考試科目	資料結構	系所別	資訊管理學系/科技組	考試時間	2 月 18 日(一) 第 3 節

I. Answer Yes(O)/No(X) for the following statements (40%):

1._____ : In a splay tree, splaying a node means moving the node to the leaf.
2._____ : Multiple entries can have the same key in a map but not in a dictionary.
3._____ : Using an unsorted list to implement a map, get(k) takes O(n) time to find the entry associated with key k.
4._____ : A hash function maps a key to an integer in a fixed interval, e.g., [0,N-1] for a hash table associated with an Array of size 2N.
5._____ : In a hash table, collision occurs when a key is mapped to different indices.
6._____ : Double hashing handles collisions by putting the colliding items in the next closest available table cell.
7._____ : A postorder traversal of a binary search tree visits the keys in increasing order.
8._____ : A preorder traversal of a binary search tree visits the keys in decreasing order.
9._____ : Removing a key takes O(n) time for a binary search tree that has n nodes with height h.
10._____ : An AVL tree is a binary search tree where for every internal node, the heights of its children are at the most one difference.
11._____ : Hashing is efficient when the load factor (the number of stored elements / the size of the Array) is close to 100%
12._____ : A skip list is a series of lists where each list is a subsequence of the previous one.
13._____ :In a skip list with n entries, the expected search, insertion and deletion time is O(n).
14._____ : Two edges in a graph are parallel if they have the same end vertices.
15._____ : Two vertices in a graph are adjacent if there exists an edge having these two vertices as its end vertices.
16._____ : The sum of the degrees of all vertices is equal to the number of edges in an undirected graph.
17._____ : The number of edges in a undirected graph is greater than n(n-1)/2 (n is the number of vertices in the graph).
18._____ : Checking whether two vertices are adjacent can be done in O(1) time in an edge-list graph.
19._____ : Removing a vertex in an adjacency-matrix graph takes O(1) time (n is the number of vertices in the graph).
20._____ : A spanning tree of a graph is a tree that covers all connected vertices in a graph.

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II. Answer the following questions (60%):

1. Evaluate and represent an arithmetic expression:

1.1 (5%) Represent the expression 2+8*6/3-2>9/3*7-(2+3)*5 using a binary tree. (An internal node stores an operator, e.g., *, +, and an external node stores a value, e.g., 3, 5.)

1.2 (8%) Complete the following pseudo code to evaluate such kind of an expression.

Algorithm: evaluateExpression(T, v)
Input: A binary tree T and a node v in T
Output: the value of v

1.3 (7%) Complete the following pseudo code that prints a binary tree expression with correct parentheses, i.e., (((2+((8*6)/3))-2)>(((9/3)*7)-((2+3)*5))).

Algorithm: printExpression(T, v)
Input: A binary tree T and a node v in T

2. Heap Construction: Use an **array** to build a max-heap of {13, 2, 16, 21, 15, 79, 32, 24, 20, 14, 7, 82, 51, 43, 55, 59, 8, 1} (the value of the parent node is larger than the value of its child node).

2.1 (10%) Describe the bottom-up construction step-by-step and show how the values of an array updated. Hint: at each iteration, add half of new values to merge heaps

2.2 (10%) Apply remove() to the heap twice and show the result step by step.

3. Divide and Conquer: Find the average of elements in an integer array A (starting from index i up to index j (included)).

3.1 (10%) The first idea is using a loop and iteratively computing average. Complete the following pseudo code and analyze its time complexity.

Algorithm IterativeAverage(A, i, j):
Input: an array A and starting index i and end index j

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Output: The average of (j-i+1) integers in A (starting from index i up to index j (included))

3.2. (10%) Similar to mergesort, we can also apply divide and conquer to find the average of n elements. The idea is to divide n elements to two parts, recursively find the average of the first half of A and the other of the second half of A, and compute the average based on these two parts. This kind of algorithm is called binary recursion algorithm, since we use two recursive calls to solve the problem. Complete the pseudo code, write its time complexity in a recursive equation, and deduct its O time complexity.

Algorithm MergeAverage(A, i, j):
Input: an array A and starting index i and end index j
Output: The average of (j-i+1) integers in A (starting from index i up to index j (included))

備註	一、作答於試題上者，不予計分。 二、試題請隨卷繳交。