國立清華大學 106 學年度碩士班考試入學試題

系所班組別：生命科學院丙組

考試科目（代碼）：計算機概論(演算法與計算機數學)(0704)

1. (20%) Answer the following questions regarding binary trees.

   1-1. (4%) Given three elements A, B, C, list all possible binary trees.

   1-2. (6%) How many different binary trees exist for n elements?

   1-3. (10%) What are the defining properties of (1) heap and (2) priority queue? Discuss the time complexity for using heap versus priority queue to sort a list of elements.

2. (20%) Given a linked list L, answer the following questions.

   2-1. (6%) Design a procedure for printing L in its **reverse order** using a stack as a supporting storage. Present your answer with pseudocode.

   2-2. (6%) Is it possible to perform the same task without explicitly using a stack?

   If so, how? Present your answer with pseudocode.

   2-3. (8%) Discuss the time and space complexity of the two procedures that you presented above.

3. (35%) Answer the following questions regarding search.

   3-1. (6%) What letters are interrogated by the binary search algorithm if it is applied to the list A, B, C, D, E, F, G, H, I, J, K, L, M, N, O when searching for the value X?

   3-2. (6%) What's the best-case and worst-case time performance of binary search?

   3-3. (8%) Is binary search faster or slower than linear search? Why? What's the "secret", such as the idea or strategy, behind the one that's faster?

   3-4. (15%) What is the ***average*** number of comparisons used by the insertion sort to sort n distinct elements? Show the steps of derivation.

   Hint: Suppose that X is the random variable equal to the number of comparisons used by the insertion sort to sort a list $a_1, a_2, \ldots, a_n$ of n distinct elements. Then $E(X)$ is the average number of comparisons used. Show how to derive $E(X)$.

4. (25%) Answer the following questions about graphs.

   4-1. (5%) Define what is a spanning tree. Provide an example to illustrate your definition.

   4-2. (10%) Define and explain what is a minimum spanning tree. Present a *greedy* algorithm that can construct a minimum spanning tree. Discuss why is it "greedy".

   4-3. (10%) Adjacency list and adjacency matrix are common representations of graphs. Compare them, and discuss the disadvantages and advantages respectively. *Hint:* Consider common operations of graphs, such as edge addition, deletion and traversal.