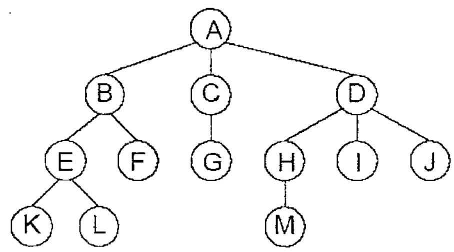
國立臺灣師範大學九十四學年度碩士班考試入學招生試題

軟體基礎 科試題（資訊工程研究所用，本試題共 4 頁）

注意：1.依次序作答，只要標明題號，不必抄題。
2.答案必須寫在答案卷上，否則不予計分。

1. For the tree shown below:



(a) Show its list representation. (5 分)

(b) Show its left child-right sibling representation. (5 分)

(c) Show its left child-right child representation. (5 分)

2. A file containing 4500 records, A_1, …, A_{4500}, is to be sorted using a computer with an internal memory capable of sorting at most 750 records. The input file is maintained on a disk and has a block length of 250 records. We have available another disk which may be used as a scratch pad. The input disk is not to be written on.

(a) Please design an "external sort" method to accomplish the sort task. (5 分)

(b) Please analyze the time complexity of your method in (a). You can define some factors (seek time, latency time, transmission time, …) for your analysis. (5 分)

(c) What is the difference between "internal sort" and "external sort"? (5 分)

請翻頁繼續作答

3. The rat in a maze experiment is a classical one from experimental psychology. A rat (or mouse) is placed through the entrance of a large box. Walls are set up so that movements in most directions are obstructed. The rat is carefully observed by several scientists as it makes its way through the maze until it eventually reaches the other exit. An example is given below. We can design a computer program for getting through a maze.

entrance →

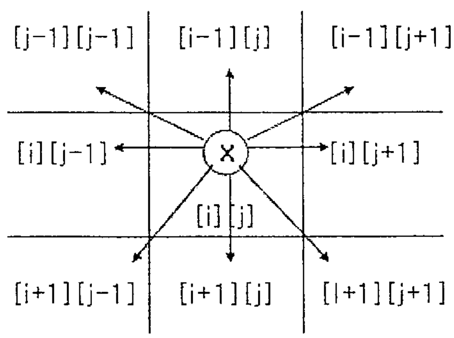
0	1	0	0	0	1	1	0	0	0	1	1	1	1	1
1	0	0	0	1	1	0	1	1	1	0	0	1	1	1
0	1	1	0	0	0	0	1	1	1	1	0	0	1	1
1	1	0	1	1	1	1	0	1	1	0	1	1	0	0
1	1	0	1	0	0	1	0	1	1	1	1	1	1	1
0	0	1	1	0	1	1	1	0	1	0	0	1	0	1
0	1	1	1	1	0	0	1	1	1	1	1	1	1	1
0	0	1	1	0	1	1	0	1	1	1	1	1	0	1
1	1	0	0	0	1	1	0	1	1	0	0	0	0	0
0	0	1	1	1	1	1	0	0	0	1	1	1	1	0
0	1	0	0	1	1	1	1	1	0	1	1	1	1	0

→ exit

1: blocked path 0: through path

(a) At first, we can represent the $m \times n$ maze by a two dimensional array, MAZE(1:m, 1:n), where a value of 1 implies a blocked path, while a 0 means one can walk right on through. We assume that the rat starts at MAZE(1, 1) and the exit is at MAZE(m, n). However, some advanced programmers like to declare the maze as MAZE(0:m+1, 0:n+1). Please explain the reasons. (3 分)

(b) Assume that the possible moves the rat can make at a point (i, j) in the maze are shown in the following figure. We can predefine the possible directions to move in a table, MOVE(1:8, 1:2). Please show the values of each element in MOVE(1:8, 1:2). (3 分)



(c) What is the maximum path length from start to finish in any maze of dimensions $m \times n$? (3 分)

(d) Backtracking method can be applied to find a path through a maze. In this method, we usually need a stack. Please explain the purpose of the stack. (3 分)

(e) What are the space requirements of the stack in order to find a path through an $m \times n$ maze? (3 分)

4. Explain the following terms.

(a) Bin packing problem. (3 分)

(b) Interpolation search. (3 分)

(c) Monte Carlo algorithm. (3 分)

(d) The n-Queens problem. (3 分)

(e) Shell sort. (3 分)

5. (a) Suppose we want to find the 100 largest elements in a list of n elements, n>100, and we are not interested in their relative order. Please design a linear-time algorithm to solve this problem. (5 分)

(b) A majority z in a list L of n elements means that the number of times z appears in L is greater than $\frac{n}{2}$. Please design a linear-time algorithm to find the majority z in L or determine that none exists. (5 分)

6. Suppose we want to store n files of lengths $L_1, L_2, \ldots, L_n$ on a sequential tape, in the order $\pi(1), \pi(2), \ldots, \pi(n)$, where π is a permutation of the numbers {1, 2, ..., n} so that $\pi(i)$ = the i-th file on the tape. Because the tape must be accessed sequentially from the beginning, the time taken to access the k-th file is $\sum_{i=1}^{k} L_{\pi(i)}$. Assume that each file is equally likely to be accessed. Our task is to arrange the files in some particular order π on the tape so that the average access time (i.e. $\frac{1}{n}\sum_{k=1}^{n}\sum_{i=1}^{k} L_{\pi(i)}$) of a file is minimized.

   (a) If we have just three files of length $L_1 = 5$, $L_2 = 37$ and $L_3 = 20$, what is the best arrangement to minimize the average access time? (5 分)

   (b) Prove that $\frac{1}{n}\sum_{k=1}^{n}\sum_{i=1}^{k} L_{\pi(i)} = \frac{1}{n}\sum_{k=1}^{n}(n-i+1)L_{\pi(i)}$. (5 分)

   (c) Design an efficient algorithm to find a permutation π of files {1, 2, ..., n} that minimizes the average access time. (5 分)

7. The Matrix-chain multiplication problem can be stated as follows: given a chain <$A_1, A_2, \ldots, A_n$> of n matrices, where for i = 1, 2, ..., n, matrix A_i has dimension $p_{i-1} \times p_i$, fully parenthesize the product $A_1, A_2, \ldots, A_n$ in a way that minimizes the number of scalar multiplications.

   (a) Find an optimal parenthesization of a matrix-chain product $A_1 \times A_2 \times A_3$, where the dimensions of the matrices A_1, A_2, A_3 are 20×2, 2×30, 30×12, respectively. (3 分)

   (b) The brute-force algorithm is to consider all possible orders and take the minimum. Please show that the run time of this brute-force algorithm is exponential. (3 分)

   (c) Please describe a dynamic programming method for solving this problem. (3 分)

   (d) What is the running time and space requirements of the dynamic programming method in (c)? (3 分)

   (e) If the dimensions of the matrices are all the same, how can we solve the problem more efficiently? (3 分)