Department of Computer Science and Engineering
National Sun Yat-sen University
Advanced Programming and Practice - Final Exam., June 20, 2019

1. Explain each of the following terms. (20%)
   (a) transitive closure in a graph
   (b) connected components of a graph
   (c) 2-D maxima finding
   (d) branch and bound
   (e) hill climbing

2. (a) What is the *Eulerian circuit* in a graph? (5%)
   (b) What is sufficient and necessary condition for that there exists an *Eulerian circuit* in a graph? (5%)

3. The 0/1 *knapsack* problem is NP-hard. However, the *knapsack* problem can be solved in polynomial time. Please present an algorithm to solve the *knapsack* problem in polynomial time. (10%)

4. Please describe the general stages of the *divide-and-conquer* strategy for solving a problem. And give the general recurrence form for analyzing its time complexity. (10%)

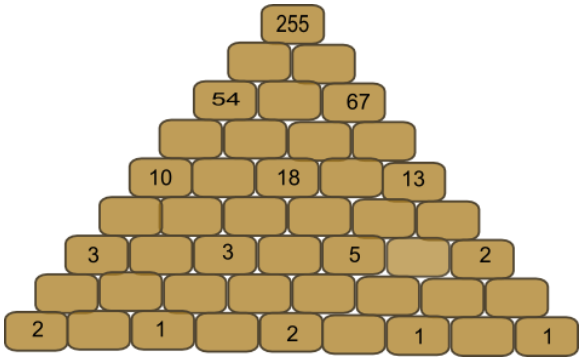
5. For given a weighted graph with positive edge weights, let $w(i,j)$ denote the weight of edge (i,j), where the vertices are indexed as 0, 1, 2, …, n-1. The *Floyd–Warshall* algorithm can find the *shortest path* of every pair of vertices. Let $d(i,j,k)$ denote the shortest path from vertex i to vertex j going through vertices not greater than k. Please describe the *Floyd–Warshall* algorithm, and give time complexity. (15%)

6. For building an *optimal binary search tree,* we are given n identifiers $a_1 < a_2 < a_3 <\ldots< a_n$ with the searching probability p_i for a_i. Here, we assume that the probability of the unsuccessful search is zero. Let $C(i,j)$ denote the cost of an optimal binary search tree containing a_i, a_{i+1}, …, a_j. Please derive the DP formula for computing $C(i,j)$. (15%)

7. The *quadratic selection sort* is described as follows: Divide the n input elements into k groups of k elements each, where $k=\sqrt{n}$. Find the largest element of each group and insert it into an auxiliary array. Find the largest of the elements in this auxiliary array. This is the largest element of the file. Then replace this element in the array by the next largest element of the group from which it came. Again find the largest element of the auxiliary array. This is the second largest element of the file. Repeat the process until the file has been sorted. Use the following 16

elements to explain how this algorithm works: 14, 5, 3, 8, 13, 15, 2, 9, 10, 4, 1, 6, 16, 7, 11, 12. (10%)

8. There are 9 rows in the magic triangle, where the top row is numbered as row 1 and row *i* has *i* cells, shown as follows. The number in each cell is the sum of the two cells below it. For example, 255 is the sum of the two cells in row 2, not shown in the figure. Please calculate all missing numbers and fill in the triangle. Your answer has been written in 9 rows, each row (from left to right) corresponds to one row of the triangle, from top to bottom. Your answer must include the numbers already shown in the figure. (10%)



Answer:

problem 8.

255

121 134

54 67 67

23 31 36 31

10 13 18 18 13

5 5 8 10 8 5

3 2 3 5 5 3 2

2 1 1 2 3 2 1 1

2 0 1 0 2 1 1 0 1