UNIVERSITY OF LONDON

IMPERIAL COLLEGE OF SCIENCE, TECHNOLOGY AND MEDICINE

EXAMINATIONS 1998

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 Royal College of Science
Associateship of the City and Guilds of London Institute

PAPER 2.11 / MC2.11

ARTIFICIAL INTELLIGENCE
Tuesday, May 12th 1998, 2.00 - 3.30

Answer THREE questions

For admin. only: paper contains 4
questions

1   Charles Dodgson (better known as Lewis Carroll) proposed the following Word Chain problem:

> Given two N letter words, form a chain between them by changing a single letter at a time, but ensuring that each intermediate string is a valid word.

> For example **HORSE** could be transformed to **MOOSE** by the (not necessarily shortest) chain of words:

<div align="center">

HORSE - HOUSE - MOUSE - MOOSE

</div>

a   Specify carefully what is meant by the State Space of any problem.

b   What is the theoretical maximum number of states for the N letter word chain problem?

What is the theoretical branching factor for naive breadth first search on the N letter word problem and how many states are theoretically reachable in **S** steps of a breadth first search?

Explain why the **real** branching factor is very much less than this.

c   Consider the Word Chain problem of changing a **BOY** into a **MAN**:

Generate part of the **actual** state-space for this problem. Try to include at least 16 words and a couple of solution paths.

d   Given any two N letter words, what is the theoretically shortest possible chain length between them? Justify your answer.
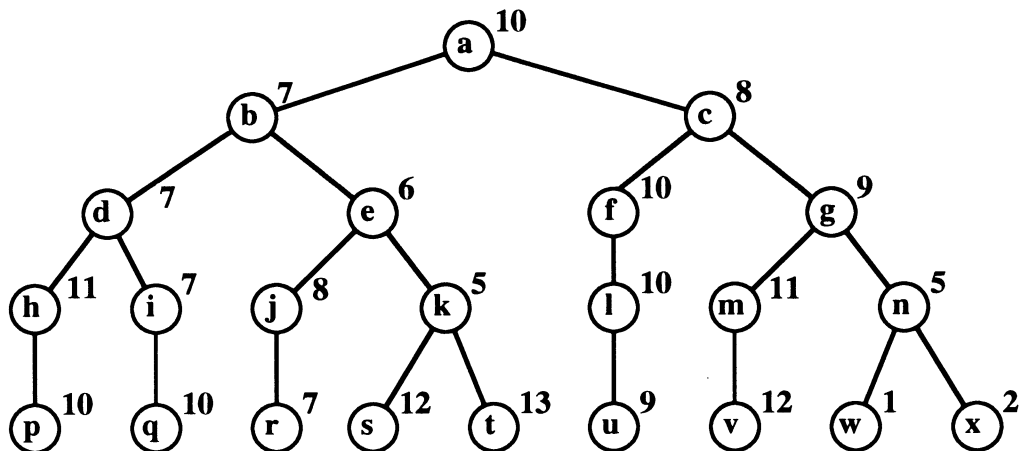
In view of this suggest a simple rule for the best change to take next and show how it would work on your state Space from part c. What would happen if the problem was to transform BOY into BIT?

2a   In the context of planning explain what is meant by *linearly separable problems* and why *Frame Axioms* are needed.

What method did Newell's General Problem Solver (GPS) use to guide its search?

b   Describe, with an example, what information a STRIPS-like planner needs about a planning problem and outline how it goes about generating a plan to solve such a problem.

c   Create an example of a *four-block* problem in the *Blocks World* domain illustrating Sussman's Anomaly.

d   Explain what problem(s) STRIPS-like planners have with Sussman's anomaly and why they arise. Suggest two ways in which they could be modified to get efficient plans for such anomalous situations.

3   The following is part of the search tree of a one person game. The number beside each node is the Positional Evaluation Function (PEF) value associated with it. In this game a **smaller** evaluation function value is better!

a 10
b 7   c 8
d 7   e 6   f 10   g 9
h 11   i 7   j 8   k 5   l 10   m 11   n 5
p 10   q 10   r 7   s 12   t 13   u 9   v 12   w 1   x 2

a   Specify the general Best First search algorithm explaining the function of the **open** and **closed** lists during the search. Demonstrate the search behaviour of Best First on the above game tree.

b   A new evaluation function **f** is defined for each node N:

$$f(N) = PEF(N) + g(N)$$

where g(N) = the "cost" of getting to the node and each step taken costs 3 units.

Apply Best First search to the above tree with the new evaluation function and once again show its behaviour.

In general what are we attempting to achieve with this new function?

c   Explain how Hill Climbing search differs from Best First search. Apply Hill Climbing to the above game and comment on its result. Suggest what could be done to resolve the problem.

4a   Commercial Chess programs exist which are capable of beating most players below Master level. Outline **three** reasons why they should not be considered Expert Systems in spite of their obvious expertise.

b   Define the terms *accountability* and *human window* and explain their importance in the context of expert systems. Describe, with an example of each, the features which should be present in an expert system to support these properties.

c   Give two further important limitations of current expert systems and briefly discuss ways in which you would try to overcome them.

End of paper