Xi'an Jiaotong-Liverpool University

西交利物浦大学

PAPER CODE	EXAMINER	DEPARTMENT	TEL
CSE104		Computer Science and Software Engineering	

2nd SEMESTER 2017/18 RESIT EXAMINATIONS

BACHELOR DEGREE – Year 2

DATA STRUCTURES AND ALGORITHMS

TIME ALLOWED: 2 Hours

INSTRUCTIONS TO CANDIDATES

1、 Total marks available are 100. This will count for 80% in the final assessment.

2、 Answer all questions.

3、 Calculator is not allowed.

4、 Answers should be written in the answer booklet(s) provided.

5、 Only answers in English are accepted.

THIS PAPER MUST NOT BE REMOVED FROM THE EXAM HALL.

Part II. (25marks) Answer the following Question.

31. There is a tree structure with the following characteristics:

1. The tree structure is a *complete binary tree*. A complete binary tree is a binary **tree** in which every level, except possibly the last, is completely filled, and all nodes are as far left as possible.

2. The value (we call it key) of a parent node must be larger or equal to the child nodes.

A tree structure such as the above is called a **Binary Heap**.
See fig.a and fig.b for examples.
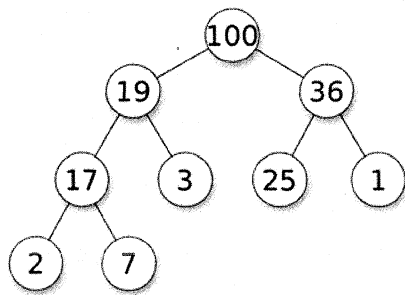
a) binary heap
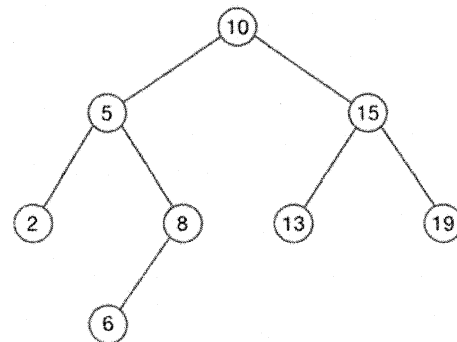
b) not a binary heap

You are assigned to design an algorithm to check if a given binary tree is a binary heap.

(a) **(6 marks)** For a complete tree, we choose array to store the tree. Assuming the root of the tree is at index [0], one node is at position with index [i], please specify the position of the parent of this node and the positions of both children (assume they exist).

(b) **(6 marks)** Please complete the method to count the total number of nodes in the binary tree.
(Your completed method should not exceed 8 lines of code.)

```
int countNodes(Node root)
{


}
```

(c) **(13 marks)** To check if a tree is binary heap or not, we have to check two properties of the tree: 1, if it is a complete tree. 2, if the key of every node is greater or equal to its child note.

Assume the tree we have to check is a complete tree, please develop a method to check if the tree meet the second property of binary heap or not. Please complete below method. (Pseudo code is acceptable.)

Hints:
- You need to consider different number of children a node has. If a node has 0 child, it is a leaf node. If a node has one child, it must be left child as it is a complete tree. If a node has both child, what to do then?
- You can compare key of elements like this: node1.key > node2.key
- Try recursive idea.

(Your completed method should not exceed 10 lines of pseudo code and/or explanation)

```
// This Function checks the heap property in the tree.
boolean isHeapUtil(Node root)
{
//Base case 1: when the node is a leaf node, which means it has no child nodes
 if (                                              ){

 }
    //Base case 2: when the node is in the second last level, which means it has only
one child.
     if (                    ){

 }

    //recursive process
    else {




 }
  }
```

END OF PAPER