國立成功大學

110學年度碩士班招生考試試題

編　號：246

系　所：資訊管理研究所

科　目：資料結構

日　期：0203

節　次：第 3 節

備　註：不可使用計算機

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1. The Euclidean algorithm is a method for computing the greatest common divisor of two positive integers. This algorithm works by continually computing remainders until 0 is reached.
   (a) (5%) Argue why this algorithm can be used to compute the greatest common divisor of two integers.
   (b) (5%) Write a program for the Euclidean algorithm.
   (c) (10%) Analyze the time complexity of the Euclidean algorithm.

2. The heapsort algorithm has two main steps: build_heap and delete-heap.
   (a) (10%) Show the results of build_heap and delete_heap by using only an array to sort {22, 45, 8, 19, 6, 39, 51}
   (b) (5%) Show that the time complexity of the heapsort algorithm is O(nlogn).
   (c) (5%) Argue whether the heapsort algorithm has the fastest running time among all sorting algorithms.

3. (10%) Set difference A – B finds the elements in A but not in B. For example, if A = {1, 2, 4} and B = {3, 4, 5}, then A – B = {1, 2}. Given two sorted linked lists L_1 and L_2, write a procedure to compute $L_1 - L_2$ using only the basic operations for the linked list, and justify your answer.

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4、[15%] **True** or **False**, and **EXPLAIN**

Circle **T(true)** or **F(false)**. If the statement is correct, ***briefly state why***. If the statement is wrong, ***explain why or give a counterexample***. Answers **WITHOUT** reasons will get **at most 1 point**.

(a) [3%] The adjacency matrix representation is usually preferred over adjacency lists, especially for storing sparse graphs compactly.

(b) [3%] Given the data structures (i.e., the nodes connectable from the source) produced by depth-first search (DFS), one can check whether a given vertex is connected to the source in constant time.

(c) [3%] For a digraph containing negative arc weight but no negative cycle, if we modify the arc weight c_{ij} by $c_{ij} + \max_{(i,j)\in A}\{|c_{ij}|\}$ for each arc (i, j), we can apply the Dijkstra's algorithm using this modified arc weight to obtain the same shortest path that uses the original weight.

Let G be any simple graph (no self-loops or parallel edges) with positive and distinct edge weights.

(d) [3%] If the weights of all edges in G are increased by 7, then any MST in G is an MST in the modified edge-weighted graph. Also, such an MST must be unique.

(e) [3%] If the weights of all edges outging from the source node *s* are increased by 7, then any shortest path originated from s is still a shortest path in the modified edge-weighted graph from *s*.

5、[20%] If we have $n = 2^{h+1} - 1$ integers with value 2^i for *i*=1,2,…,*n*. Answer the following quesionts:

(a) [4%] Draw a complete BST of height *h* =3 that stores these *n*=15 integers.

(b) [6%] Can we store these *n* integers by a complete BST of height *h* in O(*n*) time? If yes, briefly explain how to do it and why it is O(*n*) time; Otherwise, explain why not and estimate a lower bound $\varpi(n)$ time.

(c) [4%] Draw a max heap of height *h* =3 that stores these *n*=15 integers.

(d) [6%] Can we store these *n* integers as a max heap in O(*n*) time? Why or why not?

6、[15%] Answer the following questions:

(a) [5%] List the following functions by **increasing** asymptotic growth rate. Circle those functions of the same asymptotic growth rate:

$\lg n$ 1.00001^n $9999n\log n$ $n(\lg n)^2$ $0.001\lg(n^n)$ 2^{9999} n^{34}

(b) [5%] Given a BST, and we want to search for the number 45. Which (possibly multiple) of the following sequences could be the sequence of nodes examined? Explain your answer.

(b1) 1, 2, 3, 7, 15, 11 (b2) 9, 7, 6, 10, 20, 45 (b3) 50, 25, 27, 40, 44, 42, 46 (b4) 60, 21, 40, 44

(c) [5%] Please draw the red-black tree constructed by adding the following numbers in the sequence:

50, 10, 25, 75, 100, 0, 5 (please use a Square to represent a black node, and a circle for a red node)