# UNIVERSITY OF LONDON
# IMPERIAL COLLEGE OF SCIENCE, TECHNOLOGY AND MEDICINE

## EXAMINATIONS 1998

BSc Honours Degree in Mathematics and Computer Science Part III
MSci Honours Degree in Mathematics and Computer Science Part III
MSc Degree in Computing Science
for Internal Students of the Imperial College of Science, Technology and Medicine

*This paper is also taken for the relevant examinations for the*
*Diploma of Membership of Imperial College*
*Associateship of the Royal College of Science*

## PAPER M3.26

## ARTIFICIAL INTELLIGENCE

Tuesday, May 12th 1998, 2.00 - 4.00

*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:
>
> HORSE - HOUSE - MOUSE - MOOSE

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.

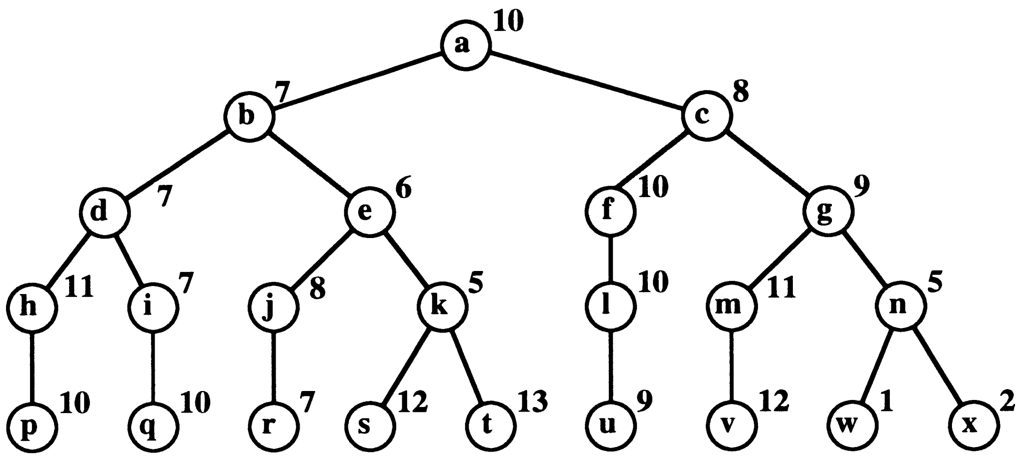
In view of this suggest a simple rule for the best change to take next and show how it would work on your *State Space* from part c. What would happen if the problem was to transform BOY into BIT?

e Outline the design for a program to match human performance in this *mind game* .

What kind of resources would it need and what is it's likelihood of success?

2 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 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.

d Define *penetrance* and use it to compare the effectiveness of Best First Search in part b with simple Breadth First Search.

*Please turn over ...*

3a 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.

e Briefly discuss one other major problem which simple planners like STRIPS or WARPLAN have in real situations with a large number of operators. Outline how STRIPS could be modified to ameliorate that 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.

d Show, with an example, how learning could be used to ease the knowledge assimilation bottleneck for expert systems. Indicate how this can give rise to *human factors* problems and suggest a way of overcoming them.

*End of paper*