Project Documentation

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Assignment: Project 3

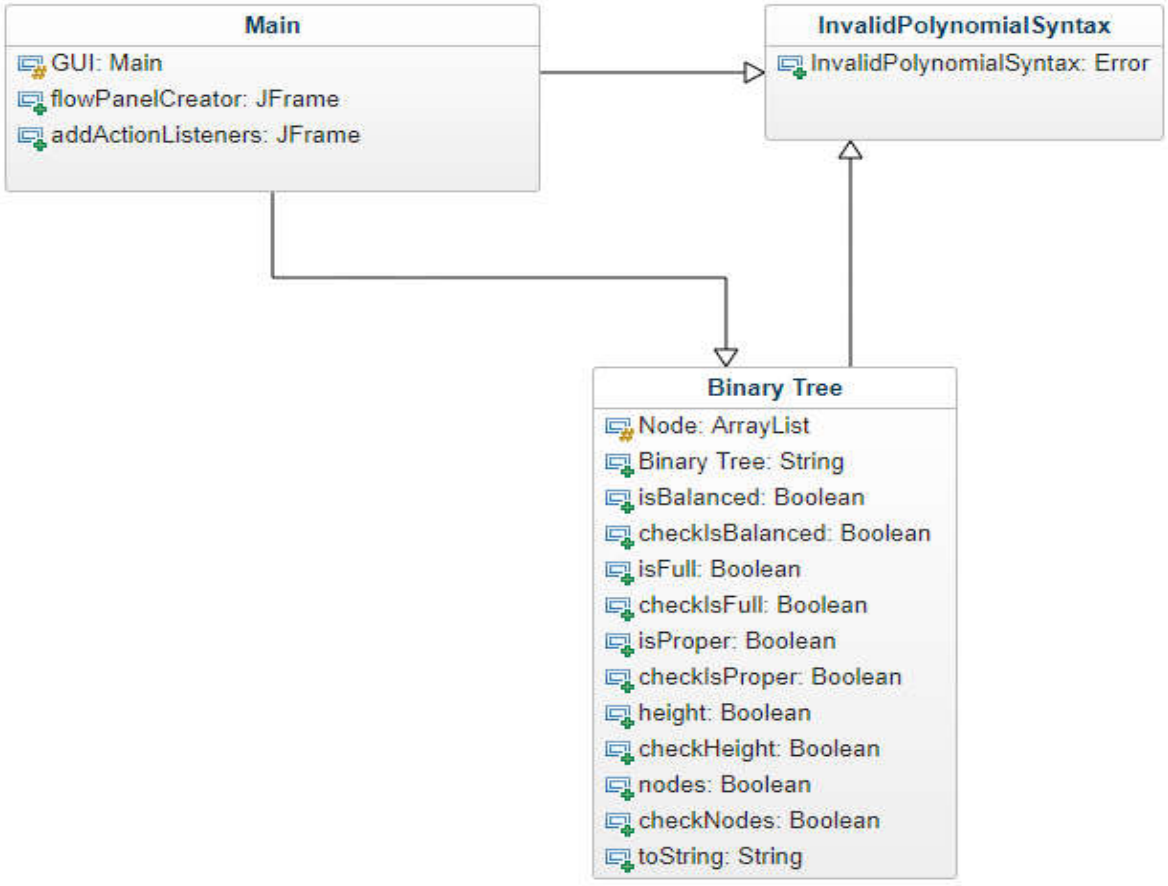
Date: September 29th, 2020

Problem Statement: A program that allows the user to enter a binary tree in parenthesized prefix format and then allows for checking if it Is Balanced, Is Full, Is Proper, Height, Nodes, and In Order.

