No calculator permitted in this examination

UNIVERSITY OF BIRMINGHAM

School of Computer Science

Degree of MSc

Computer Science

06 21921

Fundamentals: Data Structures and Algorithms

Summer Examinations 2010

Time allowed: 1 ½ hours

[Answer THREE out of FOUR Questions]

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1. (a) Define the following four notions –

data, information, abstraction, an abstract data type.

[10%]

(b) Give two possible levels of abstraction, each with a minimum of two attributes, for the following:

(i) an international airport
(ii) your CD collection
(iii) a Data Structures module of 20 lectures.

[18%]

(c) State **three** features necessary in a programming language to support data abstraction. [6%]

2. Consider a proposal to solve the collision problem in an External Hash Table organisation by constructing overflow binary search trees instead of overflow linearly linked lists.

(a) How might each entry in the Hash Table be viewed in implementing this proposal? [6%]

(b) Illustrate the two alternative organisations referred to above, i.e. collision with linearly linked lists and collision handling using binary search trees, by using a mapping Hash function of H(key) = key MOD 11 (the remainder after dividing the key by 11) to store the following strict sequence of integer key values.

46, 110, 25, 126, 73, 88, 27, 121, 14, 137, 139,
66, 92, 62, 150, 117, 99, 132, 55

[20%]

(c) State one way by which the efficiency of insertion and access to keys in these two organisations could be improved. [8%]

3. (a) Construct a Binary Search Tree (BST) from the following strict sequence of integer values –

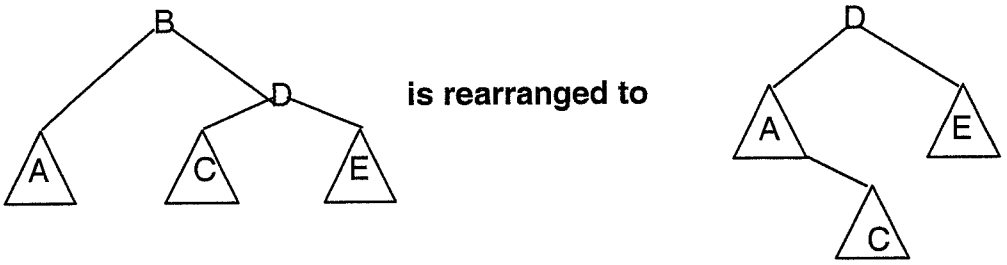
17, 11, 13, 9, 7, 12, 15, 21, 32, 10, 19, 20, 47, 18, 14

[8%]

(b) Draw the tree you constructed in part (a) after deleting node 17. Outline your deletion procedure. [12%]

(c) The delete operation on a BST can be achieved by moving entire sub trees as the following illustrates -

Deleting node B in the tree below



Draw the result of applying this procedure to delete node 21 in the BST you constructed in part (a) above.

[14%]

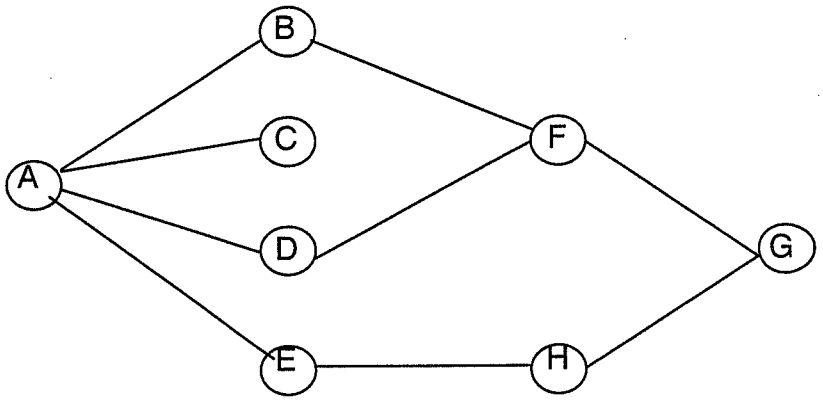
4. (a) Define the ADT known as a **graph** and briefly describe **two** possible representations for such a data type. [6%]

(b) Outlined below is an algorithm for a **depth first** traversal (DFT) of graph data type. Present an overview of how the algorithm works.

```
ALGORITHM DFT(s)
(* the argument s is a graph node and the vector visited(n) corresponds
to the n vertices of the graph, each initialised to zero*)
BEGIN
   visited(s) set to 1
    FOR each vertex w adjacent to s DO
      IF visited(w) = 0
        THEN
            Add edge (s,w) to edge sequence
            DFT(w)
      ENDIF
END
```

(8%)

(c) Consider the algorithm in part b) above and the following graph -



Starting at node A show two distinct sequences generated using the depth first traversal. How could the algorithm and graph representation be changed so that only one sequence is generated? [10%]

(d) Using the definition of a graph **cycle** modify the depth-first algorithm given above to detect the presence of a cycle. Demonstrate its use by applying it to the above graph. [10%]

End of Paper