Final Exam Section 2 Fall 2015, Part A

Computer Science Department, SJSU
CS146: Data Structures and Algorithms
Instructor: Katerina Potika

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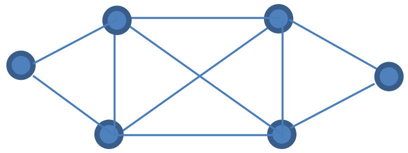
Section	Points
Section I Multiple Choice 10 questions (2 points each)	______Out of 20
Section II Short Answer Question 1	______Out of 14
Section II Short Answer Question 2	______Out of 12
Section II Short Answer Question 3	______Out of 15
Section II Short Answer Extra Question	______Out of 10
Total	______ Out of 61

Duration 50 min. Closed books. Good Luck!

SECTION I Multiple Choice [2 points each] Choose the best answer for each question.

1. For the following graph what is true:

a. It has a Hamiltonian cycle b. It has an Euler cycle c. a and b d. None	

2. What do you know about P=NP

a. It is true
b. It is false
c. It is open
d. a and c

3. Which problem can be solved optimal by a dynamic programming algorithm

a. Fractional Knapsack
b. Single source shortest path
c. All-pairs shortest path
d. Clique

4. If you want to prove that problem A is NP-complete which of the following is the correct way to prove it

a. $Longest\ Path \leq_p A$
b. $Shortest\ Path \leq_p A$

c. $A \leq_p 3 - SAT$
d. None of the above

5. The distance matrix of a (directed) graph with vertices P,Q, R and S is given by the shortest path from Q to S consists of edges

	P	Q	R	S
P	0	1	∞	2
Q	∞	0	2	5
R	3	∞	0	1
S	1	∞	∞	0

a. QR and RS
b. QS
c. QP and PS
d. there is no path

6. State whether the following statement is true or false for a NP-Complete and NP-Hard Problem

i. if Clique has an efficient algorithm then P=NP

ii. To prove NP-hardness of a problem you can only start from SAT or 3SAT.

a. i: true, ii: false

b. i: true, ii: true

c. i: false, ii: false

d. i: false, ii: true

7. Which of the following problems has a polynomial time algorithm
a. Traveling Salesperson problem
b. Fractional Knapsack
c. Longest simple path in a graph
d. Hamilton path

8. Consider the 0-1 knapsack problem. What is the best solution, with 4 items and W=10, such that w=(5, 3, 4, 2) –*weights*- and b=($30, $16, $28, $18) -*values*
a. 92
b. 64
c. 58
d. none

9. State whether the following statement is true or false for Single Source Shortest Paths

i. The problem is to determine the shortest paths from a source vertex s to all the remaining vertices of G.

ii. The way to generate the shortest paths from s to the remaining vertices is to use relaxation.

iii. If all weights are positive then the solution can be found faster.
a. i: true, ii: true, iii: true
b. i: true, ii: false, iii: true
c. i: true, ii: true, iii: false
d. i: false, ii: true, iii: false

10. De-duplicate a huge file of objects. Given is a “stream” of objects you can linear scan through a huge file and your goal is to remove duplicates (keep track of unique objects), which is the best data structure to use:

a. array
b. red black tree
c. hash table
d. linked list

Extra question

Suppose that we have a set of lectures, each lecture has (starting time, finishing time), to schedule among a large number of lecture halls, where any lecture can take place in any lecture hall. We wish to schedule all the lectures using as few lecture halls as possible (minimization problem).
(a) [6pts] Draw the following example, given lectures (1, 4), (2, 5), (6, 7), (4, 8). What is the minimum number of halls that you need?
(b) [4pts] Which design technique would you use to solve it (no algorithm required)?

SECTION II – Short Answer– Write a short answer to each question.

Question 1

[14pts: 2pts/each] Match up each application with an algorithm or data structure that we used to solve it in this course. Use each answer exactly once.

____range search	1. Hashing
____Document similarity	2. Red black tree
____Hamiltonian cycle	3. Depth-first search
____garbage collector	4. Breadth-first search
____Web crawler	5. Dijkstra's algorithm
____Google maps	6. Topological sort
____Semesters for graduating	7. Enumerate permutations

Question 2

[12pts: 3 pts/each] For each function on the left, give the best matching order of growth of the running time on the right.

_____

```
public static int f1(int n) {
   int x = 0;
   for (int i = 0; i < n; i++)
              x++;
   return x;
}
```

_____

```
public static int f2(int n) {
    if (n == 0)        return 1;
    int x = 0;
    for (int i = 0; i < n; i++)
          x += f2(n-1);
    return x;
}
```

_____

```
public static int f3(int n) {
     if (n == 0) return 0;
     return f3(n/2) + f1(n) + f3(n/2);
}
```

_____

```
public static int f4(int n) {
     int x = 0;
     for (int i = n; i > 0; i = i/2)
         x += f1(i);
     return x;
}
```

A. O(log n)
B. O(n)
C. O(n log n)
D. O(n^2)
E. O(2^ n)
F. O(n!)

Question 3

[15pts] Consider the following 36-character text string: F C F C E C A C B D E D F E A B F B A F F C D C B E D F F F C C D E E F. Find the frequency of each letter and then compute the Huffman codes.

SCRATCH PAPER