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

## EXAMINATIONS 1997

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

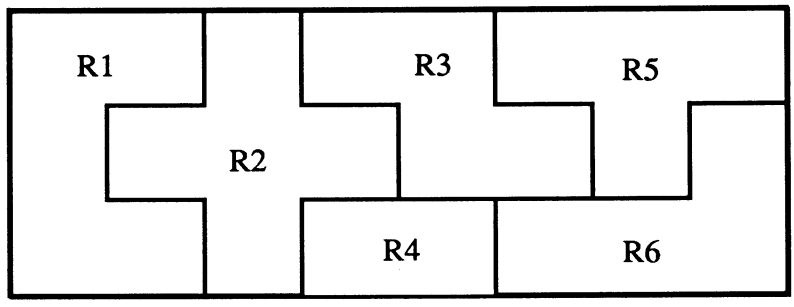
Tuesday, April 22nd 1997, 2.00 - 3.30

*Answer THREE questions*

For admin. only: paper contains 4 questions

1a Specify the two components of any Constraint Satisfaction problem (CSP) and give three specific examples of such CSPs.

b Give the three stages you have to go through when finding a solution to a CSP and illustrate the stages on the task of finding a colouring of the following map using only three or four of the colours - red, green, blue and yellow.




R7 (All of the outside)

c Show how your initial naive program generates a solution. Then explain carefully two ways in which the running of your program could be made more efficient.

*The three parts carry, respectively 25%, 40% and 35% of the marks.*

2a Carefully explain the terms *Best First Search*, *Heuristic cost function* and *Admissible search algorithm.*

The Five puzzle is a simplified version of the Eight puzzle with 5 numbered tiles in a 3 x 2 tray.

| | | | |
|---|---|---|---|
| The Start state is | 4 5 2<br>1 3 | and the Goal state is | 1 2 3<br>5 4 |

b Without generating the search space, prove that breadth first search is admissible. Suggest two other examples of admissible heuristic functions for the 5 puzzle indicating how they could be "discovered" from the rules of the puzzle.

c Describe carefully the requirements and operation of the A* search algorithm, using the Five puzzle with one of your two heuristic functions as an example. Show how A* differs from the simple *best first search.* When expanding the selected node in the tree you should chose to move the gap *first* right *then* left, up and down (whichever are applicable).

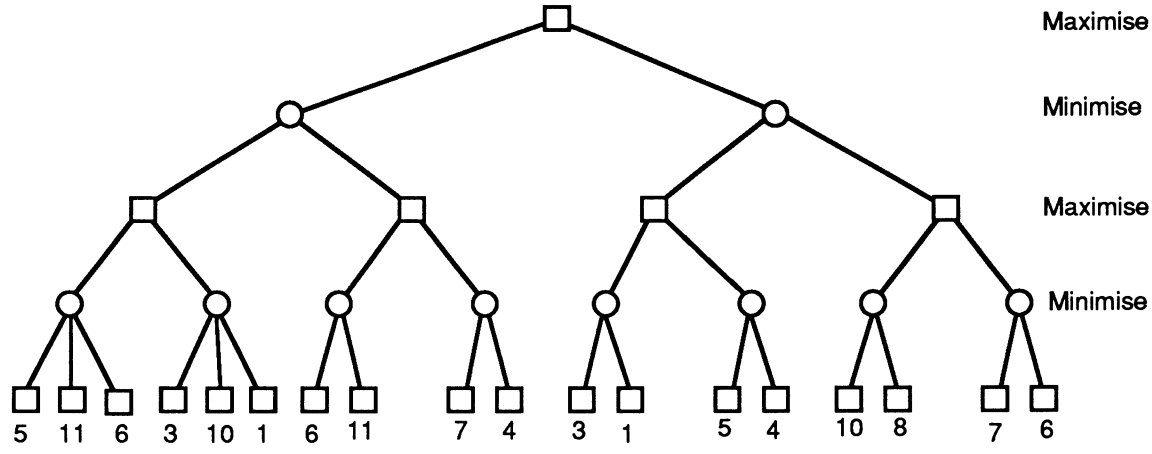
d Define *Penetrance* and use it to compare the effectiveness of the search in part b) using your chosen heuristic function, with a simple breadth first search (assuming an average branching factor of two for this problem).

*The four parts carry, respectively, 25%, 25%, 35% and 15% of the marks.*

3a Define the terms Static Evaluation function, Quiescence and Horizon Effect giving examples of each.

b Describe the Minimax procedure on the following Game tree.

Then show carefully how the Alpha-Beta cutoff can reduce the number of nodes which need to be evaluated.




c Give one other method of improving the search and indicate the factors which affect the effectiveness of any search methods chosen.

d What critical assumption does the Minimax procedure make when choosing the "best" move?

Briefly explain why a program using the Minimax procedure cannot play as effectively as an experienced human player against a novice. Outline how this could be remedied.

*The four parts carry, respectively, 30%, 35% 15% and 20% of the marks.*

4a State two reasons, one from each stream of Artificial Intelligence research, why Natural Language Processing is an important topic in AI, giving examples .

b Briefly describe the capabilities of two early natural language systems, indicating their limitations when considered as *Intelligent systems.*

c Carefully explain *Schank's Explanation Game* and his aim in proposing it .

State two abilities of programs that he is using it to look for. Suggest some essential components a program should possess to satisfy his test

d Give *two* examples of ways in which humans "test the intelligence" of their peers. Outline how a program could be developed to "pass" *one* such test.

*The four parts carry, respectively, 20%, 25%, 30% and 25% of the marks.*

*End of paper*