Analysis: Tree used:

```
(A(G(j)(1))(z(5)))

(A(G(j)(1)) (z())) - for error
```

Design (for project assignments only):



Code:

```
package BeckProject3;

import java.awt.event.ActionListener;
import javax.swing.JButton;
import javax.swing.JComponent;
import javax.swing.JFrame;
import javax.swing.JLabel;
import javax.swing.JOptionPane;
import javax.swing.JPanel;
import javax.swing.JTextField;
import java.awt.Component;
import java.awt.FlowLayout;
import java.awt.GridLayout;

/* File: Project 3 - GUI
 * Author: Dan Beck
 * Date: September 29, 2020
 * Purpose: Class that generates the GUI and passes parameters to
 *                          other classes.
 */

public class GUI extends JFrame
{
        private static final long serialVersionUID = 1L;
        private JTextField input = new JTextField(40);
```

```
        private JTextField output = new JTextField(40);
        private static BinaryTree categories;

        public static void main(String[] args)
        {
                // Executes the program
                GUI createFrame = new GUI();
                createFrame.setVisible(true);
        }//End Main

        public GUI()
        {

        /**************************************************************************
********
            * DESCRIPTION: Constructor that generates the frame
            * 1. Default settings
            * Layers:
            * 2. Input Field
            * 3. Buttons
            * 4. Output Field

**************************************************************************
/

        /**************************************************************************
********
```

```
        * DESCRIPTION: 1. Default Settings
        * A. Title
        * B. Size
        * C. Layout
        * D. Default Settings
**********************************************************************************
/
            //A. Title
            super("Binary Tree Categorizer");

            //B. Size
            setSize(800, 200);
            setLocationRelativeTo(null);

            //C. Layout
            //For this GUI, three levels 3x1 (input text, buttons and output text)
            setLayout(new GridLayout(3, 1));

            //D. Default settings
            setDefaultCloseOperation(JFrame.EXIT_ON_CLOSE);
            setResizable(false);

        /**********************************************************************
********
        * DESCRIPTION: 2. Input Field
```

```
**************************************************************************
/
                JComponent[] inputText =
                        {
                                new JLabel("Enter Tree: "), input
                        };
                flowPanelCreator(inputText);



        /**************************************************************************
********
                * DESCRIPTION: 3. Buttons
                * Creates the buttons laterally in order from left to right

**************************************************************************
/
                JButton[] buttons =
                        {
                                new JButton("Make Tree"),
                                new JButton("Is Balanced?"),
                                new JButton("Is Full?"),
                                new JButton("Is Proper?"),
                                new JButton("Height"),
                                new JButton("Nodes"),
                                new JButton("In Order")
                        };
```

```
                flowPanelCreator(buttons);
                addActionListeners(buttons);


        /**************************************************************************
********
            * DESCRIPTION: 4. Output Field
**************************************************************************
/
                JComponent[] outputText =
                        {
                                new JLabel("Output: "), output
                        };
                flowPanelCreator(outputText);
                output.setEditable(false);
        }//end public GUI()


        /**************************************************************************
********
    * DESCRIPTION: Creates a flow panel from array of panelObjects
**************************************************************************
/
        private void flowPanelCreator(JComponent[] panelObjects)
        {
                JPanel jp = new JPanel(new FlowLayout());
```

```
            for (Component panelObject: panelObjects)
            {
                jp.add(panelObject);
            }//end for (Component panelObject: panelObjects)

            add(jp);
        }//end private void flowPanelCreator(JComponent[] panelObjects)

        /**************************************************************************
********
    * DESCRIPTION: Method that adds ActionListener to panel's buttons

**************************************************************************
/
        private void addActionListeners (JButton[] buttons)
        {
            for (JButton button: buttons)
            {
                button.addActionListener(panelListener);
            }//end for (JButton button: buttons)
        }//end private void addActionListeners (JButton[] buttons)

        /**************************************************************************
********
    * DESCRIPTION: What the ActionListener performs for each button
```

```
**************************************************************************
/
        private final ActionListener panelListener = event ->
        {
                try
                {
                        switch ((event.getActionCommand()))
                        {
                        case "Make Tree":
                                categories = new BinaryTree(input.getText());
                                output.setText(categories.toString());
                                break;
                        case "Is Balanced?":
                                output.setText(String.valueOf(categories.isBalanced()));
                                break;
                        case "Is Full?":
                                output.setText(String.valueOf(categories.isFull()));
                                break;
                        case "Is Proper?":
                                output.setText(String.valueOf(categories.isProper()));
                                break;
                        case "Height":
                                output.setText(String.valueOf(categories.height()));
                                break;
                        case "Nodes":
```

```
                        output.setText(String.valueOf(categories.nodes()));
                        break;
                case "Inorder":
                        output.setText(categories.inOrder());
                        break;
                }//end switch ((event.getActionCommand()))
            }//end try
            catch (InvalidTreeSyntax its)
            {
                JOptionPane.showMessageDialog(getParent(),its.getMessage());
            }//end catch (InvalidTreeSyntax its)
            catch (IndexOutOfBoundsException e)
            {
                JOptionPane.showMessageDialog(getParent(),"No input given!");
            }//end catch (IndexOutOfBoundsException e)
        };
}//End GUI class

package BeckProject3;

import java.util.EmptyStackException;
import java.util.Stack;

/* File: Project 3 - BinaryTree Class
 * Author: Dan Beck
```

```
 * Date: September 29, 2020
 * Purpose: Class that accepts the tree and check is the tree
 * Is Balanced, Is Full, Is Proper, Height, Nodes, and In Order
 */

public class BinaryTree
{
        /**********************************************************************
********
    * DESCRIPTION: Creates the node
    * Creates nodes to be used in entered tree

**********************************************************************
/
                public static class Node
                {
                        private String info;
                        private Node left;
                        private Node right;

                        public Node(String info)
                        {
                                this.info = info;
