CS314 Spring 2017 Final Exam Solution and Grading Criteria.

Grading acronyms:

AIOBE - Array Index out of Bounds Exception may occur

BOD - Benefit of the Doubt. Not certain code works, but, can't prove otherwise

Gacky or Gack - Code very hard to understand even though it works. (Solution is not elegant.)

LE - Logic error in code.

NN - Not necessary. Code is unneeded. Generally no points off

NPE - Null Pointer Exception may occur

OBOE - Off by one error. Calculation is off by one.

RTQ - Read the question. Violated restrictions or made incorrect assumption.

1. Answer as shown or -1 unless question allows partial credit.

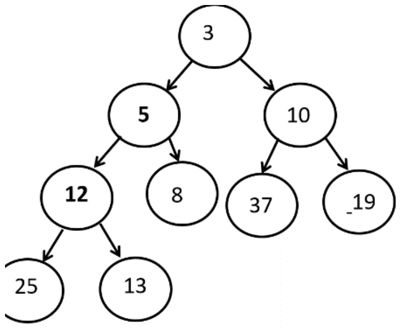
A. 1

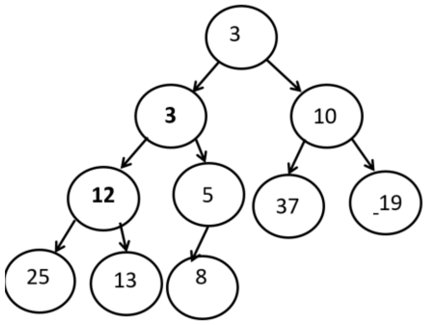
B. 32

C. Adjacency Matrix. Simply need to check all N vertices. With adjacency list must check each Vertex's list of edges.

D. Because most graphs are sparse and an adjacency matrix wastes a lot of space given sparse graphs.

E. --->





F.

G. O(N) when we have to do a linear search and there are no or few null values left in the hash table. (or words to that affect)

H. Each distinct path from a node to each null link must contain the same number of black nodes

I. 5 bits

J. .00048 seconds

K. 52

L. 80 seconds. (Radix sort O(NlogMax) and logMax hasn't changed.)

M. 2 seconds (best case with min heap implementation)

N. O(N^2logN)

O. O(NlogN)

P. 14 (D to C to I to H to G)

Q. 37

R. 30 14 6

S. 30 to 50 inclusive

T. 42 / 5 seconds or 8.4 seconds

2. Comments.

```
    public int insertAndRemove(E insertAfter, E insertVal, E remove) {
     // remove targets at front;
     while (first != null && first.data.equals(remove))
         first = first.next;
     if (first != null)
          first.prev = null;
     int numElements = 0;
     Node<E> temp = first;
     while (temp != null) {
         numElements++;
         if (temp.data.equals(insertAfter)) {
             Node<E> newNode = new Node<>();
             newNode.data = insertVal;
             newNode.prev = temp;
             newNode.next = temp.next;
             if (temp.next != null)
                 temp.next.prev = newNode;
             temp.next = newNode;
         } else if (temp.data.equals(remove)) {
             numElements--;
             temp.prev.next = temp.next;
             if (temp.next != null)
                 temp.next.prev = temp.prev;
         }
         temp = temp.next;
     }
     return numElements;
 }
```

16 points , Criteria:

- special case for removing elements from front and adjusting front (can be special case in general loop), 3 points
- Loop until end of list, 2 points
- if target add, add correctly, 3 points
- remove correctly, 3 points
- move temp reference down in list correctly, 3 points
- count and return number of elements in list, 2 points

Other penalties:

- == instead of .equals -4 once
- disallowed methods, add (-6), remove(-6)
- worse than O(N), -6
- doesn't handle last case / nulls -2
- Comparing Nodes not data in Nodes - 5

3. Suggested Solution:

```
    public int makePerfectToGivenDepth(int depth, int newVal) {
        int oldSize = size;
        root = perfectHelp(root, depth, 0, newVal);
        return size - oldSize;
    }

    private BNode perfectHelp(BNode n, int targetDepth, int currentDepth,
                                                               int newVal) {
        if (currentDepth <= targetDepth) {
            if (n == null) {
                // need a node at this level
                n = new BNode(newVal);
                size++;
            }
            int newDepth = currentDepth + 1;
            n.left = perfectHelp(n.left, targetDepth, newDepth, newVal);
            n.right = perfectHelp(n.right, targetDepth, newDepth, newVal);
        }
        // else too deep, nothing to do
        return n;
    }
```

16 points, Criteria:

