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package AVLTree;

import List.LNode;

/**
 * AVLTree class is a Binary Search Tree data structure that implements single and double, Left and
 * right, AVL rotations to maintain a Height Balance factor of no more than 1. If an item is added to
 * the tree more than once; a counter, c, of TNode is incremented by one. Implemented operations are:
 *
 * insert      Insert a String into the tree.
 * inOrder     Perform an In-Order (Symmetric-Order) traversal of the tree.
 * isAVL       Checks if each node in the tree is AVL compliant, returns true or false.
 * delete      Find a node in the tree and remove it.
 *
 * When an inOrder traversal is performed, the word will be printed to the console with it's respective
 * number of occurrences next to it (word - #).
 *
 * ***** Valid Input *****
 *
 * words       An LNode Linear Linked-List of Strings.
 *
 * ***** Public Operations *****
 *
 * insert      Insert a given String into the tree.
 * inOrder     Perform an In-Order traversal of the tree, output to console.
 * isAVL       Returns true if the tree is AVL compliant, false if not.
 * delete      Find and remove a given string from the tree.
 *
 * ***** Global Variables *****
 *
 * data        Private variable for root pointer.
 *
 * @author Matt Laidman (5199807)
 * @version 1.0 (October 21, 2014)
 */

public class AVLTree {

    private TNode data; // Private variable to store root pointer

    /**
     * Public constructor to call private buildTree function with List of words.
     *
     * @param words An LNode Linear Linked-List storing words to add to tree.
     */

    public AVLTree (LNode words) {

        buildTree(words); // Call buildTree method.
    }

    /**
     * Public insert method to call private insert function to add a String into the tree.
     *
     * @param item String to add to tree.
     * @return Root of tree with String added.
     */

    public TNode insert (String item) {

        data = insert(data, item); // Call private insert function.
        return data; // Return root of tree
    }

    /**
     * Public inOrder method to call private method with private data variable.
     */

    public void inOrder ( ) {

        inOrder(data);
    }
}

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}

/**
 * Public isAVL function to call private isAVL with private data variable.
 *
 * @return      True if tree is AVL compliant, false if not.
 */

public boolean isAVL ( ) {

    return isAVL(data);
}

/**
 * Public delete to call private delete to remove a String from the tree.
 *
 * @param item      The String to remove from the tree.
 * @return          The root node of the tree.
 */

public TNode delete (String item) {

    data = delete(data, item);          // Call private delete method
    return data;                        // Return root node of tree
}

/**
 * Private delete function to locate and remove a String from the tree. Recursively navigates the
 * tree to target node, checks left and right side heights as the recursion pops and calls appropriate
 * AVL rotation functions.
 *
 * @param tree      The local root of the tree to delete from (absolute root originally).
 * @param item      The String to locate in the tree and remove.
 * @return          The root TNode of the tree.
 */

private TNode delete (TNode tree, String item) {

    if (tree == null) {                // If node is null
        return null;                  // Return null
    }
    if (item.compareTo(tree.key) < 0) { // If item is less than Node
        tree.left = delete(tree.left, item); // Recursive call with left subtree
        if (height(tree.right) - height(tree.left) == 2) { // If right subtree heavier
            if (height(tree.right.right) >= height(tree.right.left)) {
                tree = singleLeft(tree); // Right side (outside) of subtree
            } else {
                tree = doubleLeft(tree); // heavier, call singleLeft, otherwise
            } // call doubleLeft.
        } else {
            // Update height
            tree.height = Math.max(height(tree.right), height(tree.left)) + 1;
        }
    } else if (item.compareTo(tree.key) > 0) { // If item is greater than Node
        tree.right = delete(tree.right, item); // Recursive call with right subtree
        if (height(tree.left) - height(tree.right) == 2) { // If left subtree heavier
            if (height(tree.left.left) >= height(tree.left.right)) {
                tree = singleRight(tree); // Left side (outside) of subtree
            } else {
                tree = doubleRight(tree); // heavier, call singleRight, otherwise
            } // call doubleRight
        } else {
            // Update height
            tree.height = Math.max(height(tree.right), height(tree.left)) + 1;
        }
    } else if (tree.left != null && tree.right != null) { // If node has left and right children
        tree.key = successor(tree).key; // Copy successor key to key
        tree.right = delete(tree.right, tree.key); // Delete successor
        if (height(tree.right) - height(tree.left) == 2) { // If right subtree heavier
            if (height(tree.right.right) >= height(tree.right.left)) {
                tree = singleLeft(tree); // Right side (outside) of subtree
            } else {
                tree = doubleLeft(tree); // heavier, call singleLeft, otherwise
            } // call doubleLeft.
        }
    }
}

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        }
    } else {
        tree.height = Math.max(height(tree.right), height(tree.left)) + 1;
    }
} else {
    // Node to delete has one or no children
    if (tree.left != null) {
        // If there is left child
        tree = tree.left;
        // Copy left child to Node
    } else {
        tree = tree.right;
        // Otherwise copy right child to Node
    }
}
return tree;
// Return node
}

/**
 * Private successor function performs the successor algorithm (right once, left as far as possible)
 * on a given node and returns it's successor
 *
 * @param tree The TNode to locate successor of.
 * @return The successor of the given TNode.
 */

private TNode successor (TNode tree) {

    tree = tree.right;
    // Right once
    if (tree == null) {
        // If null tree, return null
        return null;
    }
    while (tree.left != null) {
        // Left as far as possible
        tree = tree.left;
    }
    return tree;
    // Return successor
}