                        }//end public Node(String info)

                        private void addChild(Node child) throws InvalidTreeSyntax
```

```
{
        //simple conditions for nodes, can have at most 2 children
        if (this.left == null)
        {
                this.setLeft(child);
        }//end if (this.left == null)
        else if (this.right == null)
        {
                this.setRight(child);
        }//end else if (this.right == null
        else
        {
                throw new InvalidTreeSyntax("Nodes can only have 2
children!");
        }//end else
}//end private void addChild(Node child) throws InvalidTreeSyntax

//Setters for the left and right nodes
private void setLeft(Node newLeft)
{
        left = newLeft;
}//end private void setLeft(Node newLeft)
private void setRight(Node newRight)
{
        right = newRight;
```

```
                }//end private void setRight(Node newRight)


                @Override
                public String toString()
                {
                        return toString(this);
                }//end public String toString()


                // recursively printing out the nodes
                private static String toString(Node root)
                {
                        return (root == null) ? "" : "(" + root.info + toString(root.left) +
toString(root.right) + ")";
                }//end private static String toString(Node root)
        }//end public static class Node


        //After the constructor, parent and child nodes created
        Node parent, child;


        /**********************************************************************
********
    * DESCRIPTION: Buttons
    * 1. Make Tree
    * 2. Is Balanced?
    * 3. Is Full?
    * 4. Is Proper?
```

```
    * 5. Height
    * 6. Nodes
    * 7. In Order
**********************************************************************************
/

        /**********************************************************************
********
    * DESCRIPTION: 1. Make Tree

**********************************************************************************
/
        //1. Make Tree
        public BinaryTree(String input) throws InvalidTreeSyntax
        {
                Stack<Node> nodeStack = new Stack<>();
                // remove first & last parenthesis

                String[] inputArray = input.substring(1, input.length()-1)

                //and split the String into an arr of strings, retain the parenthesis
                .split("(?<=\\()|(?=\\()|(?<=\\))|(?=\\))");

                //setting the new first character to the root
                parent = new Node(inputArray[0]);
```

```
//loop starting on the third character of the string
for (int i = 1; i < inputArray.length - 1; i++)
{
	//if there is another child. Child becomes parent if one exists
	if (inputArray[i].equals("("))
	{
		nodeStack.push(parent);


		if (child != null)
		{
			parent = child;
		}//end if (child != null)
	}//end if (inputArray[i].equals("("))
	else if(inputArray[i].equals(")"))
	{
		try
		{
			child = parent; parent = nodeStack.pop();
		}//end try
		catch (EmptyStackException emptyStack)
		{
			throw new InvalidTreeSyntax("Incorrect parenthesis!");
		}//end catch (EmptyStackException emptyStack)
		//if it gets here, it is a value to be assigned as child to parent.
	}//end else if(inputArray[i].equals(")"))
```

```
                else
                {
                        child = new Node(inputArray[i]);
                        if (parent != null)
                        {
                                parent.addChild(child);
                        }//end if (parent != null)
                }//end else
        }//end for (int i = 1; i < inputArray.length - 1; i++)

        //for every node, will have 2 parenthesis
        if (this.checkNodes(parent) * 3 != input.length()) throw new
InvalidTreeSyntax("Incorrect Syntax");
    }//end public BinaryTree(String input) throws InvalidTreeSyntax

    /**********************************************************************
********
   * DESCRIPTION: 2. Is Balanced
   * determine if the absolute difference between branches is at most 1.
   * calls recursive method, which also calls recursive height method.

**********************************************************************
/
    public boolean isBalanced()
    {
        return checkIsBalanced(this.parent);
    }//end public boolean isBalanced()
```

```
	private boolean checkIsBalanced(Node root)
	{
		//base case
		if (root == null)
		{
			return true;
		}//end if (root == null)

		//return true if the absolute difference is at most 1
		return (Math.abs(checkHeight(root.left) - checkHeight(root.right)) <= 1) &&
				(checkIsBalanced(root.left) && checkIsBalanced(root.right));
	}//end private boolean checkIsBalanced(Node root)

	/**************************************************************************
********
	 * DESCRIPTION: 3. Is Full
	 * determines if a tree has the maximum nodes for the height or not.
	 * calls recursive method, which also calls recursive height method.

**************************************************************************
/
	public boolean isFull()
	{
		return checkIsFull(this.parent, checkHeight(this.parent), 0);
	}//end public boolean isFull()
```

```
//the index of of parent in this exercise is 0
private boolean checkIsFull(Node root, int height, int index)
{
	//if it is empty, by BT logic: it is full
	if (root == null)
	{
		return true;
	}//end if (root == null)
	//check to see if height is same among leaves
	if (root.left == null && root.right == null)
	{
		return (height == index + 1);
	}//end if (root.left == null && root.right == null)
	//one child empty
	if (root.left == null || root.right == null)
	{
		return false;
	}//end if (root.left == null || root.right == null)

	//recursive call to both children
	return checkIsFull(root.left, height, index+1) &&
			checkIsFull(root.right, height, index+1);
}//end private boolean checkIsFull(Node root, int height, int index)
```

```
        /**************************************************************************
********

    * DESCRIPTION: 4. Is Proper

    * determines if every node in a tree has either 2 or 0 children.

**************************************************************************
/

        public boolean isProper()

        {

                return checkIsProper(this.parent);

        }//end public boolean isProper()


        private boolean checkIsProper(Node root)

        {

                //base case

                if(root == null) {return true;}

                //returns true or false based on two or zero children

                return ((root.left != null || root.right == null) &&

                                (root.left == null || root.right != null))

                                && (checkIsProper(root.left) && checkIsProper(root.right)); //
and calling recursively

        }//end private boolean checkIsProper(Node root)


        /**************************************************************************
********

    * DESCRIPTION: 5. Height

    * finds the height of the binary tree, where the root node is 0.
```

```
    * calls the recursive method, which adds one to the the larger of left or right

**************************************************************************
/
        public int height()
        {
                return checkHeight(this.parent)-1;
        }//end public int height()


        //subtracted one since in this exercise, root is 0
        private int checkHeight(Node root)
        {
                //adds one to the greater of left and right, zero if null
                return (root == null) ? 0 : 1 + Math.max(checkHeight(root.left),
                                checkHeight(root.right));
                // found every chance to use the conditional operator in this (had a lot of single
if/else's)
        }//end private int checkHeight(Node root)


        /**************************************************************************
********
    * DESCRIPTION: 6. Nodes
    * finds the amount of nodes in a binary tree. Calls the recursive method,
    * which adds one for every node of left and right subtree, 0 if null.

**************************************************************************
/
```

