

CS106X

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Solutions

PRACTICE FINAL EXAM 1 - SOLUTIONS

1. Graphs

```
Vertex* findLargestTree(BasicGraph& graph) {
    int largestTreeSize = 0;
    Vertex* largestTreeRoot = NULL;

    for (Vertex* v : graph.getVertexSet()) {
        graph.resetData();

        int treeSize = findLargestTree(v, graph);
        if (treeSize > largestTreeSize) {
            largestTreeRoot = v;
            largestTreeSize = treeSize;
        }
    }

    return largestTreeRoot;
}

int findLargestTree(Vertex* v, BasicGraph& graph) {
    if (v == NULL) return 0;
    if (v->visited) return -1;

    v->visited = true;
    int treeSize = 1;
    for (Edge* e : v->edges) {
        int subTreeSize = findLargestTree(e->finish, graph);
        if (subTreeSize < 0) return -1;
        treeSize += subTreeSize;
    }
    return treeSize;
}
```

2. Pointers and Linked Lists

```

struct listnode {
    int val;
    listnode * next;
};

bool contains(listnode* list, listnode* sub) {
    if (sub == NULL) {
        return true;
    } else if (list == NULL) {
        return false;
    }

    if (list->val == sub->val) {
        return contains(list->next, sub->next);
    } else {
        return contains(list->next, sub);
    }
}

```

3. Recursion

```

Set<int> maxSumSubset (treenode* root) {
    if (root == NULL) return Set<int>();

    Set<int> childSet = maxSumSubset(root->left) +
                        maxSumSubset(root->middle) +
                        maxSumSubset(root->right);

    int childSum = 0;
    for (int i : childSet) {
        childSum += i;
    }

    if (childSum > root->key) {
        return childSet;
    } else {
        Set<int> us;
        us += root->key;
        return us;
    }
}

```

4. BSTs and Heaps

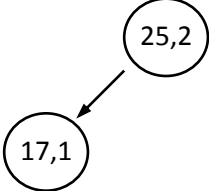
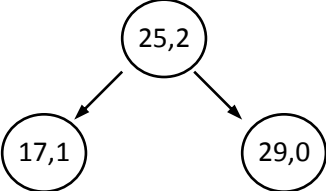
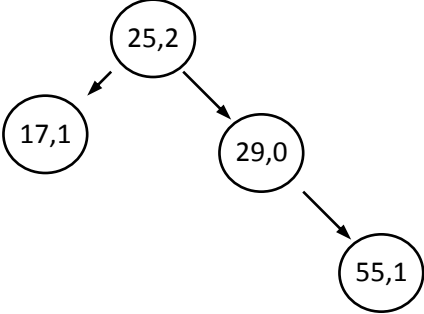
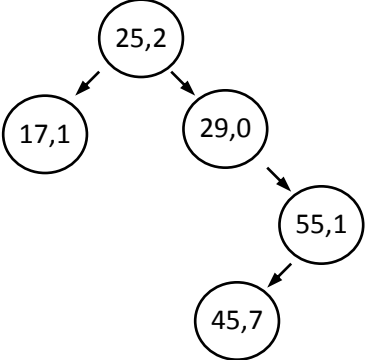
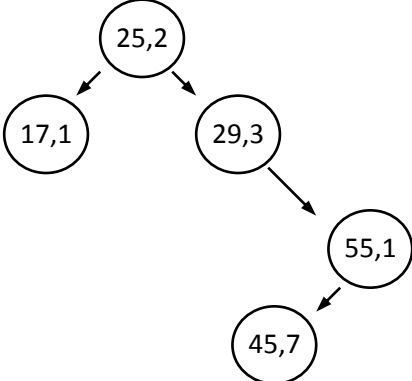
Diagram after inserting (25,2):  <i>This one is completed for you.</i>	Diagram after inserting (17,1): 
Diagram after inserting (29,0): 	Diagram after inserting (55,1): 
Diagram after inserting (45,7): 	Diagram after inserting (29,3): 

Diagram after inserting 25:



This one is completed for you.

