



CSE2010: DATA STRUCTURES AND ALGORITHMS
FLORIDA TECH, COMPUTER SCIENCES
FALL 2007
FINAL EXAM

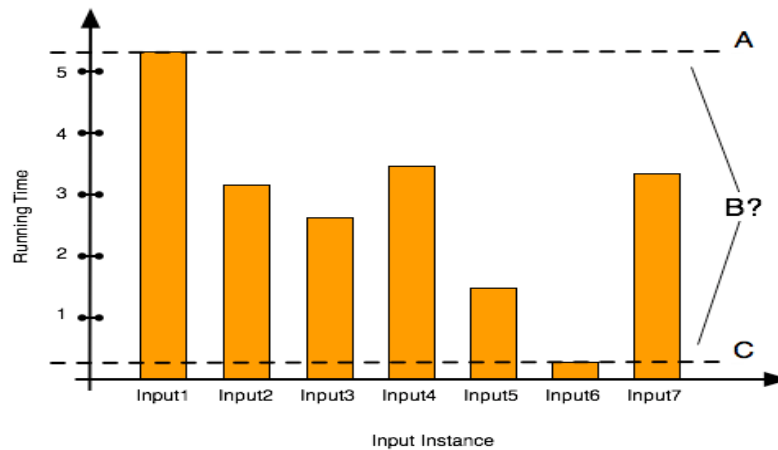
- Read the whole exam before starting.
- Questions will be answered **only** in the first 15 minutes.
- Clearly indicate/write your answer.
- All answers should be written in the papers provided. No scratch paper will be accepted.
- This is a closed-book exam.
- The duration of the exam is 2 hours. I'll let you know when you have 30 minutes left and 10 minutes left.
- You cannot leave the examination before 40 minutes. This is to allow for students who may be running late.
- Good luck!

Name:
Student ID (Last 4 Digits):

MULTIPLE-CHOICE QUESTIONS (5 points/question)

1. How can one define *the running time of an algorithm*?
 - (a) It is the amount of time the implementation of the algorithm would take when it is implemented in a computer
 - (b) It is a function of the input size of algorithm that describes the number of steps taken in that algorithm.
 - (c) It is measurement of how many lines of code the algorithm has.
 - (d) It is a measurement used in algorithm design that allows us to decide what language should be used in the implementation of the algorithm.
 - (e) None of the above.
2. Throughout the semester we have studied many algorithms. Which function below cannot be used to describe the running time of any of the algorithms we studied?
 - (a) $f(n) = n$
 - (b) $f(n) = \log n$
 - (c) $f(n) = \text{sqrt}(n)$
 - (d) $f(n) = n \log n$
 - (e) $f(n) = n^2$

3. Given the graph below where the y-axis represents the running time of a specific algorithm and the x-axis represents several input instances. What can we say A, B and C respectively represents?



- (a) Best Case, Average Case, Worst Case
 (b) Average Case, Worst Case, Best Case
 (c) Average Case, Best Case, Worst Case
 (d) Worst Case, Average Case, Best Case
 (e) Worst Case, Best Case, Average Case
4. What is the output of the recursive algorithm below?

```
Recursive(A,n)
  Input: An integer array A and an integer n>=1, such that n is the length
        of A.

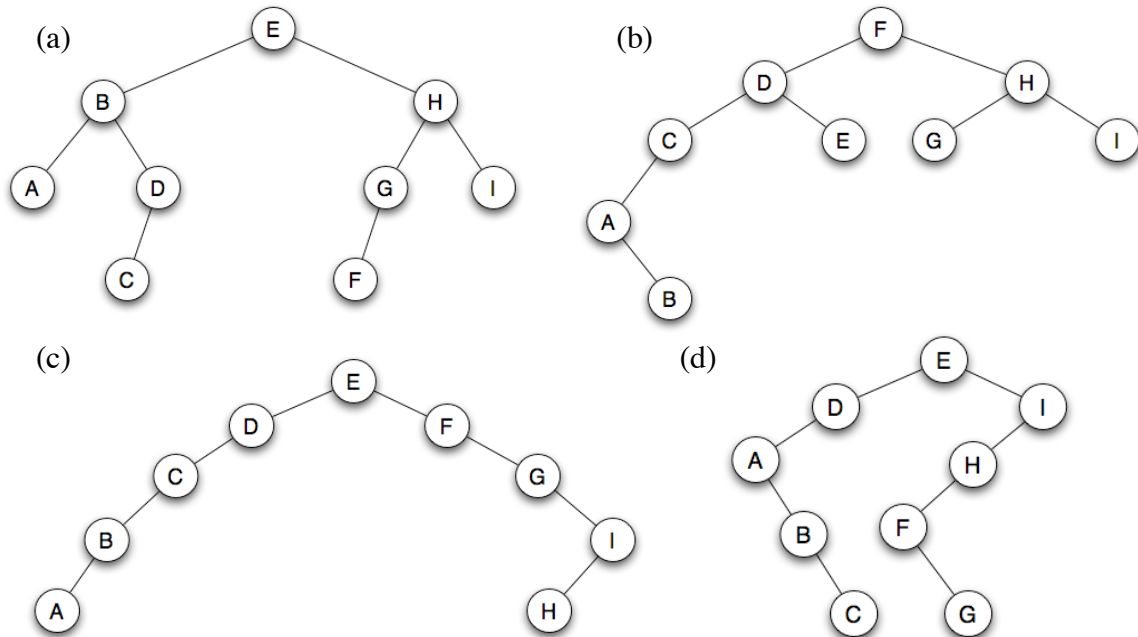
  if n == 1 then
    return A[0]
  else
    return Recursive(A,n-1)+A[n-1]
```

