UNIVERSITY OF EDINBURGH

FACULTY OF SCIENCE

ARTIFICIAL INTELLIGENCE 2

Monday, 10th June, 1985 2-5p.m.

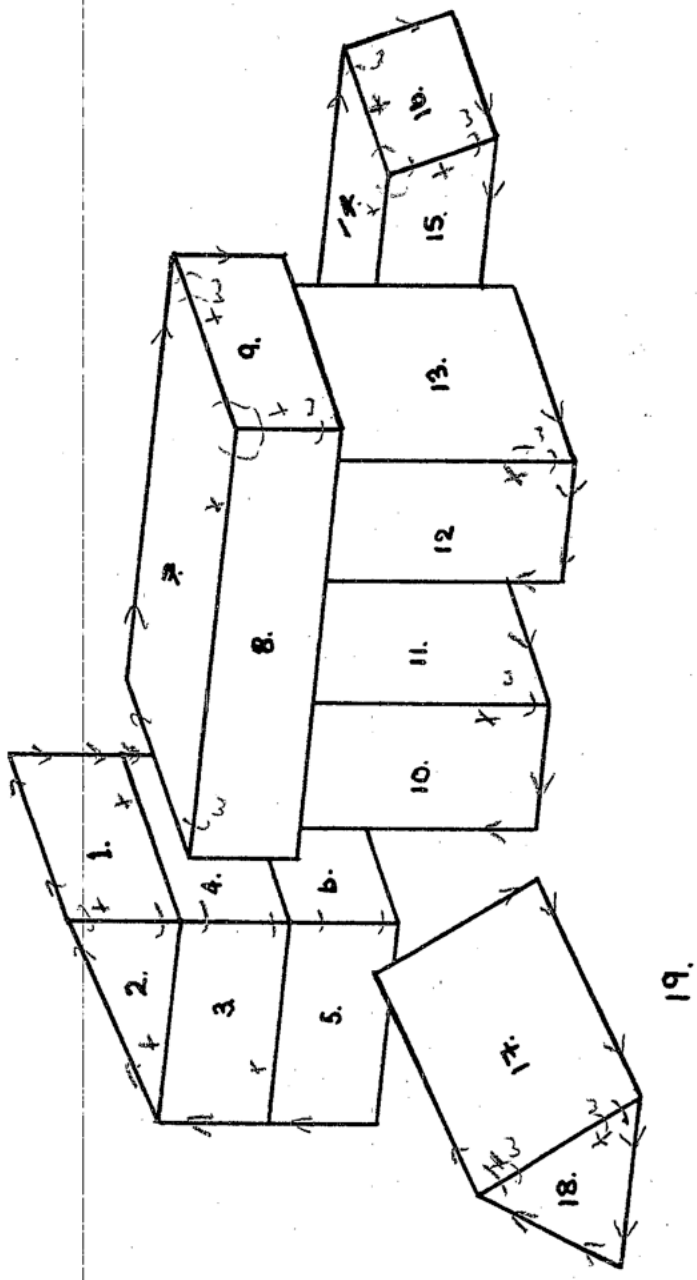
Examiners: Chairman J A M Howe
External J B H du Boulay

INSTRUCTIONS TO CANDIDATES

1. Candidates in the third or later years for the degree of B.A. (Arts), B.Com., B.Sc. (Social Sciences) B.Sc. (Science) and LL.B. should put (3) after their names on the script book.
2. Answer any FOUR questions. All questions carry equal weight.
3. Each question is marked out of 15. The marks at the side of the questions show how these are apportioned.

WORKSHEET FOR QUESTION 2

NAME. .....



REMEMBER TO DETACH THIS WORKSHEET AND ATTACH IT TO YOUR ANSWER BOOKLET

1. a) For quality control in a toy factory, you have to build a 3-D vision system capable of checking that a toy Action Man doll, standing on his own on a flat surface, has a complete set of components, i.e. head, torso, arms and legs. Which 3-D vision techniques would you use? Outline each, describing the assumptions you have made about the situation. (8)

b) Explain how you might alter the system to check groups of dolls, where the problem is partial occlusion of body parts. (5)

c) Discuss the strengths and weaknesses of the techniques chosen. (2)

