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Algorithm Steps for computing 2-3 tree:

Step 0: inFile args[0]

debugFile args[1]

treeFile args[2]

Step 1: initialTree (inFile, debugFile)

Step 2: data read one data item from inFile

Step 3: Spot findSpot (Root, data)

If Spot == null write "data is in the database, no need to insert" to treeFile

Repeat step 2

Else printNode (Spot, debugFile) // with caption saying it is Spot

Step 4: newNode get a treeNode (data, -1, null, null, null, null)

Step 5: treeInsert (Spot, newNode)

Step 6: preOrder (debugFile) // if printing is too much, then, call preorder every 3 insertions.

Step 7: repeat step 2 to step 6 until inFile is empty

Step 8: preOrder (treeFile)

Step 9: close all files

```

import java.io.FileNotFoundException;
import java.io.FileReader;
import java.io.FileWriter;
import java.io.IOException;
import java.util.Scanner;

public class Main {

    public static void main(String[] args) throws IOException {
        String in = args[0];
        String out1 = args[1];
        String out2 = args[2];

        Tree23 tree = new Tree23();
        int data = -1;
        Tree23.treeNode spot = tree.new treeNode(-1, -1, null, null, null, null);

        try {
            Scanner inFile = new Scanner(new FileReader(in));
            FileWriter debugFile = new FileWriter(out1);
            FileWriter treeFile = new FileWriter(out2);
            Tree23.treeNode root = tree.initialTree(inFile, debugFile);
            while (inFile.hasNext()) {
                data = inFile.nextInt();
                spot = tree.findSpot(root.child1, data);
                if (spot == null) {
                    treeFile.write(data + " data is in the database, no need to
insert\n");
                    continue;
                } else {
                    debugFile.write("spot node\n");
                    root.child1.printNode(spot, debugFile);

                    Tree23.treeNode newNode = tree.new treeNode(data, -1,
null, null, null, null);
                    tree.treeInsert(spot, newNode);
                    tree.preOrder(root.child1, debugFile);
                }
            }
            inFile.close();
            debugFile.close();
            treeFile.close();
        } catch (FileNotFoundException e) {
            e.printStackTrace();
        }
    }
}

```

```

    }
}

```

```

import java.io.FileWriter;
import java.io.IOException;
import java.util.Scanner;

```

```

public class Tree23 {
    public class treeNode {
        int key1;
        int key2;
        treeNode child1;
        treeNode child2;
        treeNode child3;
        treeNode father;

        treeNode root;

        public treeNode(int key1, int key2, treeNode child1, treeNode child2, treeNode
child3, treeNode father) {
            this.key1 = key1;
            this.key2 = key2;
            this.child1 = child1;
            this.child2 = child2;
            this.child3 = child3;
            this.father = father;
        }

        public void printNode(treeNode node, FileWriter outFile) {
            if (isRoot(node)) {
                try {
                    outFile.write("root node\n");
                } catch (IOException e) {

```

```

        e.printStackTrace();
    }
}
// leaf
if (isLeaf(node)) {
    try {
        outFile.write(node.key1 + ", " + node.key2 + ", NULL,
NULL, NULL, " + node.father.key1 + "\n");
    } catch (IOException e) {
        e.printStackTrace();
    }
    // three children
} else if (node.child1 != null && node.child2 != null && node.child3 != null)
{
    try {
        if (isRoot(node)) {
            outFile.write(node.key1 + ", " + node.key2 + ", " +
node.child1.key1 + ", " + node.child2.key1
+ ", " + node.child3.key1 + ", NULL"
+ "\n");
        } else {
            outFile.write(node.key1 + ", " + node.key2 + ", " +
node.child1.key1 + ", " + node.child2.key1
+ ", " + node.child3.key1 + ", " +
node.father.key1 + "\n");
        }
    } catch (IOException e) {
        e.printStackTrace();
    }
    // two children
} else if (node.child1 != null && node.child2 != null && node.child3 == null)
{
    try {
        if (isRoot(node)) {
            outFile.write(node.key1 + ", " + node.key2 + ", " +
node.child1.key1 + ", " + node.child2.key1
+ ", NULL, NULL" + "\n");
        } else {
            outFile.write(node.key1 + ", " + node.key2 + ", " +
node.child1.key1 + ", " + node.child2.key1
+ ", NULL, " + node.father.key1 +
"\n");
        }
    } catch (IOException e) {

