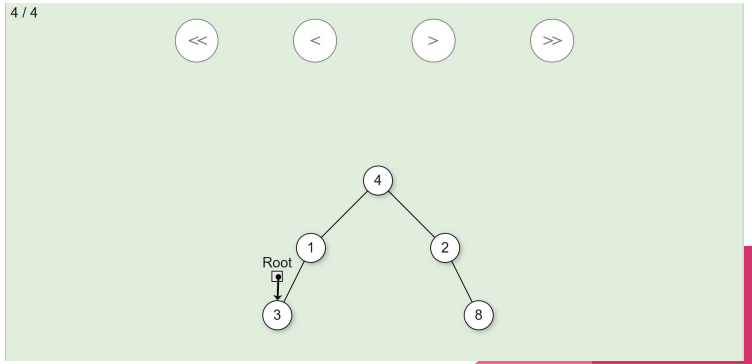


Pointing to second left child, value 3

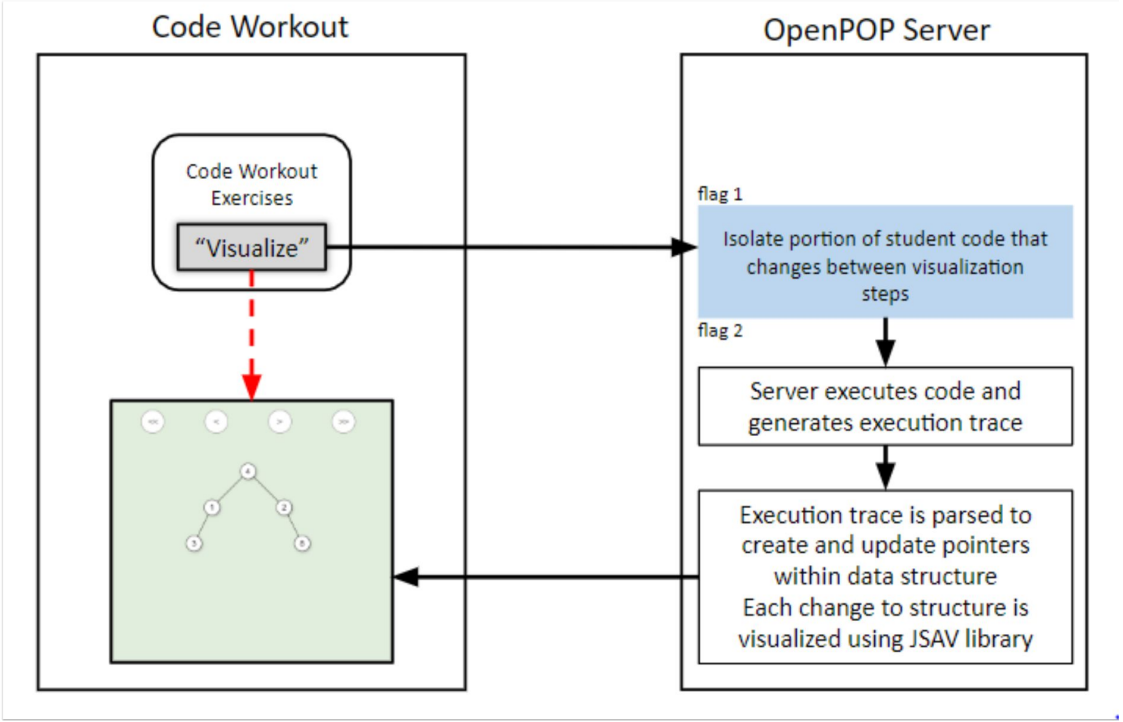
Completed Project Work

- Implemented binary tree visualizations
  - All code is compatible with existing code
- Used JSAV library to visualize binary tree
- Included JSAV pointers to show recursive value checking





Quick Deep Dive



System Diagram of interaction between CodeWorkout and OpenPOP Server (OPEN Pointer OPerations)