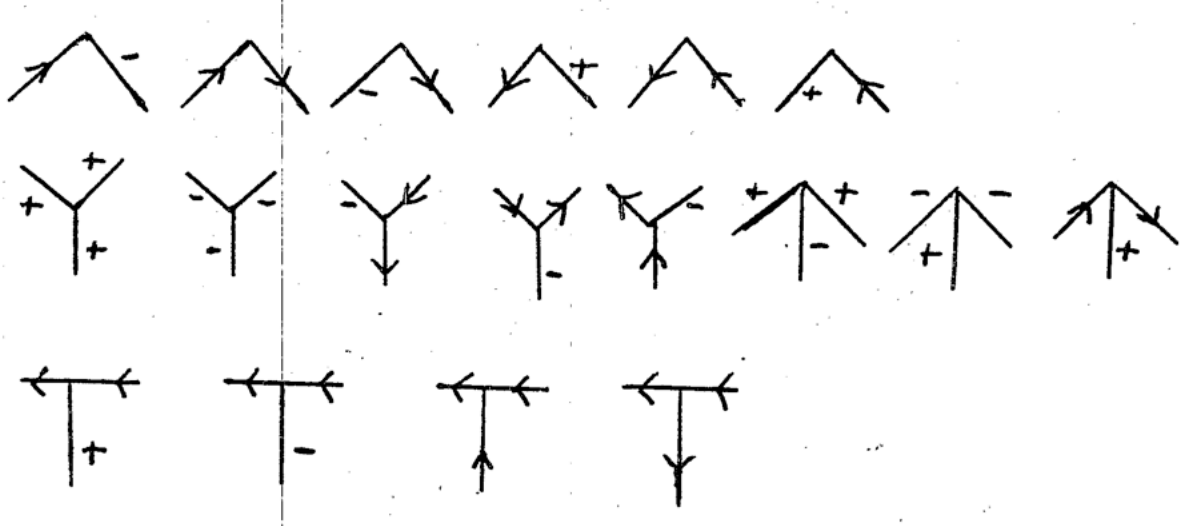
2. a) Why is the Huffman/Clowes/Waltz line labelling technique more successful at segmenting a blocks world scene than Guzman's region linking technique? (3)

b) Label the scene given overleaf on the worksheet provided, using the junction labels given below. (7)

c) Identify the bodies as lists of regions, and explain your separation criterion. (2)

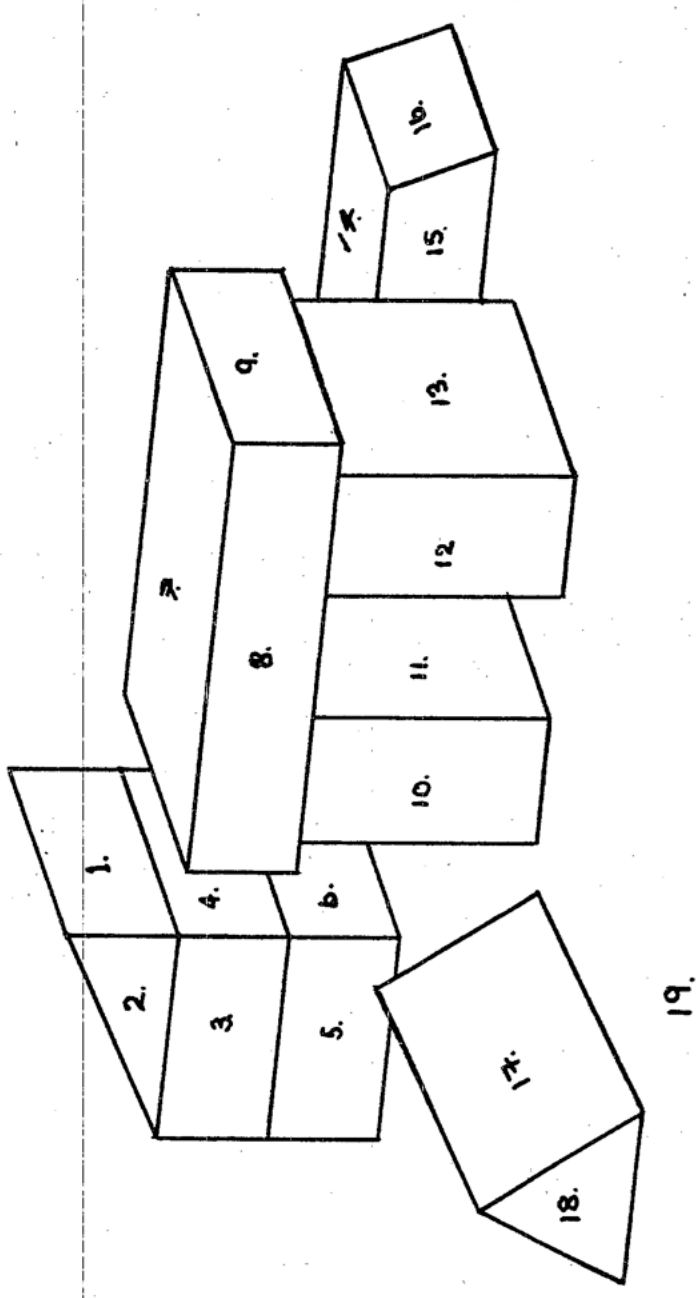
d) Discuss any problems encountered during the labelling of this scene. (3)

NOTE: Attach worksheet securely to outer booklet.