```

```

        e.printStackTrace();
    }
    } else {
        System.out.print("error testing leaf, 2 or 3 children");
    }
}
}

public Tree23() {
    // empty
}

public treeNode initialTree(Scanner inFile, FileWriter debugFile) {
    treeNode root = new treeNode(-1, -1, null, null, null, null);
    treeNode high = new treeNode(-1, -1, null, null, null, root);
    root.child1 = high;
    int data1 = inFile.nextInt();
    int data2 = inFile.nextInt();
    if (data1 > data2) {
        data1 = swap(data2, data2 = data1);
    }
    treeNode newNode1 = new treeNode(data1, -1, null, null, null, high);
    treeNode newNode2 = new treeNode(data2, -1, null, null, null, high);
    high.child1 = newNode1;
    high.child2 = newNode2;
    high.key1 = data2;
    high.printNode(high, debugFile);
    return root;
}

public int swap(int data2, int data1) {
    return data2;
}

public treeNode swap(treeNode d2, treeNode d1) {
    return d2;
}

public void preOrder(treeNode node, FileWriter debugFile) {
    if (node == null)
        return;

    node.printNode(node, debugFile);

```

```

        preOrder(node.child1, debugFile);
        preOrder(node.child2, debugFile);
        preOrder(node.child3, debugFile);
    }

    public boolean isLeaf(treeNode node) {
        if (node.child1 == null) {
            return true;
        }
        return false;
    }

    public boolean isRoot(treeNode node) {
        if (node.father.father == null) {
            return true;
        }
        return false;
    }

    public void treeInsert(treeNode spot, treeNode newNode) {
        // two children
        if (spot.child1 != null && spot.child2 != null && spot.child3 == null) {
            treeNode c1 = spot.child1;
            treeNode c2 = spot.child2;
            treeNode c3 = newNode;
            c3.father = spot;
            if (c1.key1 > c2.key1)
                c1 = swap(c2, c2 = c1);
            if (c2.key1 > c3.key1)
                c2 = swap(c3, c3 = c2);
            if (c1.key1 > c2.key1)
                c1 = swap(c2, c2 = c1);
            spot.child1 = c1;
            spot.child2 = c2;
            spot.child3 = c3;
            spot.key1 = findMinSubTree(spot.child2);
            spot.key2 = findMinSubTree(spot.child3);
            updateFather(spot.father);
            // three children
        } else if (spot.child1 != null && spot.child2 != null && spot.child3 != null) {
            treeNode c1 = spot.child1;
            treeNode c2 = spot.child2;
            treeNode c3 = spot.child3;
            treeNode c4 = newNode;

```

```

        c4.father = spot;
        if (c1.key1 > c2.key1)
            c1 = swap(c2, c2 = c1);
        if (c2.key1 > c3.key1)
            c2 = swap(c3, c3 = c2);
        if (c3.key1 > c4.key1)
            c3 = swap(c4, c4 = c3);
        if (c1.key1 > c2.key1)
            c1 = swap(c2, c2 = c1);
        if (c2.key1 > c3.key1)
            c2 = swap(c3, c3 = c2);
        if (c1.key1 > c2.key1)
            c1 = swap(c2, c2 = c1);
        treeNode sibling = new treeNode(-1, -1, null, null, null, spot.father);
        spot.child1 = c1;
        c1.father = spot;
        spot.child2 = c2;
        c2.father = spot;
        spot.child3 = null;
        sibling.child1 = c3;
        c3.father = sibling;
        sibling.child2 = c4;
        c4.father = sibling;
        sibling.child3 = null;
        spot.key1 = findMinSubTree(spot.child2);
        spot.key2 = -1;
        sibling.key1 = findMinSubTree(sibling.child2);
        sibling.key2 = -1;
        updateFather(spot.father);
//        if (sibling == sibling.father.child2 || sibling == sibling.father.child3) {
//            updateFather(sibling.father);
//        }
        if (isRoot(spot)) {
            makeNewRoot(spot, sibling);
        } else {
            treeInsert(spot.father, sibling);
        }
        updateFather(sibling.father);
    }
}

public treeNode findSpot(treeNode spot, int data) {
    if (isLeaf(spot)) {
        System.out.print("You are at leaf level. You are too far down the tree.");
    }
}