- (a) The output is the length of the array
 (b) The output is max element in the array
 (c) The output is the sum of all elements in the array
 (d) The output is the value of the last element in the array
 (e) The output is the value of the first element in the array
5. In a job interview you're asked about the data structure that could help solve the problem of *matching parentheses*. The problem consists of reading an array of n characters each of which is either an open or a close parenthesis, and output true of false depending on whether they match or not. For instance, $((()))$ does match but $()()$ and $((()))$ does not match.

What data structure below would you pick as the most appropriate to help you solving the aforementioned problem?

- (a) AVL Tree
 (b) B-Tree
 (c) Queue
 (d) Stack
 (e) Hash Table.

6. Which binary tree below has the inorder traversal ABCDEFGHI? (mark all that apply).



(e) All of the above

7. A dense undirected graph is:

- (a) A graph in which $E = O(V^2)$
- (b) A graph in which $E = O(V)$
- (c) A graph in which $E = O(\log V)$
- (d) All items above may be used to characterize a dense undirected graph
- (e) None of the above

8. In a min-heap with N nodes what is the cost of removing the minimum element in the heap?

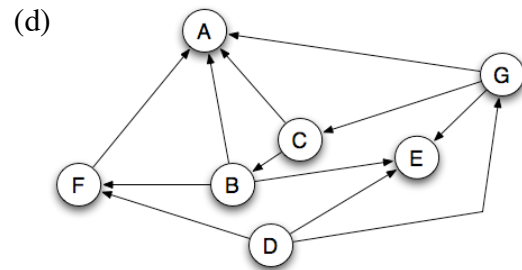
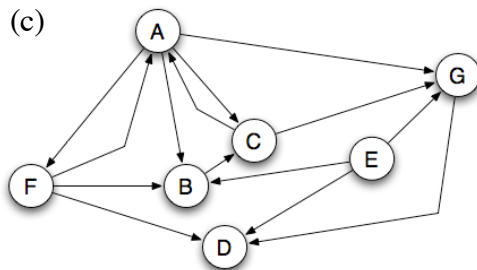
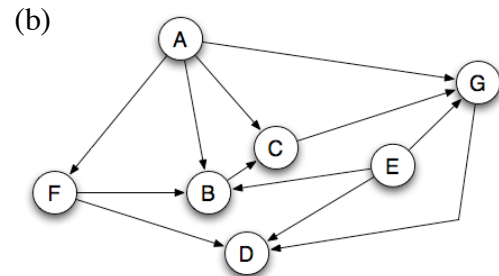
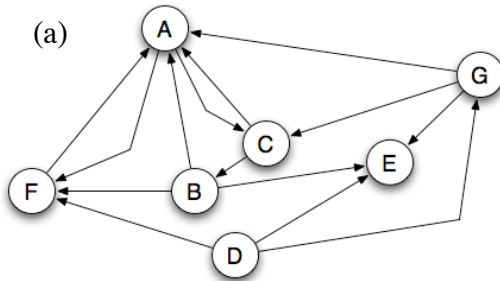
- (a) $O(1)$
- (b) $O(\log N)$
- (c) $O(N)$
- (d) $O(N \log N)$
- (e) $O(N^2)$

9. What algorithm technique is used in the implementation of Dijkstra's solution for the single-source shortest paths?

- (a) Greedy Technique
- (b) Divide-and-Conquer Technique
- (c) Dynamic Programming Technique
- (d) The algorithm combines more than one of the above techniques.
- (e) The algorithm does not use any of the above techniques.

10. Which graph below corresponds to the following adjacency list?

A = {B, C, F, G}
 B = {C}
 C = {A, G}
 D = {}
 E = {B, D, G}
 F = {A, B, D}
 G = {D}



(e) None of the above

11. If you had to sort a list of 10^{30} numbers ranging in value from 0 to 999999, which sort algorithm would be the most appropriate choice?

