Department of Computer Science and Engineering
National Sun Yat-sen University
Advanced Programming and Practice - Final Exam., June 6, 2024

1. Explain each of the following terms. (20%)
   (a) Euler circuit in a graph
   (b) best first search
   (c) sum of subset problem
   (d) coloring problem in a graph
   (e) Huffman codes

2. (a) What is the *knapsack* problem? (5%)
   (b) Design a *greedy* algorithm for solving the above problem. (10%)

3. (a) Present an algorithm for finding all *2-D maxima* in a set of 2-D points. (10%)
   (b) Analyze the time complexity of your algorithm. (5%)

4. (a) Explain the *longest common subsequence* problem. Please give an example to describe your answer. (5%)
   (b) Present a *dynamic programming* method for solving the above problem. And analyze the time complexity of your algorithm. (10%)

5. (a) Let C(n,m) denote m-combinations selected from {1,2,…,n} without repetition. Each m-combination is represented with *lexicographic order*. For example, the two combinations 251 and 512 are the same, and they are represented with 125. These m-combinations in C(n,m) are represented with the *lexicographic order*. For example, all 3-combinations selected from {1,2,3,4} in lexicographical order are 123, 124, 134, 234. What is the next one of 13589 in C(9,5)? (5%)
   (b) Let P(n,m) denote m-permutations selected from {1,2,…,n} without repetition. The m-permutations in P(n,m) are represented with the *lexicographic order*. What is the next one of 81397in P(9,5)? (5%)

6. The logic-OR and logic-AND operations can be implemented by the linear constraints. For example, the implementation of $w = x$ OR y is
   $w \geq x$
   $w \geq y$
   $w \leq x + y$ (+: integer addition)
   $w, x, y \in \{0,1\}$.
   With the similar concept, please present the implementation of $w = x$ AND y. (10%)

7. In the *range minimum query* (RMQ) problem, we are given a list of integers $T=<t_1, t_2, \ldots, t_n>$, where the elements in T are not sorted. The goal of the problem is to build

a data structure during the preprocessing stage so that the minimum value of a specified range can be determined efficiently during the query stage. For example, consider T=<5, 3, 10, 7, 8, 5, 9, 4> and n=8. The answer of RMQ for the range [2, 5] is 3, which is the minimum of 3, 10, 7, 8 (i.e. t_2, t_3, t_4, t_5). As more examples, the answers of RMQ for [1, 5], [3, 5] and [5, 7] are 3, 7 and 5, respectively. Please design an algorithm for solving this problem such that the preprocessing stage requires O(n) time and each query requires O(log n) time. You have to analyze the time complexity of your algorithm. (15%)

Answers:
5. (a) 13678
   (b) 81423

6. logic-AND

$w \le x$

$w \le y$

$w \ge x + y$ -1 (+: integer addition)

$w, x, y \in \{0,1\}$.

https://cs.stackexchange.com/questions/12102/express-boolean-logic-operations-in-zero-one-integer-linear-programming-ilp

7. 採用 segment tree (線段樹)。細節請查詢 網路說明。