- create helper with correct params, 2 points
- return correct value of nodes added, 2 points
- base case for beyond target depth, 2 points
- If null node, create new node, 3 points
- if null node increment size instance var, 2 points
- recursive calls with new depth and child nodes correct, 3 points

Other deductions:

- doesn't return / set references or use look ahead correctly, -6

4.
```java
public static void updateRefCount(int objectRef,
                                                 Map<Integer, int[]> refMap) {
    if (objectRef > 0) {
        // adding a reference
        int[] count = refMap.get(objectRef);
        if (count == null) {
            // first reference
            refMap.put(objectRef, new int[]{1});
        } else {
            // increment count
            count[0]++; // no need to put back due reference
        }
    } else {
        // decrementing a reference
        objectRef *= -1;
        int[] count = refMap.get(objectRef);
        if (count != null) {
            count[0]--;
            if (count[0] == 0) {
                // Uh-oh. Need to remove and decrement things I refer to
                refMap.remove(objectRef);
                for (int i = 1; i < count.length; i++) {
                    updateRefCount(-count[i], refMap);
                }
            }
        }
    }
}
```
16 points, Criteria:

- determine increment or decrement case correctly, 1 point
- increment reference case
- check if key present correctly, 1 point
- if key not present, put key and new array with 1 element and value of 1, 2 points
- if key present, increment ref count, element 1 in array, no need to put again due to refs, 1 point
- decrement reference case
- flip int back to positive, 1 point
- check key present, 1 point
- get array of ints correctly, 1 point
- decrement first element of array, 1 point (no need to put back due to refs)
- if count is 0, remove key from map, 2 points
- loop correctly through references, 2 points (must start at 1)
- correctly decrementing references, 3 points (iterative or recursive)

Other:

- any iteration through all of keys or values, -6
- using contains, - 2
- incrementing all ref counts, -3

```
5. public double dfsPathCost(String start, String dest) {

        if (vertices.get(start) == null
                || vertices.get(dest) == null) {
            return -1;
        } else {
            clearAll();
            return dfsHelp(vertices.get(start), dest);
        }
    }

    private double dfsHelp(Vertex current, String dest) {
        if (current.name.equals(dest)) {
            return 0;
        } else {
            if (current.scratch == 1) {
                return -1; // going in a circle
            }
            // mark the node so we don't go in circles
            current.scratch = 1;
            for (Edge e : current.adjacent) {
                // try the edge
                double result = dfsHelp(e.dest, dest);
                if (result != -1) {
                    // found a solution, add my cost
                    return result + e.cost;
                    e.dest.prev = current;
                }
                // loop just tries the next one
                // nothing to undo
            }
            return -1; // never found a solution
        }
    }
```

16 points, Criteria:

- return -1 if either vertex not present, 1 point
- call to setPrev, 1 point
- call recursive helper method, 1 point
- success base case in recursive helper (can be in loop), 2 points
- failure base case, scratch != 0, going in a circle return -1, 3 points
- mark scratch to prevent cycles, 1 point
- loop through edges of current, 2 points
- recursive call with new current, 2 points
- check result of recursive call, set prev, return cost of edge if != -1, 2 points
- return false after loop, 1 point

Other:

- not recursive backtracking, -6, other data structures, -6, not calling clearAll - 2
- early return -6, not stopping on success, -6,

6. Comments:

```
QUESTION: Compression if average run length > 9 (or words to that affect)

    public static int bitsSaved(BitInputStream in) {
        int originalBits = 0;
        int compressedBits = 0;
        int previousBit = in.readBits(1);
        int count = 1;
        while (previousBit != -1) {
            originalBits++;
            int currentBit = in.readBits(1);
            if (currentBit != previousBit) {
                // End of a run.
                compressedBits += bitsNeeded(count);
                count = 1;
                previousBit = currentBit;
            } else {
                count++;
            }
        }
        // take care of the last run
        compressedBits += bitsNeeded(count);
        return originalBits - compressedBits;
    }
    private static int bitsNeeded(int runLength) {
        // How many chunks to write?
        int chunks = runLength / 256;
        int result = 9 * chunks;
        if (runLength % 256 > 0) {
            result += 9;
        }
        return result;
    }
```

16 points, Criteria:

- answer question correctly, 2 point
- variables for original bits, compressed bits, current count: 1 point
- loop until read returns -1, 1 point
- read and compare current bit to previous bit read, 2 point
- continue run, increment counter, 1 point
- end of run (or 256 bits), calculate compressed bits correctly, 4 points
- change previous bit at end of run, 1 point
- get last run of bits, 3 points
- return correct answer, 1 point

Other:
any other classes or data structures, -2 to -8 depending on severity
read a byte at a time, -2, missing mod -2, uses Strings (efficiency) -6, using nonexistent iterator - 5