Department of Computer Science and Engineering
National Sun Yat-sen University
Advanced Programming and Practice - Final Exam., June 28, 2018

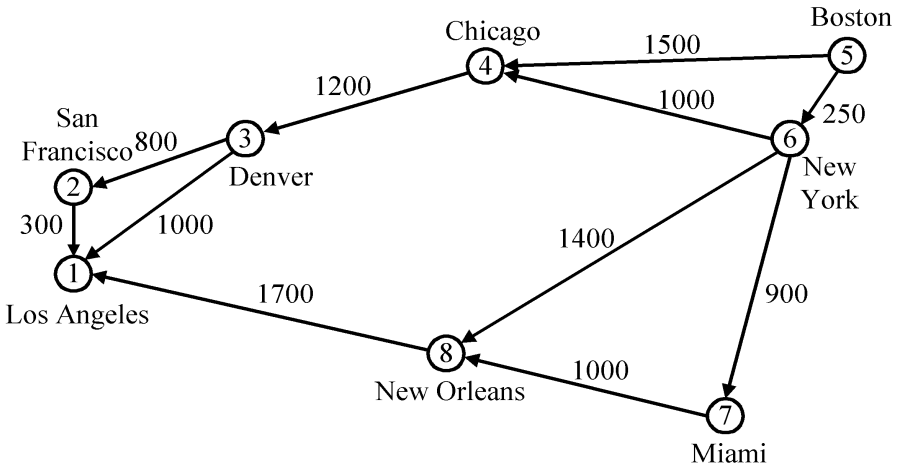
1. Explain each of the following terms. (16%)
   (a) topological order
   (b) convex hull
   (c) fast Fourier transform
   (d) lexicographic order

2. What will be printed after each of the following C programs is executed? (8%)
   (a)
   ```
   for(int i=3; i<100; i += (i&-i))    printf("%d    ", i);
   printf("\n");
   for(int i=9; i<100; i += (i&-i))    printf("%d    ", i);
   ```
   (b)
   ```
   for(int i=15; i>0; i -=(i&-i))    printf("%d    ", i);
   printf("\n");
   for(int i=27; i>0; i -=(i&-i))    printf("%d    ", i);
   ```

3. What is the definition of the *knapsack* problem? What is the difference between the *knapsack* problem and the 0/1 *knapsack* problem? (9%)

4. Explain the *depth-first search* method in a graph. What data structure should be used? What is the time complexity? (10%)

5. (a) Please present an algorithm for finding the *shortest path* of a graph. Explain your algorithm with the following graph, from vertex 5 to vertex 1. (10%)
   (b) Analyze the time complexity of your algorithm. (5%)



6. Suppose there are seven symbols A, B, C, D, E, F, G in a file with occurrences 2, 3, 5, 8, 13, 15, 18, respectively. Please give the Huffman code tree constructed by

Huffman algorithm. (12%)

7. In the *matrix-chain multiplication* problem, we are given n matrices $A_1, A_2, \ldots, A_n$ with size $p_0 \times p_1$, $p_1 \times p_2$, $p_2 \times p_3$,…, $p_{n-1} \times p_n$. It is well-known that the computation of $A_i \times A_{i+1}$ needs $p_{i-1} \times p_i \times p_{i+1}$ scalar multiplications. The problem is to determine the multiplication order such that the number of scalar multiplications is minimized. It can be solved by the dynamic programming (DP) approach. Let $m(i,j)$ denote minimum number of scalar multiplications for computing $A_i \times A_{i+1} \times \ldots \times A_j$. Please give the DP formula for solving this problem. (15%)

8. Given a set S of n numbers, $n \geq 4$, you are asked to find whether there exist four numbers $a, b, c, d \in S$ such that $a+b+c=d$. For solving this problem, a trivial method is to examine all 4-number combinations, which requires $O(n^4)$ time. However, this method is not efficient enough. Please design a more efficient algorithm to solve this problem and analyze the time complexity. Note that if your algorithm needs less than $O(n^3 \log n)$ time, you will get higher score. (15%)

Answer:
2.
(a) 3 4 8 16 32 64
9 10 12 16 32 64
(b) 15 14 12 8
27 26 24 16