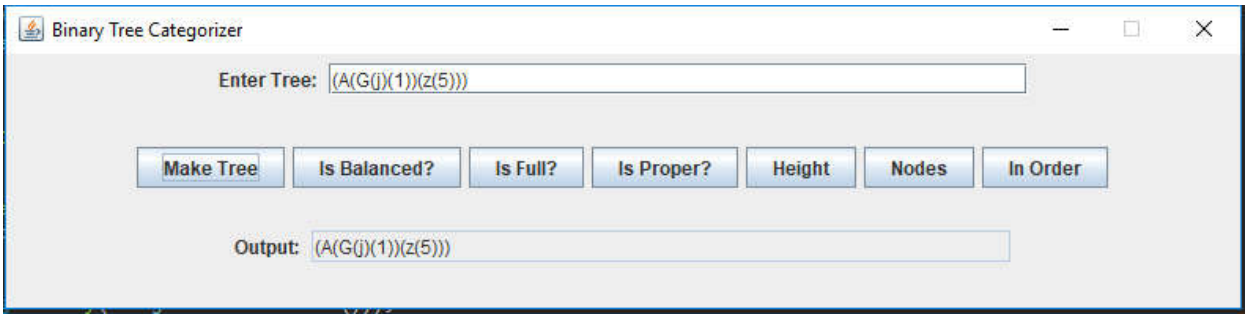
```
	public int nodes()
	{
		return checkNodes(this.parent);
	}//end public int nodes()

	private int checkNodes(Node root)
	{
		//adds 1 for both left and right. If null, zero
		return (root == null) ? 0 : 1 + checkNodes(root.left) +
					checkNodes(root.right);
	}//end private int checkNodes(Node root)

	/**************************************************************************
********
    * DESCRIPTION: 7. In Order
    * prints the info of the nodes in the binary tree in order.
    * Calls the recursive method which uses the algorithm left -> node -> right

**************************************************************************
/
	public String inOrder()
	{
		return checkInOrder(this.parent);
	}//end public String inOrder()

	private String checkInOrder(Node root)
```

```
	{
		return (root == null) ? "" : "(" + checkInOrder(root.left) + root.info +
checkInOrder(root.right) + ")";
	}//end private String checkInOrder(Node root)

	/**************************************************************************
********
    * DESCRIPTION: toString
**************************************************************************
/
	@Override
	public String toString()
	{
		return parent.toString();
	}//end public String toString()
}//end public class BinaryTree

package BeckProject3;

/* File: Project 3 - InvalidTreeSyntax Class
 * Author: Dan Beck
 * Date: September 23, 2020
 * Purpose:Class that creates InvalidTreeSyntax error to be caught in program
 */

public class InvalidTreeSyntax extends RuntimeException
```