```

```

        return null;
    } else if (data == spot.key1 || data == spot.key2) {
        return null;
    } else if (isLeaf(spot.child1)) {
        return spot;
    } else if (spot.child2 == null) {
        return findSpot(spot.child1, data);
    } else if (data < spot.key1) {
        return findSpot(spot.child1, data);
    } else if (spot.key2 == -1 || data < spot.key2) {
        return findSpot(spot.child2, data);
    } else if (spot.key2 != -1 && data >= spot.key2) {
        return findSpot(spot.child3, data);
    } else {
        System.out.print("logic error in spot");
        return null;
    }
}

```

```

public void updateFather(treeNode fatherNode) {
    if (fatherNode.father == null) {
        return;
    }
    fatherNode.key1 = findMinSubTree(fatherNode.child2);
    fatherNode.key2 = findMinSubTree(fatherNode.child3);
    updateFather(fatherNode.father);
}

```

```

public int findMinSubTree(treeNode node) {
    if (node == null) {
        return -1;
    }
    if (isLeaf(node)) {
        return node.key1;
    } else {
        return findMinSubTree(node.child1);
    }
}

```

```

public void makeNewRoot(treeNode spot, treeNode sibling) {
    treeNode newRoot = new treeNode(-1, -1, spot, sibling, null, spot.father);
    spot.father = newRoot;
    sibling.father = newRoot;
    newRoot.father.child1 = newRoot;
}

```



```
newRoot.key1 = findMinSubTree(sibling);  
    }  
}
```

Argv[1] output1 debugFile:

root node

234, -1, 54, 234, NULL, NULL

spot node

root node

234, -1, 54, 234, NULL, NULL

root node

112, 234, 54, 112, 234, NULL

54, -1, NULL, NULL, NULL, 112

112, -1, NULL, NULL, NULL, 112

234, -1, NULL, NULL, NULL, 112

spot node

root node

112, 234, 54, 112, 234, NULL

root node

112, -1, 54, 234, NULL, NULL

54, -1, 9, 54, NULL, 112

9, -1, NULL, NULL, NULL, 54

54, -1, NULL, NULL, NULL, 54

234, -1, 112, 234, NULL, 112

112, -1, NULL, NULL, NULL, 234

234, -1, NULL, NULL, NULL, 234

spot node

54, -1, 9, 54, NULL, 112

root node

112, -1, 54, 234, NULL, NULL

54, 74, 9, 54, 74, 112

9, -1, NULL, NULL, NULL, 54

54, -1, NULL, NULL, NULL, 54

74, -1, NULL, NULL, NULL, 54

234, -1, 112, 234, NULL, 112

112, -1, NULL, NULL, NULL, 234

234, -1, NULL, NULL, NULL, 234

spot node

54, 74, 9, 54, 74, 112

root node

54, 112, 35, 74, 234, NULL

35, -1, 9, 35, NULL, 54

9, -1, NULL, NULL, NULL, 35

35, -1, NULL, NULL, NULL, 35

74, -1, 54, 74, NULL, 54

54, -1, NULL, NULL, NULL, 74

74, -1, NULL, NULL, NULL, 74
234, -1, 112, 234, NULL, 54
112, -1, NULL, NULL, NULL, 234
234, -1, NULL, NULL, NULL, 234
spot node
35, -1, 9, 35, NULL, 54
root node
54, 112, 11, 74, 234, NULL
11, 35, 9, 11, 35, 54
9, -1, NULL, NULL, NULL, 11
11, -1, NULL, NULL, NULL, 11
35, -1, NULL, NULL, NULL, 11
74, -1, 54, 74, NULL, 54
54, -1, NULL, NULL, NULL, 74
74, -1, NULL, NULL, NULL, 74
234, -1, 112, 234, NULL, 54
112, -1, NULL, NULL, NULL, 234
234, -1, NULL, NULL, NULL, 234
spot node
11, 35, 9, 11, 35, 54
root node
54, -1, 22, 112, NULL, NULL
22, -1, 11, 35, NULL, 54
11, -1, 9, 11, NULL, 22
9, -1, NULL, NULL, NULL, 11
11, -1, NULL, NULL, NULL, 11
35, -1, 22, 35, NULL, 22
22, -1, NULL, NULL, NULL, 35
35, -1, NULL, NULL, NULL, 35
112, -1, 74, 234, NULL, 54
74, -1, 54, 74, NULL, 112
54, -1, NULL, NULL, NULL, 74
74, -1, NULL, NULL, NULL, 74
234, -1, 112, 234, NULL, 112
112, -1, NULL, NULL, NULL, 234
234, -1, NULL, NULL, NULL, 234
spot node
35, -1, 22, 35, NULL, 22
root node
54, -1, 22, 112, NULL, NULL
22, -1, 11, 33, NULL, 54
11, -1, 9, 11, NULL, 22
9, -1, NULL, NULL, NULL, 11
11, -1, NULL, NULL, NULL, 11