Diagram after inserting 37:

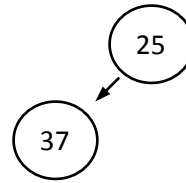


Diagram after inserting 28:

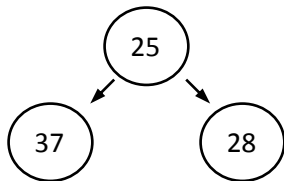


Diagram after inserting 12:

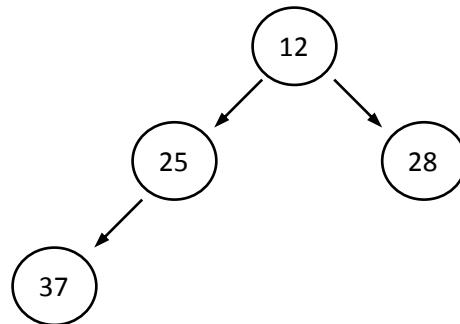


Diagram after inserting 30:

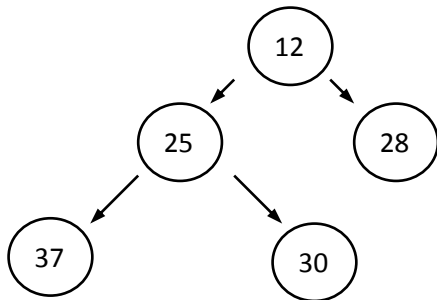
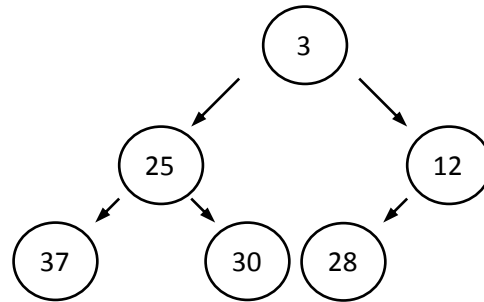


Diagram after inserting 3:



5. Inheritance

```
class Byron {
public:
    virtual void m3() {
        cout << "B 3" << endl;
        m1();
    }

    virtual void m1() {
        cout << "B 1" << endl;
    }
};
```

```
class Yeats : public Byron {
public:
    virtual void m3() {
        Byron::m3();
        cout << "Y 3" << endl;
    }

    virtual void m4() {
        cout << "Y 4" << endl;
    }
};
```

```
class Plath : public Yeats {
public:
    virtual void m1() {
        cout << "P 1" << endl;
        Yeats::m1();
    }

    void m3() {
        cout << "P 3" << endl;
    }
};
```

```
class Angelou : public Plath {
public:
    virtual void m4() {
        cout << "A 4" << endl;
        m3();
    }

    void m3() {
        cout << "A 3" << endl;
    }
};
```

Now assume that the following variables are defined:

```
Byron* var1 = new Plath();
Yeats* var2 = new Angelou();
Byron* var3 = new Byron();
Byron* var4 = new Yeats();
Yeats* var5 = new Plath();
```

In the table below, indicate in the right-hand column the output produced by the statement in the left-hand column. If the statement produces more than one line of output, indicate the **line breaks with slashes** as in "x/y/z" to indicate three lines of output with "x" followed by "y" followed by "z".

If the statement does not compile, write "**compiler error**". If a statement would crash at runtime or cause unpredictable behavior, write "**crash**".

<u>Statement</u>	<u>Output</u>
var4->m3();	B 3 / B 1 / Y 3
var4->m1();	B 1
var4->m4();	COMPILER ERROR
var2->m3();	A 3
var2->m1();	P 1 / B 1
var2->m4();	A 4 / A 3
var1->m4();	COMPILER ERROR
var1->m3();	P 3
var1->m1();	P 1 / B 1
var5->m1();	P 1 / B 1
var5->m4();	Y 4
var5->m3();	P 3

<u>Statement</u>	<u>Output</u>
((Yeats*) var4)->m3();	B 3 / B 1 / Y 3
((Yeats*) var4)->m4();	Y 4
((Angelou*) var3)->m4();	CRASH
((Byron*) var5)->m4();	COMPILER ERROR
((Plath*) var2)->m3();	A 3
((Angelou*) var2)->m3();	A 3

6. Algorithms

(a)

$O(\log n)$

If n is even, we divide by two, otherwise we add one to n . Clearly, **Binky** cannot add one to n twice in a row. There must therefore be at least as many steps where we divide n by 2 as there can be steps where we add one to n . As n gets large, the number of times we have to divide n by two will be the factor that determines how quickly we approach zero or one. There can be at most $\log(n)$ of those steps, so the running time is therefore $O(\log n)$

(b)

Does this strategy work? YES **NO** (circle) Briefly explain why or why not:

If we are deleting the last cell in the list, **ptr->next** is **NULL**. When try to access assign to ***(ptr)** in the next line, the right hand side will dereference **NULL** and crash.

(c)

	Worst-case big-O
1.	$O(n^2)$
2.	$O(n \log(n))$
3.	$O(n^2)$