/**
 * Private isAVL function recursively checks every node in the tree to ensure that the entire tree
 * is AVL compliant (height balance of 1).
 *
 * @param tree The current TNode to check.
 * @return True if tree is AVL, false if not.
 */

private boolean isAVL (TNode tree) {

    return (tree == null) || (Math.abs(height(tree.left) - height(tree.right)) <= 1 &&
        isAVL(tree.left) && isAVL(tree.right));
    // Check heights and call left and right
}

/**
 * Private inOrder function recursively performs an In-Order traversal of the tree (LVR).
 *
 * @param tree The current TNode to enumerate.
 */

private void inOrder (TNode tree) {

    if (tree.left != null) {
        // If tree has left child
        inOrder(tree.left);
        // Recursive call left
    }
    System.out.println(tree.key + " - " + tree.c);
    // Print node contents (visit)
    if (tree.right != null) {
        // If tree has right child
        inOrder(tree.right);
        // Recursive call right
    }
}

/**
 * Private insert function recursively adds a string to it's appropriate spot on the tree and
 * initiates the AVL rotations to rebalance the tree.
 *
 * @param tree The TNode to add to.
 * @param item The String to add.
 */

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* @return           The tree with TNode added.
*/

private TNode insert (TNode tree, String item) {

    if (tree == null) {                                // If tree is empty
        tree = new TNode(item);                        // Return item as root
    } else if (item.compareTo(tree.key) < 0) {          // If item less than current key
        tree.left = insert(tree.left, item);           // Recursive call left
        if (height(tree.left) - height(tree.right) == 2) { // If left subtree heavier
            if (item.compareTo(tree.left.key) < 0) {    // If item added to left
                tree = singleRight(tree);              // Single right rotation
            } else {
                tree = doubleRight(tree);              // Otherwise double right rotation
            }
        } else {
            tree.height = 1 + Math.max(height(tree.left), height(tree.right)); // Update tree height
        }
    } else if (item.compareTo(tree.key) > 0) {          // If item less than current key
        tree.right = insert(tree.right, item);         // Recursive call right
        if (height(tree.right) - height(tree.left) == 2) { // If right subtree heavier
            if (item.compareTo(tree.right.key) > 0) {    // If item greater than current key
                tree = singleLeft(tree);               // Single left rotation
            } else {
                tree = doubleLeft(tree);               // Otherwise double left rotation
            }
        } else {
            tree.height = 1 + Math.max(height(tree.right), height(tree.left)); // Update tree height
        }
    } else {
        tree.c++;                                       // If item is equal to current key
        // Increase count
    }
    return tree;                                       // Return TNode
}

/**
 * Private singleRight function performs the single left to right AVL rotation on the tree, while
 * maintaining the binary search property.
 *
 * @param tree      The TNode to perform the rotation on.
 * @return          The TNode after the rotation.
 */

private TNode singleRight (TNode tree) {

    TNode ptr = tree.left;                            // Current points left to left child's
    tree.left = ptr.right;                             // right child
    ptr.right = tree;                                  // Left child points right to current
    tree.height = Math.max(height(tree.left), height(tree.right))+1;
    ptr.height = Math.max(height(ptr.left), tree.height)+1; // Update heights
    return ptr;                                        // Return current TNode
}

/**
 * Private doubleRight function performs the double left to right AVL rotation on the tree, while
 * maintaining the binary search property. This is accomplished using a single left rotation and a
 * single right rotation, from the respective singleLeft and singleRight functions.
 *
 * @param tree      The TNode to perform the rotation on.
 * @return          The TNode after the rotation.
 */

private TNode doubleRight (TNode tree) {

    tree.left = singleLeft(tree.left);                // Left rotation on left child
    return singleRight(tree);                          // Right rotation on current
}

/**
 * Private singleLeft function performs the single right to left AVL rotation on the tree, while
 * maintaining the binary search property.

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*
* @param tree      The TNode to perform the rotation on.
* @return          The TNode after the rotation.
*/

private TNode singleLeft (TNode tree) {

    TNode ptr = tree.right;                // Current points right to right child's
    tree.right = ptr.left;                 // left child
    ptr.left = tree;                       // Right child points left to current
    tree.height = Math.max(height(tree.left), height(tree.right))+1;
    ptr.height = Math.max(height(ptr.right), tree.height)+1; // Update heights
    return ptr;                            // Return current TNode
}

/**
 * Private doubleLeft function performs the double right to left AVL rotation on the tree, while
 * maintaining the binary search property. This is accomplished using a single right rotation and a
 * single left rotation, from the respective singleRight and singleLeft functions.
 */
* @param tree      The TNode to perform the rotation on.
* @return          The TNode after the rotation.
*/

private TNode doubleLeft (TNode tree) {

    tree.right = singleRight(tree.right); // Right rotation on right child
    return singleLeft(tree);             // Left rotation on current
}

/**
 * Private height function returns the height of a given TNode in the tree. If the TNode is null, -1
 * is returned.
 */
* @param node      The TNode to get the height of.
* @return          The height of the TNode in the tree.
*/

private int height(TNode node) {

    if (node == null) {                   // If null TNode
        return -1;                       // Return -1
    } else {
        return node.height;              // Otherwise return height
    }
}

/**
 * Private buildTree function builds the binary search tree by calling the insert function with each
 * word in the supplied LNode list of words.
 */
* @param words      The List of words to build tree from.
*/

private void buildTree (LNode words) {

    if (words == null) {                 // If null word list
        throw new AVLTreeException();   // Throw AVLTreeException
    }
    while (words != null) {              // While there are words in List
        data = insert(words.key);        // Insert word into tree
        words = words.next;              // Next word
    }
}
}

```