IMPERIAL COLLEGE OF SCIENCE, TECHNOLOGY AND MEDICINE

EXAMINATIONS 2010

BEng Honours Degree in Computing Part II
MEng Honours Degrees in Computing Part II
BSc Honours Degree in Mathematics and Computer Science Part II
MSci Honours Degree in Mathematics and Computer Science Part II
for Internal Students of the Imperial College of Science, Technology and Medicine

This paper is also taken for the relevant examinations for the Associateship of the City and Guilds of London Institute
This paper is also taken for the relevant examinations for the Associateship of the Royal College of Science

PAPER MC202

SOFTWARE ENGINEERING - ALGORITHMS

Tuesday 4 May 2010, 14:30
Duration: 60 minutes
(Reading time 5 minutes)

Answer ALL TWO questions

Paper contains 2 questions
Calculators required

Section A (Use a separate answer book for this Section)

1 a i) Compare and contrast “Big Theta”, “Big Omega”, and “Big O”.

ii) Give plausible “Big Theta” and “Big O” expressions for the following function.

$T(n) = n + 10 \log n \Rightarrow T(n) =$

iii) Indicate whether each expression is true or false.

$f(n) = O(2^n) \Rightarrow f(n) = O(n^2)$

$n^2 + (1.5)^n = O(2^{\frac{n}{2}})$

$n \log n + \Theta(\sqrt{n}) = O(n\sqrt{n})$

b Explain how the digital search tree and binary search trie compare. Be sure to discuss tradeoffs in using one versus the other.

c i) Draw the optimized existence TST that results when you insert the first three (3) keys defined by suffixes of the string

`arandomstring`

in decreasing order of their length (i.e., moving left to right) into an initially empty trie.

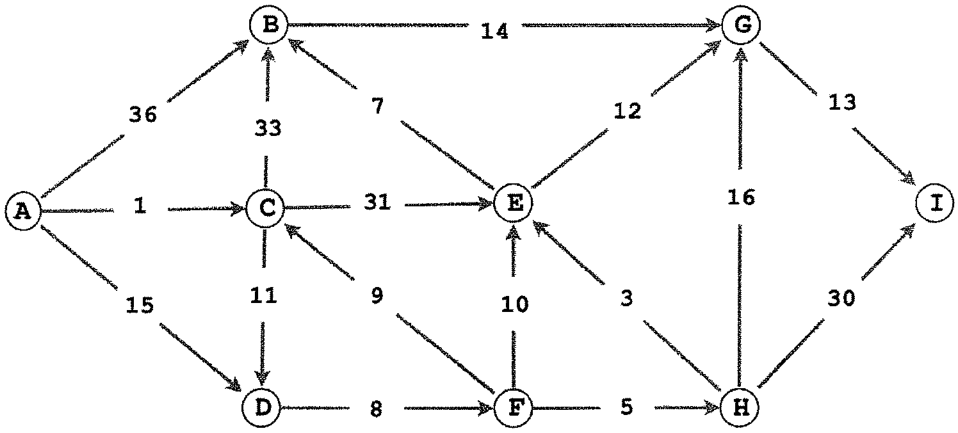
ii) Describe how you would decrease the space used by the optimized TST as compared to a naive implementation.

d Your must find the longest (contiguous) substring that appears in two different novels, using one of the data structures discussed in the module. Sketch your solution in prose (i.e., do not attempt to write a program). Justify your approach, which will be evaluated based on its correctness, efficiency, and clarity.

The four parts carry equal marks.

Section B (Use a separate answer book for this Section)

2a Run Dijkstras algorithm on the weighted directed graph below, starting at vertex A.



List the vertices in the order in which the vertices are dequeued (for the first time) from the priority queue and give the length of the shortest path from A.

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vertex:    A  ___  ___  ___  ___  ___  ___  ___  ___
distance:  0  ___  ___  ___  ___  ___  ___  ___  ___
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b Consider the following linear-programming system of difference constraints (note that one constraint is an equality):

$$x_1 - x_4 \leq -1$$
$$x_1 - x_5 \leq -4$$
$$x_2 - x_1 \leq -4$$
$$x_2 - x_3 = -9$$
$$x_3 - x_1 \leq 5$$
$$x_3 - x_5 \leq 2$$
$$x_4 - x_3 \leq -3$$
$$x_5 - x_1 \leq 5$$
$$x_5 - x_4 \leq 1$$

i) Draw the constraint graph for these constraints.

ii) Solve for the unknowns x_1, x_2, x_3, x_4 and x_5 or explain why no solution exists.

c A large number of problems that we now refer to as optimization problems actually date back to King Arthur's time. The following example is no exception: King Arthur's court had n knights. He ruled over m counties. Each knight i has a quota q_i of the numbers of counties he can oversee. Each county j, in turn, produces a set S_j of the knights that it would be willing to be overseen by. King Arthur sets you the task of computing an assignment of counties to the knights, so that no knight would exceed his quota, while every county j is overseen by a knight from its set s_j.

i) Show how you can employ the Max-Flow algorithm to compute the assignments.

ii) Describe the running time of your algorithm (You may express your running time using function $F(v, e)$, where $F(v, e)$ denotes the running time of the Max-Flow algorithm on a network with v vertices and e edges).

The three parts carry, respectively, 30%, 30%, and 40% of the marks.