CS106B Instructor: Cynthia Lee

Autumn 2017 Solutions

PRACTICE FINAL EXAM 3 - SOLUTIONS

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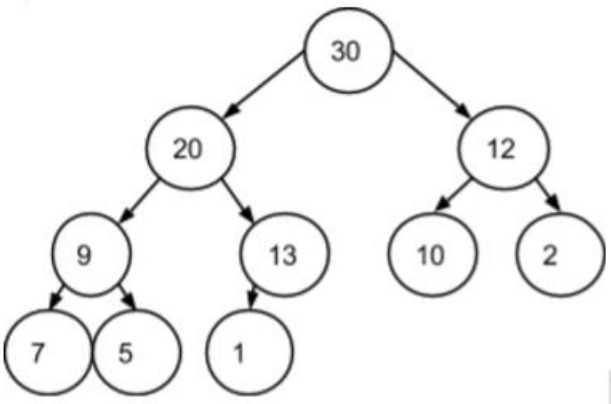
1. Sorting

9	4	8	5	1	2	3	7	6
4	9	8	5	1	2	3	7	6
4	8	9	5	1	2	3	7	6
4	5	8	9	1	2	3	7	6
1	4	5	8	9	2	3	7	6
1	2	4	5	8	9	3	7	6
1	2	3	4	5	8	9	7	6
1	2	3	4	5	7	8	9	6
1	2	3	4	5	6	7	8	9

2. Heap



Circle: YES

3. BST

(5,2)	(5,5)
(5,5) \ (9,3)	(5,5) \ (9,3) / (6,12)
(5,5) \ (9,3) / (6,12) \ (7,5)	(5,5) \ (9,3) / (6,12) \ (7,5) \ (8,1)

4. Trees

```
Node* makeTree(Stack<Node*>& expression) {
   Node* tree = NULL;
   if (!expression.isEmpty()) {
      tree = expression.pop();
      if (current->operator == '+') {
         tree->left = makeTree(expression);
         tree->right = makeTree(expression);
      }
   }
   return tree;
}
```

5. Hashing

```
struct node {
  int val;
  node* left;
  node* right;
};
const int P = 715827883;
const int Q = 2796203;

Map<int, Vector<node*>> simulateTreeHash(Vector<node*> trees, int k) {
  Map<int, Vector<node*>> result;
  for (node* root : trees) {
```

```
    int key = hash(root, k);
    result[key] += root;
  }
  return result;
}

int hash(node *root, int k) {
  if(root == NULL) return 1;
  return (P * hash(root->left, k) * h(root->val)
         + Q * hash(root->right, k)) % k;
}
```

6. Graphs and Classes

```
/* This solution uses some structs and a Map to implement its own version of
 * Graph ADT, using the Adjacency List style of Graph representation that we
 * learned in class (instead of the full BasicGraph class). It is also
 * reasonable to solve it with BasicGraph.
 */
class LifeGame {
public:
   void initializeCells(string filename);
   void updateCells();
   void printCells();
private:      //this may be more space than you need
   struct edge {
     int start;
     int end;
     int weight;
   }
   struct cell {
     Vector<edge> friends;
     bool alive;
   }
   Map<int, cell> graph;

   getFriends(int center, int dist, Set<int> result);
   countFriends(int center);
};


static const int MAXDIST = 20;

#include <iostream>

void LifeGame::initializeCells(string filename){
```

```
   ifstream myfile;
   myfile.open(filename);
   int numCells;
   myfile >> numCells;
   for (int i = 0; i < numCells; i++) {
      graph[i].alive = getRandomInteger(0, 1);
      for (int j = 0; j < numCells; j++) {
         int weight;
         myfile >> weight;
         if (weight > 0) {
            edge e = {i, j, weight};
            graph[i].friends += e;
         }
      }
   }
}

void LifeGame::updateCells() {

  Map<int, int> counts;
  for (int key : graph) {
     counts[key] = countFriends(key);
  }
  for (int key : graph) {
     if (counts[key] < 2 || counts[key] > 3) {
        graph[key].alive = false;
     } else if (counts[key] == 3) {
        graph[key].alive = true;
     }
  }
}

void LifeGame::getFriends(int center, int dist, Set<int>& result){
  if (result.contains(center)) return; // We've been here before
  result.add(center);
  for (edge e : graph[center].neighbors) {
     if (dist >= e.weight) {
        getFriends(e.end, dist – e.weight, result);
     }
  }
}

int LifeGame::countFriends(int center) {
   Set<int> friends;
   getFriends(center, MAXDIST, friends);
   int count = 0;
   for (int friendID : friends) {
```

```
      if (graph[friendID].alive) count++;
   }
   return count;
}
```