"heap":{"172":["INSTANCE","BinNode",["elem",4],["left",["REF",173]],["right",["REF",175]]],

```
for (var key in trace[step].heap) { //this for loop goes through each node in a single heap / tree
    //this grabs all the data for a single node and notes is there are any changes to the tree to add a jsav step
    var data = trace[step].heap[key][2][1];
    var leftRef = trace[step].heap[key][3][1];
    var rightRef = trace[step].heap[key][4][1];
    if (leftRef != null) {
        leftRef = leftRef[1];
    }
    if (rightRef != null) {
        rightRef = rightRef[1];
    }
    if (nodeIDs.includes(key)) { //this is if the node already exists
        let node = nodes.find(node => node.nodeReference == key);
        if (node.getLeft() != leftRef) {
            node.setLeft(leftRef);
            valueChanged = true;
        }
        if (node.getRight() != rightRef) {
            node.setRight(rightRef);
            valueChanged = true;
        }
        if (node.getData() != data) {
            node.setData(data);
            valueChanged = true;
        }
    }
    else { //this is if it is a new node and adds it to the array of nodes
        let treeNode = new TreeNode(data, key, leftRef , rightRef);
        nodes.push(treeNode);
        nodeIDs.push(key);
        if (first) {
            roots = treeNode;
            first = false;
        }
        valueChanged = true;
    }
```

Grabs all data for a single node

Checks if any values have changed if the node already existed

Adds the node to an array of nodes if it doesn't already exist

```
//connecting nodes with real pointers
for(let node of nodes) {
    var leftNum = node.getLeft();
    var rightNum = node.getRight();
    if (node.getReference() == rootPointerID) {
        node.setIsRoot(true);
    }
    else {
        node.setIsRoot(false);
    }
    if (leftNum == null && rightNum == null) {
        continue; //skips looking for pointers if both child are should be null
    }
    for (let nodeTwo of nodes) {
        if (leftNum != null && nodeTwo.getReference() == leftNum) {
            node.setLeftNode(nodeTwo);
        }
        if (rightNum != null && nodeTwo.getReference() == rightNum) {
            node.setRightNode(nodeTwo);
        }
    }
}
```

Goes through all nodes and sets their child nodes with pointers to tree node objects

```
if (firstPointer) { //this is making the jsav tree but only the first time
    firstPointer = false;
    bt.root(roots.getData());
    bt.layout();
    pointer = jsav.pointer("Root", bt.root(), {top: -20, arrowAnchor: "center top"});
}
//given something has changed on this iteration this adds a jsav step and visualizes it recurssively
if (valueChanged) {
    recursiveJsavVisualize(roots, bt.root(), jsav, pointer);
    bt.layout();
    jsav.step();
}
```

Creates JSAV binary tree, pointer to the root, and sets first visualization step

```
//this method creates the jsav tree recurssively and also sets the pointer to the correct node
function recursiveJsavVisualize(node, btnode, jsav, pointer) {
    var leftNum = node.getLeft();
    var rightNum = node.getRight();
    if (node.getIsRoot() == true) {
        pointer.target(btnode);
    }
 if (leftNum != null) {
    var newBtNode = btnode.left(node.getLeftNode().getData());
    recursiveJsavVisualize(node.getLeftNode(), newBtNode, jsav, pointer);
 }
 if (rightNum != null) {
     var newBtNode = btnode.right(node.getRightNode().getData());
     recursiveJsavVisualize(node.getRightNode(), newBtNode, jsav, pointer);
 }
 return;
}
```

Makes the tree recursively for the JSAV object

Project Timeline

- Create tree from trace ✓
- Write code for basic tree visualization ✓
- Visualize multiple steps of students code ✓
- User Testing ✗

Lessons Learned

- Constant communication with client will help project stay on deadline
- Having Windows vs. Linux made the project more difficult
- The JSAV api is very easy to work with when visualizing data structures
- Analyzing binary tree data from a stack trace introduces timing errors when creating nodes

Future Work

- Implement project work in all OpenDSA Tree exercises
- Expand project to include other data structures
  - Hash table
  - M-nary tree
- Optimize current code

Acknowledgements

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Questions?