- (a) Insertion Sort
- (b) Quicksort
- (c) Mergesort
- (d) Heapsort
- (e) Radixsort

12. What is the recurrence relation that best describes the worst-case running time of MergeSort for arrays of size n ?

- (a) $T(n) = T(n/2) + 1$
- (b) $T(n) = 2T(n/2) + 1$
- (c) $T(n) = T(n/2) + n$
- (d) $T(n) = 2T(n/2) + n$
- (e) None of the above

13. Given the following recursive algorithm.

```
public static int ackermann(int m, int n) {  
    if (m == 0)  
        return n+1;  
    else if (m > 0 && n == 0)  
        return ackermann(m-1, 1);  
    else  
        return ackermann(m-1, ackermann(m, n-1));  
}
```

What is the result of a call `ackermann(3, 2)`?

- (a) 13
- (b) 9
- (c) 11
- (d) 61
- (e) 29

14. Which statement below is FALSE?

- (a) The execution of a DFS in a graph generates a spanning tree.
- (b) Spanning trees are not unique, no matter the structure of the graph.
- (c) Prim's algorithm is used to find the MST of weighted graphs.
- (d) Dijkstra's algorithm is not guaranteed to work on graphs containing negative edges.
- (e) BFS can be used to report whether a graph is cyclic.

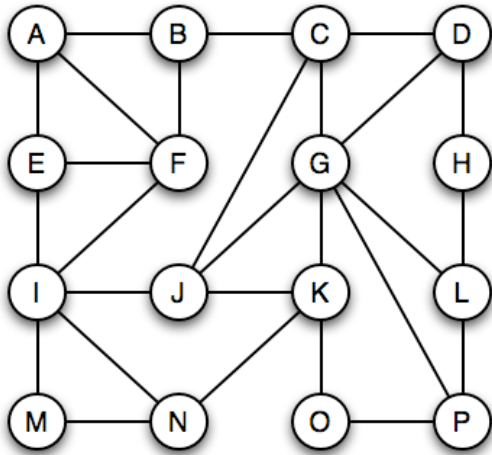
15. Which topic below was not part of the "advanced" topics presented by students in class?

- (a) Convex Hull.
- (b) Deluney Triangulation.
- (c) Matrix Multiplication.
- (d) Solving Linear Equations.
- (e) Largest Common Substring.

OPEN QUESTIONS (15 points each)

16. Describe a linear-time algorithm for reversing a queue Q . To access the queue, you are only allowed to use the methods of the queue ADT.

17. When performing a BFS in the graph below, what is the order that nodes are **visited** (black) if we start at node D and assume nodes are encountered (gray) in alphabetical order.



18. A palindrome is a string that is equal to its reverse. For instance ABBA, TENET, and DETARTRATED, are examples of a palindrome.

(a) Write an algorithm that takes a string as an input and outputs a Boolean value indicating whether the string is a palindrome.

Note: Efficient algorithms will earn more points than non-efficient ones.

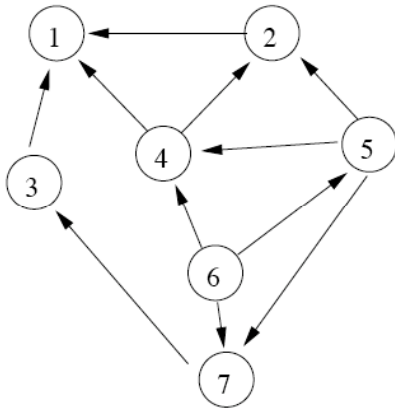
(b) Describe the performance of your algorithm in terms of the length of the string received as input. Explain the performance.

19. Assuming a graph representation using adjacency matrix

(a) Write an algorithm to compute the complement of a unweighted undirected graph $G=(V,E)$. The complement of a graph is defined as the graph with the exact same vertices and the exact opposite set of edges.

(b) What is the worst case running time of your algorithm? Explain your answer

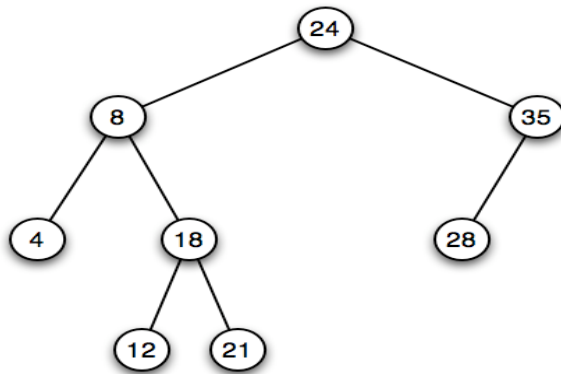
20. Given the graph below



(a) Find a reverse topological sort of the graph. You need only to list the vertices in order, although showing your work will help you earn partial credit in case of a mistake.

(b) Is the reverse topological sort unique in this graph? If not, provide an alternative reverse topological sort.

21. Consider the following binary tree



(a) Assuming it is an AVL tree, show the state of the tree after inserting 10 and then again after deleting 28. If rotations are used, indicate the name of the rotation.

(b) Assuming it is a standard BST, show the state of the tree after deleting 24 and then again after inserting 10.