UNIVERSITY OF LONDON
IMPERIAL COLLEGE OF SCIENCE, TECHNOLOGY AND MEDICINE

EXAMINATIONS 2000

BEng Honours Degree in Computing Part II
MEng Honours Degrees in Computing Part II
BEng Honours Degree in Mathematics and Computer Science Part II
MEng Honours Degree in Mathematics and Computer Science Part II
BEng Honours Degree in Mathematics and Computer Science Part III
MEng Honours Degree in Mathematics and Computer Science Part III
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 C231=MC231

ARTIFICIAL INTELLIGENCE I

Wednesday 17 May 2000, 14:00
Duration: 90 minutes
(Reading time 5 minutes)

Answer THREE questions

Paper contains 4 questions

1 A game is played with a pile of 5 gold coins. Two players A and B take it in turns to remove 1, 2 or 3 coins from the pile. When all the coins are finally taken each player must discard all complete sets of three coins they hold. If both players are left with one coin then the game is a draw. Otherwise the player holding a non zero number of coins wins all the coins.

a i) For this two person game explain what is meant by the terms *Game Tree*, *backed up values* and *forcing tree*.

ii) What information must be held for each position in this game?

b Draw the game-tree for this game and compute the expected outcome using the mini-max procedure. Generate moves in your tree in the order *take 1*, *take 2* or *take 3 coins*.

Hint - **do not** duplicate states when generating the tree.

c Show carefully on your game tree how Alpha-Beta cutoff can be used to reduce the number of nodes that need to be expanded. How many nodes can be safely ignored?

If the moves are now considered from right to left in the tree (ie in the order *take 3 coins*, *take 2 coins*, *take 1 coin*) then show how this changes the effectiveness of alpha-beta pruning. Suggest why this is so.

2a Give two reasons, one from each stream of Artificial Intelligence research, why Natural Language Processing is an important topic in AI.

Explain carefully why Schank proposed his "Explanation Game".

b Use Schank's "game" approach to rate the "quality of NL understanding" of current Internet search engines in terms of the pages they retrieve in response to the types of query you can ask. Give examples of two problems caused by current search engine limitations and suggest how one of these could be ameliorated.

To answer more complex questions a system needs to use some kind of semantic "meaning" representation. You are given the following passage:

> Tom loved tinkering with cars and finally he saved enough money to buy a sports car. Unfortunately the rear visibility was poor so he backed into a low wall and smashed his rear lights. The garage gave the cost of the repair as labour plus twice the cost of a rear light unit. They said rear light unit was £50 and labour was £70 since a light unit needed a special tool and took ages to fit.
>
> Tom immediately checked his bank balance and then started frantically hunting through his tool boxes.

c Give an appropriate meaning representation of relevant parts of the passage (and queries) which could enable a system to answer such questions as:

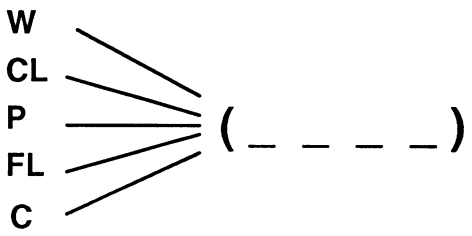
How much was the price for the repair?

Briefly sketch out the steps by which this meaning representation might be extracted from the English text.

3a Describe briefly the three main mechanisms proposed for the development of Artificial Intelligence, giving an example of the application of each one.

b The following is a question from an "IQ" test which is traditionally supposed to measure "intelligence".

QU: Work out the word in brackets which can be prefixed by each of the letters on the left to make other valid words.



[NOTE - You do NOT need to solve these IQ problems for this exam question and for your interest the answers are at the end of the question].

Suggest your own design for a program which could solve this and similar problems indicating any special resources which would be required and difficulties which might be encountered.

c Outline what extensions would be necessary for your program to be able to find the words in the brackets in the following IQ-Test question

(Note that + means string concatenation).

C + <piece of furniture> = <accommodation>

What qualities do you think a person would require to be able to solve these problems and state briefly what this tells us about a program also able to solve them?

(The missing words in parts a) and b) are INCH and STABLE)

4 The QuadFlip Puzzle consists of 4 counters placed in a line. Each counter is red on one side and white on the other. The start state has the 4 white faces uppermost.

An allowable move is to simultaneously flip over of any two adjacent counters so that each counter stays in the same position but changes its colour.

a Specify carefully what is meant by the state space of a problem.

b Using the breadth first search control strategy, generate the state space attainable from the given initial position, numbering the states in the order in which they are visited.

What are the total number of possible states in the QuadFlip puzzle? Why is this not the same as your generated space?

(When building the state space assume that moves are generated in the order *invert-left-pair, invert-middle-pair, invert-right-pair*).

c State and illustrate the general problem that the *naive depth first* search strategy has with this puzzle and ones with similar state spaces. Suggest a way in which it can be overcome.

The resulting augmented depth first search after considerable computation finds that the state below is unreachable. Suggest a general property of this Goal state which enables us to decide without search whether or not it is accessible from the given initial state.

End of paper