33, 35, 22, 33, 35, 22
22, -1, NULL, NULL, NULL, 33
33, -1, NULL, NULL, NULL, 33
35, -1, NULL, NULL, NULL, 33
112, -1, 74, 234, NULL, 54
74, -1, 54, 74, NULL, 112
54, -1, NULL, NULL, NULL, 74
74, -1, NULL, NULL, NULL, 74
234, -1, 112, 234, NULL, 112
112, -1, NULL, NULL, NULL, 234
234, -1, NULL, NULL, NULL, 234
spot node
74, -1, 54, 74, NULL, 112
root node
54, -1, 22, 112, NULL, NULL
22, -1, 11, 33, NULL, 54
11, -1, 9, 11, NULL, 22
9, -1, NULL, NULL, NULL, 11
11, -1, NULL, NULL, NULL, 11
33, 35, 22, 33, 35, 22
22, -1, NULL, NULL, NULL, 33
33, -1, NULL, NULL, NULL, 33
35, -1, NULL, NULL, NULL, 33
112, -1, 55, 234, NULL, 54
55, 74, 54, 55, 74, 112
54, -1, NULL, NULL, NULL, 55
55, -1, NULL, NULL, NULL, 55
74, -1, NULL, NULL, NULL, 55
234, -1, 112, 234, NULL, 112
112, -1, NULL, NULL, NULL, 234
234, -1, NULL, NULL, NULL, 234
spot node
55, 74, 54, 55, 74, 112
root node
54, -1, 22, 74, NULL, NULL
22, -1, 11, 33, NULL, 54
11, -1, 9, 11, NULL, 22
9, -1, NULL, NULL, NULL, 11
11, -1, NULL, NULL, NULL, 11
33, 35, 22, 33, 35, 22
22, -1, NULL, NULL, NULL, 33
33, -1, NULL, NULL, NULL, 33
35, -1, NULL, NULL, NULL, 33
74, 112, 55, 98, 234, 54

55, -1, 54, 55, NULL, 74
54, -1, NULL, NULL, NULL, 55
55, -1, NULL, NULL, NULL, 55
98, -1, 74, 98, NULL, 74
74, -1, NULL, NULL, NULL, 98
98, -1, NULL, NULL, NULL, 98
234, -1, 112, 234, NULL, 74
112, -1, NULL, NULL, NULL, 234
234, -1, NULL, NULL, NULL, 234
spot node
234, -1, 112, 234, NULL, 74
root node
54, -1, 22, 74, NULL, NULL
22, -1, 11, 33, NULL, 54
11, -1, 9, 11, NULL, 22
9, -1, NULL, NULL, NULL, 11
11, -1, NULL, NULL, NULL, 11
33, 35, 22, 33, 35, 22
22, -1, NULL, NULL, NULL, 33
33, -1, NULL, NULL, NULL, 33
35, -1, NULL, NULL, NULL, 33
74, 112, 55, 98, 234, 54
55, -1, 54, 55, NULL, 74
54, -1, NULL, NULL, NULL, 55
55, -1, NULL, NULL, NULL, 55
98, -1, 74, 98, NULL, 74
74, -1, NULL, NULL, NULL, 98
98, -1, NULL, NULL, NULL, 98
234, 351, 112, 234, 351, 74
112, -1, NULL, NULL, NULL, 234
234, -1, NULL, NULL, NULL, 234
351, -1, NULL, NULL, NULL, 234
spot node
33, 35, 22, 33, 35, 22
root node
54, -1, 22, 74, NULL, NULL
22, 33, 11, 27, 35, 54
11, -1, 9, 11, NULL, 22
9, -1, NULL, NULL, NULL, 11
11, -1, NULL, NULL, NULL, 11
27, -1, 22, 27, NULL, 22
22, -1, NULL, NULL, NULL, 27
27, -1, NULL, NULL, NULL, 27
35, -1, 33, 35, NULL, 22