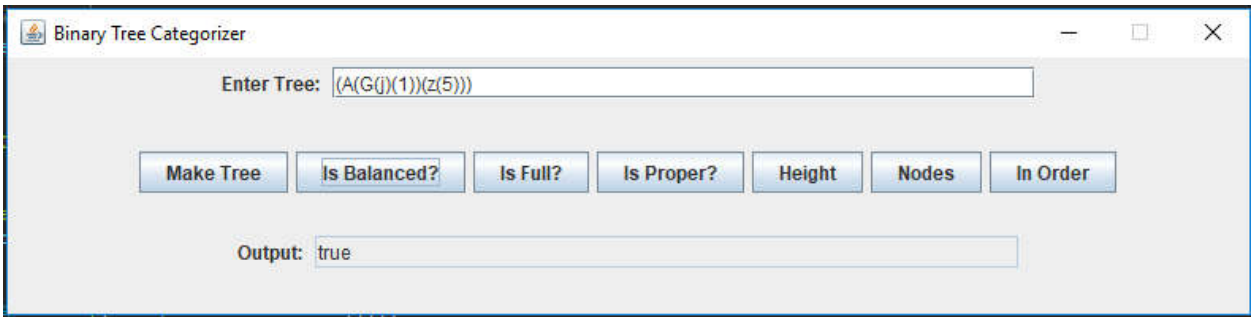
```
{
   private static final long serialVersionUID = 1L;


   InvalidTreeSyntax(String msg)
   {
      super(msg);
   }//end InvalidPolynomialSyntax(String msg)
}//end class InvalidPolynomialSyntax
```

Output:

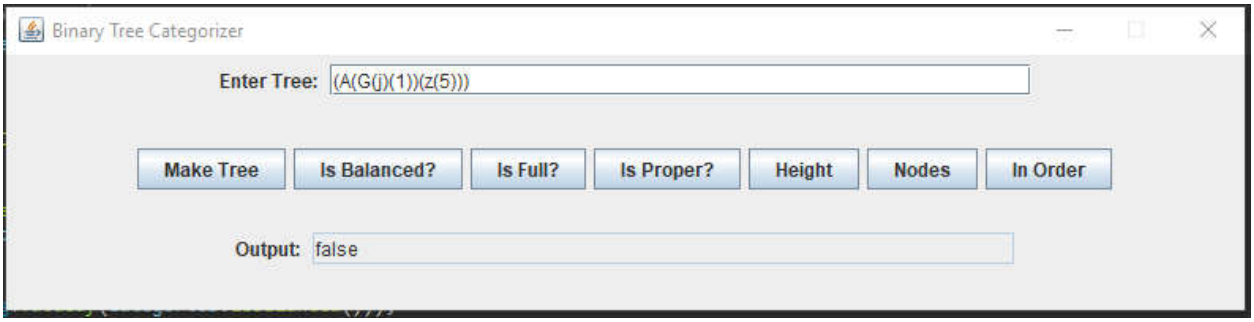
Make Tree



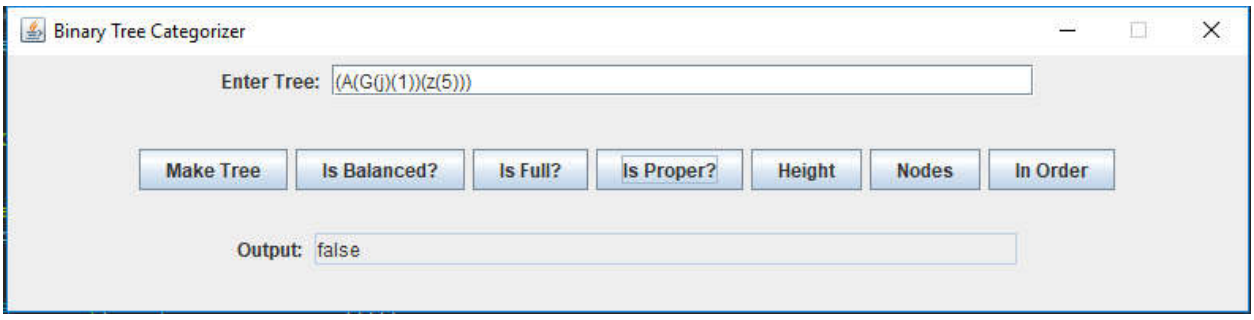
Is Balanced



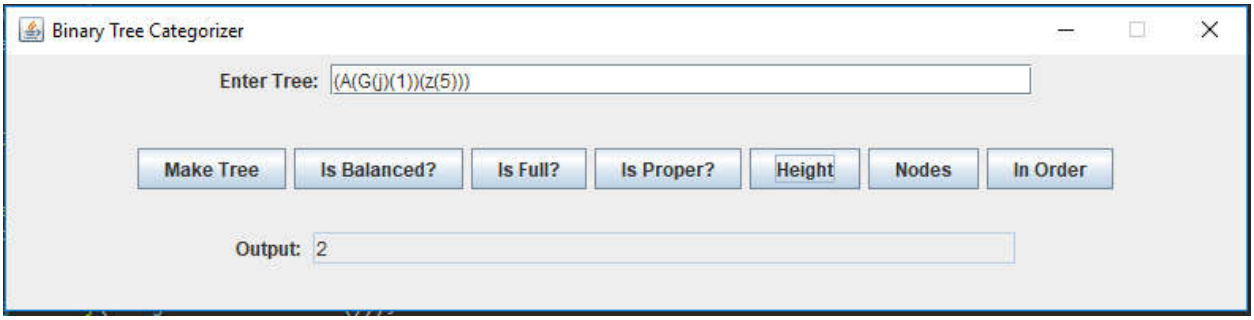
Is Full



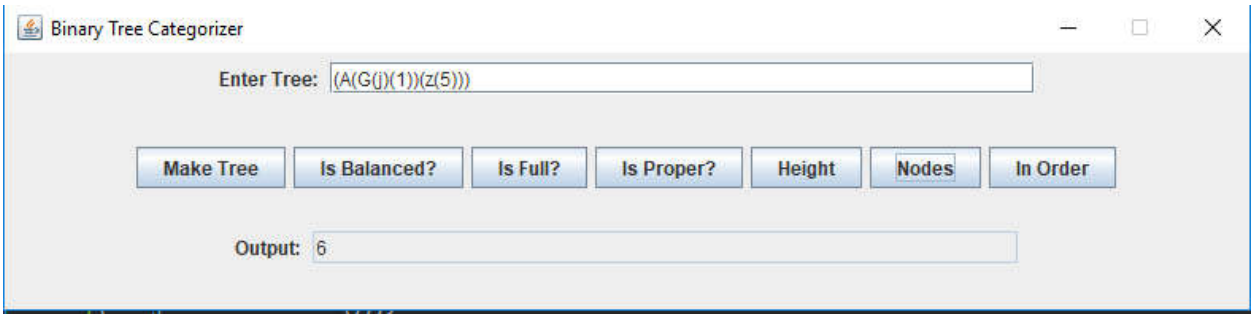
Is Proper



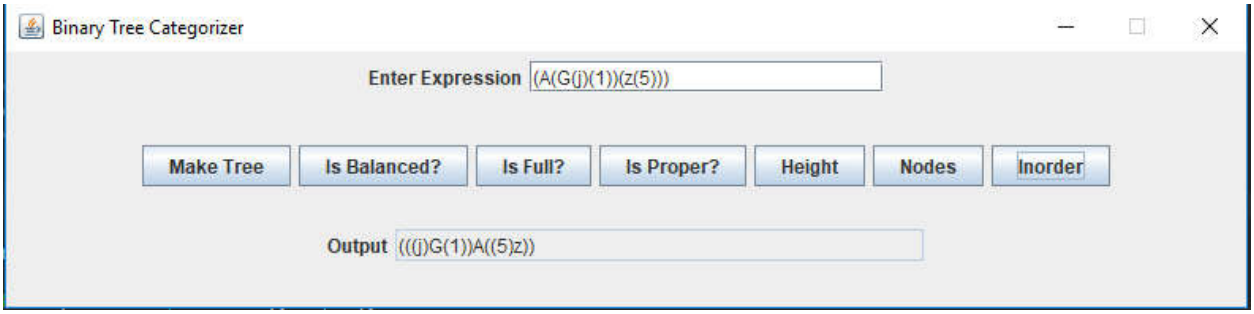
Height



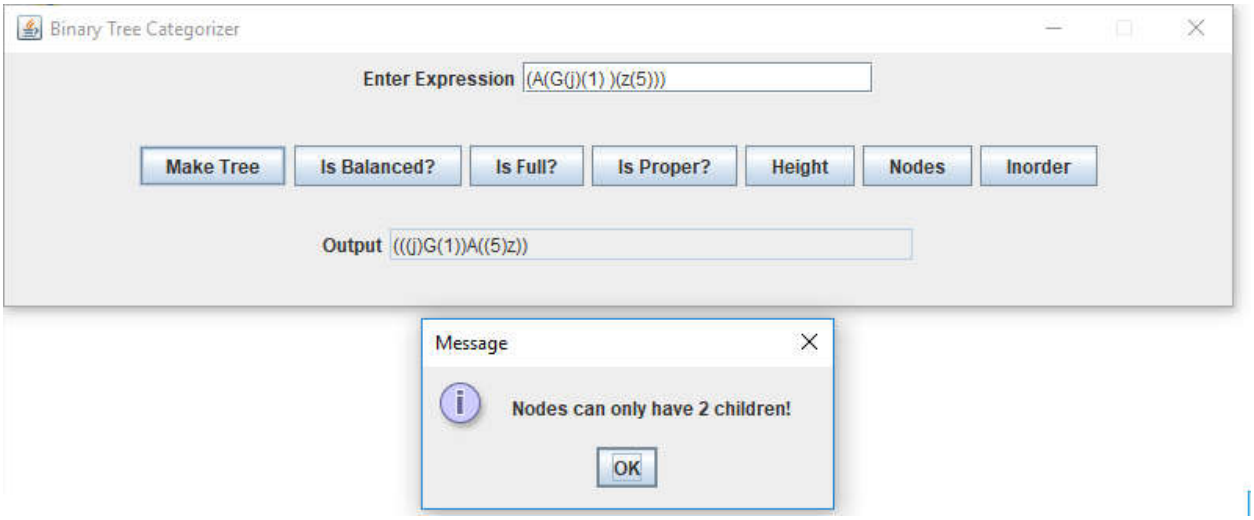
Nodes



In Order



Syntax Error



Reflection: I found this project to be much more difficult than the other projects so far as I had no familiarity with binary trees. This project gave me excellent exposure to the binary tree algorithm making me want to dive deeper into how they work.