University of Nevada Las Vegas

Computer Science 477/677 Fall 2020

Practice Third Examination November 18, 2020

The entire examination is 395 points.

1. True (T) False (F) or Open (O) meaning that the answer is not publicly known to science at this time.

   (a) _____ Open hashing uses open addressing.

   (b) _____ Every $\mathcal{NP}$-complete problem can be solved in polynomial time.

   (c) _____ The height of an AVL tree with n nodes is $O(\log n)$ in the worst case.

   (d) _____ Dynamic programming is a divide-and-conquer technique.

   (e) _____ Computers are so fast nowadays that time complexity of programs no longer matters.

2. Fill in the blanks.

   (a) [10 points] In _____ hashing, there are no collisions.

   (b) [10 points] The maximum numbor of edges a planar graph of 10 vertices can have is _____ (Exact answer neeeded. No partical credit.)

   (c) [10 points] If a graph of 20 vertices is a tree, it must have exactly _____ edges.

3. [20 points] What is the difference between open hashing and closed hashing?

4. Consider the following recursive function.

```
int george(int n)
  {
   if (n <= 1) return 1;
   else return (2*george(n/3)+george(n/2)+george(n/4)+1) % 17;
  }
```

   (a) [20 points] write pseudocode for an algorithm which computes `george(n)` using dynamic programming. What is the asymptotic time complexity of your program?

   (b) [20 points] You might be interested only in the value of `george(n)` istead of all the values for $i \leq n$. Write pseudocode for a memoization algorithm which computes `george(n)` in less time than dynamic programming.

5. [20 points] Some problem involving cuckoo hashing.

6. [20 points] Some problem related to AVL trees.

7. [20 points] Some problem related to treaps.

8. [20 points] Explain the linear probing and quadratic probing in closed hashing.

9. [20 points] In class, we discussed a deterministic algorithm for finding the median of an ununrdered array of numbers. The time complexity of that algorithm is the solution to a certain recurrence. What is that recurrence, and what is that asymptotic time complexity?

10. [20 points] Describe radix sort for a list of n zip codes. How many branching statements will be executed during the computation? (Approximate answer, such as: "approximately $10n$")

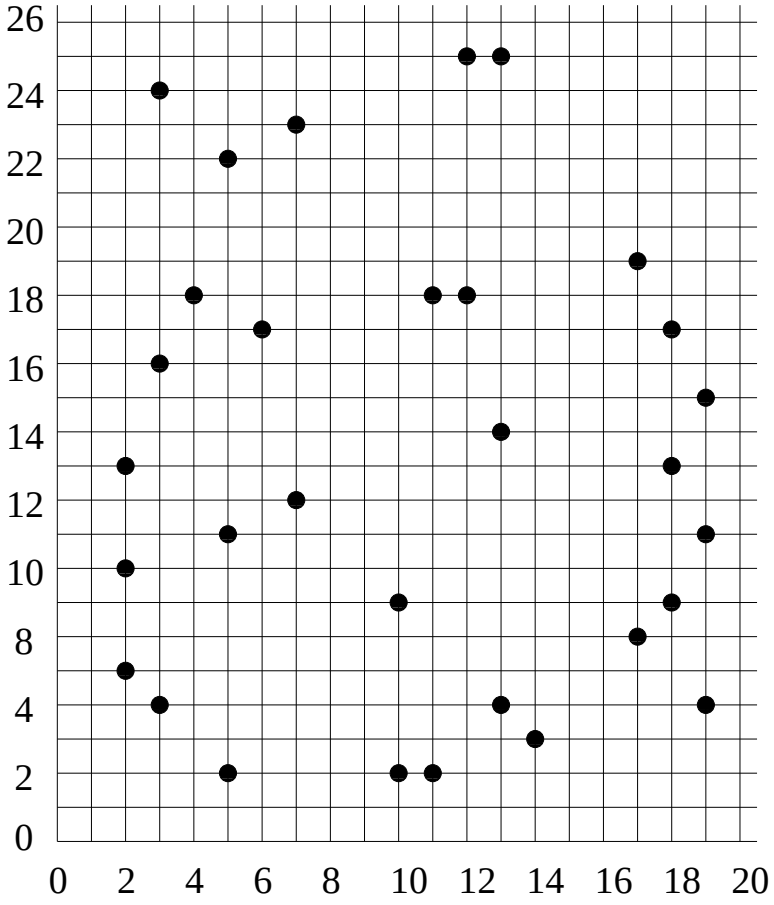
11. [20 points] Write psedocode for the Bellman Ford algorithm on a weighted graph with start vertex s.

12. [20 points] Compute the Levenshtein distance between the strings *maneuver* and *manauevor*. Show the matrix.

13. [20 points] Compute the longest common substring of the strings $abcdefagh$ and $bcdabfgh$. Show the matrix.

14. [20 points] Describe a Las Vegas algorithm which finds the median of an unsrted arrray of numbers in less expected time that it would be possible by a deteriministic algorithm.

15. [20 points] Use Graham Scan to find the boundary of the convex hull of the set of points indicated in the plot below. Indicate your work on the figure, and circle every vertex of the boundary.



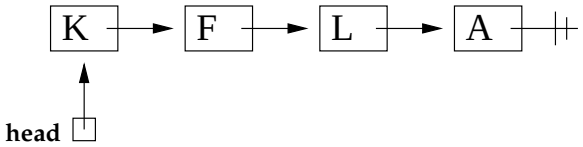
16. [20 points] A pirate ship visits a chain of islands on consecutive days. The captain knows how much loot is available on each island, and wants to maximumize the amount gathered. The Internation Pirate's

Union requires pirates be given a day's rest after they loot an island. There is a Navy ship close behind, so the captain must continue sailing, forcing him to skip the next island. Design an algorithm to maximize the loot.

You want to design a dynamic programming algorithm which inputs a sequence of numbers, and finds that subsequence which has the largest total, subject to the condition that no two consecutive terms of the original sequence are in the subsequence. What should your subproblems be?

Example: if the input sequence is 3,1,4,1,5,9,2,6,5,3,5, your algorithm will find the subsequence 3,4,9,6,5, whose terms add up to 27.

17. [20 points] Suppose a search structure is implemented as an unordered linked list. Here is a figure showing such a list.



Each search must be linear search, but after each item is found, that item is moved to the front.

Starting with an empty list, perform the following operations, illustrating the linked list after each operation.

Insert A
Insert B
Find A
Insert C
Insert D
Find A
Find D

18. [20 points] Circle the strong components of the directed graph illustrated below.