33, -1, NULL, NULL, NULL, 35
35, -1, NULL, NULL, NULL, 35
74, 112, 55, 98, 234, 54
55, -1, 54, 55, NULL, 74
54, -1, NULL, NULL, NULL, 55
55, -1, NULL, NULL, NULL, 55
98, -1, 74, 98, NULL, 74
74, -1, NULL, NULL, NULL, 98
98, -1, NULL, NULL, NULL, 98
234, 351, 112, 234, 351, 74
112, -1, NULL, NULL, NULL, 234
234, -1, NULL, NULL, NULL, 234
351, -1, NULL, NULL, NULL, 234
spot node
98, -1, 74, 98, NULL, 74
root node
54, -1, 22, 74, NULL, NULL
22, 33, 11, 27, 35, 54
11, -1, 9, 11, NULL, 22
9, -1, NULL, NULL, NULL, 11
11, -1, NULL, NULL, NULL, 11
27, -1, 22, 27, NULL, 22
22, -1, NULL, NULL, NULL, 27
27, -1, NULL, NULL, NULL, 27
35, -1, 33, 35, NULL, 22
33, -1, NULL, NULL, NULL, 35
35, -1, NULL, NULL, NULL, 35
74, 112, 55, 90, 234, 54
55, -1, 54, 55, NULL, 74
54, -1, NULL, NULL, NULL, 55
55, -1, NULL, NULL, NULL, 55
90, 98, 74, 90, 98, 74
74, -1, NULL, NULL, NULL, 90
90, -1, NULL, NULL, NULL, 90
98, -1, NULL, NULL, NULL, 90
234, 351, 112, 234, 351, 74
112, -1, NULL, NULL, NULL, 234
234, -1, NULL, NULL, NULL, 234
351, -1, NULL, NULL, NULL, 234
spot node
11, -1, 9, 11, NULL, 22
root node
54, -1, 22, 74, NULL, NULL
22, 33, 11, 27, 35, 54

11, 18, 9, 11, 18, 22
9, -1, NULL, NULL, NULL, 11
11, -1, NULL, NULL, NULL, 11
18, -1, NULL, NULL, NULL, 11
27, -1, 22, 27, NULL, 22
22, -1, NULL, NULL, NULL, 27
27, -1, NULL, NULL, NULL, 27
35, -1, 33, 35, NULL, 22
33, -1, NULL, NULL, NULL, 35
35, -1, NULL, NULL, NULL, 35
74, 112, 55, 90, 234, 54
55, -1, 54, 55, NULL, 74
54, -1, NULL, NULL, NULL, 55
55, -1, NULL, NULL, NULL, 55
90, 98, 74, 90, 98, 74
74, -1, NULL, NULL, NULL, 90
90, -1, NULL, NULL, NULL, 90
98, -1, NULL, NULL, NULL, 90
234, 351, 112, 234, 351, 74
112, -1, NULL, NULL, NULL, 234
234, -1, NULL, NULL, NULL, 234
351, -1, NULL, NULL, NULL, 234
spot node
35, -1, 33, 35, NULL, 22
root node
54, -1, 22, 74, NULL, NULL
22, 33, 11, 27, 35, 54
11, 18, 9, 11, 18, 22
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11, -1, NULL, NULL, NULL, 11
18, -1, NULL, NULL, NULL, 11
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27, -1, NULL, NULL, NULL, 27
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35, -1, NULL, NULL, NULL, 35
36, -1, NULL, NULL, NULL, 35
74, 112, 55, 90, 234, 54
55, -1, 54, 55, NULL, 74
54, -1, NULL, NULL, NULL, 55
55, -1, NULL, NULL, NULL, 55
90, 98, 74, 90, 98, 74
74, -1, NULL, NULL, NULL, 90

90, -1, NULL, NULL, NULL, 90
98, -1, NULL, NULL, NULL, 90
234, 351, 112, 234, 351, 74
112, -1, NULL, NULL, NULL, 234
234, -1, NULL, NULL, NULL, 234
351, -1, NULL, NULL, NULL, 234
spot node
234, 351, 112, 234, 351, 74
root node
54, 112, 22, 74, 351, NULL
22, 33, 11, 27, 35, 54
11, 18, 9, 11, 18, 22
9, -1, NULL, NULL, NULL, 11
11, -1, NULL, NULL, NULL, 11
18, -1, NULL, NULL, NULL, 11
27, -1, 22, 27, NULL, 22
22, -1, NULL, NULL, NULL, 27
27, -1, NULL, NULL, NULL, 27
35, 36, 33, 35, 36, 22
33, -1, NULL, NULL, NULL, 35
35, -1, NULL, NULL, NULL, 35
36, -1, NULL, NULL, NULL, 35
74, -1, 55, 90, NULL, 54
55, -1, 54, 55, NULL, 74
54, -1, NULL, NULL, NULL, 55
55, -1, NULL, NULL, NULL, 55
90, 98, 74, 90, 98, 74
74, -1, NULL, NULL, NULL, 90
90, -1, NULL, NULL, NULL, 90
98, -1, NULL, NULL, NULL, 90
351, -1, 234, 613, NULL, 54
234, -1, 112, 234, NULL, 351
112, -1, NULL, NULL, NULL, 234
234, -1, NULL, NULL, NULL, 234
613, -1, 351, 613, NULL, 351
351, -1, NULL, NULL, NULL, 613
613, -1, NULL, NULL, NULL, 613
spot node
11, 18, 9, 11, 18, 22
root node
54, -1, 22, 112, NULL, NULL
22, -1, 11, 33, NULL, 54
11, -1, 9, 18, NULL, 22
9, -1, 3, 9, NULL, 11

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9, -1, NULL, NULL, NULL, 9
18, -1, 11, 18, NULL, 11
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18, -1, NULL, NULL, NULL, 18
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27, -1, 22, 27, NULL, 33
22, -1, NULL, NULL, NULL, 27
27, -1, NULL, NULL, NULL, 27
35, 36, 33, 35, 36, 33
33, -1, NULL, NULL, NULL, 35
35, -1, NULL, NULL, NULL, 35
36, -1, NULL, NULL, NULL, 35
112, -1, 74, 351, NULL, 54
74, -1, 55, 90, NULL, 112
55, -1, 54, 55, NULL, 74
54, -1, NULL, NULL, NULL, 55
55, -1, NULL, NULL, NULL, 55
90, 98, 74, 90, 98, 74
74, -1, NULL, NULL, NULL, 90
90, -1, NULL, NULL, NULL, 90
98, -1, NULL, NULL, NULL, 90
351, -1, 234, 613, NULL, 112
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112, -1, NULL, NULL, NULL, 234
234, -1, NULL, NULL, NULL, 234
613, -1, 351, 613, NULL, 351
351, -1, NULL, NULL, NULL, 613
613, -1, NULL, NULL, NULL, 613
spot node
9, -1, 3, 9, NULL, 11
root node
54, -1, 22, 112, NULL, NULL
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6, 9, 3, 6, 9, 11
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6, -1, NULL, NULL, NULL, 6
9, -1, NULL, NULL, NULL, 6
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11, -1, NULL, NULL, NULL, 18
18, -1, NULL, NULL, NULL, 18
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27, -1, 22, 27, NULL, 33

22, -1, NULL, NULL, NULL, 27
27, -1, NULL, NULL, NULL, 27
35, 36, 33, 35, 36, 33
33, -1, NULL, NULL, NULL, 35
35, -1, NULL, NULL, NULL, 35
36, -1, NULL, NULL, NULL, 35
112, -1, 74, 351, NULL, 54
74, -1, 55, 90, NULL, 112
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argv [2] outfile2 treeFile

112 data is in the database, no need to insert

36 data is in the database, no need to insert

18 data is in the database, no need to insert