WORKSHEET FOR QUESTION 2

NAME. .....



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3. Forward chaining and backward chaining are control strategies used in conjunction with a production rule knowledge base.

   a) Define forward and backward chaining briefly. (3)

   b) Depending on certain characteristics of rule sets, one strategy may be much more efficient than the other. Describe two of these characteristics. (4)

   c) Justify your claims in part (b) by constructing toy rule sets which differ according to the characteristics you have described above. Indicate which strategy is more efficient for each rule set and demonstrate clearly why this is so. Be sure to state any assumptions made. (8)

4. Choose one of the following expert systems which you studied this year: MYCIN, INTERNIST, CASNET, CENTAUR, MECHO. Explain how it works. (15)

   [It is not necessary to include a vast amount of detail. The only thing that matters is that you demonstrate that you understand the system. Suggestion: Begin with a high level description (with diagram(s)s) of the overall system architecture. Describe the structure of the knowledge base and the control mechanisms. Finally, discuss by way of simple examples how problem solving is achieved. Be sure to include any focusing strategies employed which reduce search.]

5. a) Using the lexical categories:

Det:	a, the
Num:	four
N:	party, friend, bottle, tubes
PropN:	Bruce, Sheila, Fosters
Prep:	of, with, to
Adj:	large
V:	went, took
Conj:	and

give a context-free phrase structure grammar for the following sentences (capturing any structural ambiguities).

i) Bruce and Sheila went to a party.

ii) Sheila took four tubes of Fosters.

iii) Bruce went to the party with a friend and a large bottle. (5)

b) Give tree diagrams generated by your grammar for sentence (iii) reflecting two of the possible different structural analyses of the sentence. Bracket the sentence to indicate each of the meanings these reflect. (5)

c) Draw RTN's that could generate these three sentences, based on your grammar. (3)

d) Briefly, describe how the structural ambiguity in your grammar is reflected in the RTN's. Describe two principal ways a parser designed to use such an RTN grammar can cope with this, to produce all possible structures. (2)

6. Consider a question-answering system that can answer questions relating to poker hands. Assertions are represented in predicate logic. Questions are answered by proving theorems in predicate logic.

The following assertions are made by the user:

i) Luigi has a pair.
ii) Renaldo has a flush.
iii) Pepe has a fullhouse.

a) Translate these assertions into predicate logic formulae, using a predicate 'has'. (1)

b) Represent the following meaning postulates in predicate logic formulae using the predicate 'has', a two place predicate 'beats' and a single place predicate 'winner'.

M1. A flush beats a pair.
M2. A fullhouse beats a flush and a pair.
M3. The winner is the person who beats all the other players. (3)

c) Consider the following questions:

1. Does Renaldo beat Luigi?
2. What does Pepe have?
3. Who is the winner?

Translate each of these three questions into predicate logic theorems to be proved; make the steps that you use in the translation explicit. (6)

d) Using the assertions and meaning postulates, trace out goal-directed proofs for each of these three questions. (3)

e) Explain why ATN's are more powerful mechanisms than RTN's, particularly in relation to dealing with Wh-questions. (2)

7. Make a ROBMOD model of a swivel chair. This should have feet in the form of a cross, a supporting column, a seat which is a rectangular block and a backrest (of adjustable height) which is also a block. Draw the chair you have modelled. (15)

8. A controller for lifts is to be designed, using an incremental shaft encoder and a servo-motor to position the passenger carrying cage. The high-level portion of the control system is to be written in Prolog. The following predicates are provided:

button(N)	will succeed if the button on floor N has been pressed since the last call of button with the same N.
cagebutton(N)	will succeed if the button in the cage corresponding to floor(N) has been pressed since the last call of cagebutton with the same N.
move_to(H)	will move the cage to height H.
opendoors	opens the doors of the cage.
closedoors	closes the doors of the cage.

a) To adapt the controller for a given building, it is necessary to write a height predicate, where height(N,H) says that the floor number N is at height H. Write down a definition of this predicate for the building shown in the figure overleaf. (3)

b) Write a descend predicate, where descend(N) will be called only when the lift is above floor N, with the doors closed, and will cause the lift to stop at every floor N1, where $N1 \leqslant N$, for which a button has been pushed. (9)

c) What would be a possible serious consequence of a failure of the shaft encoder? What technique could be used to detect malfunction of the shaft encoder? (3)

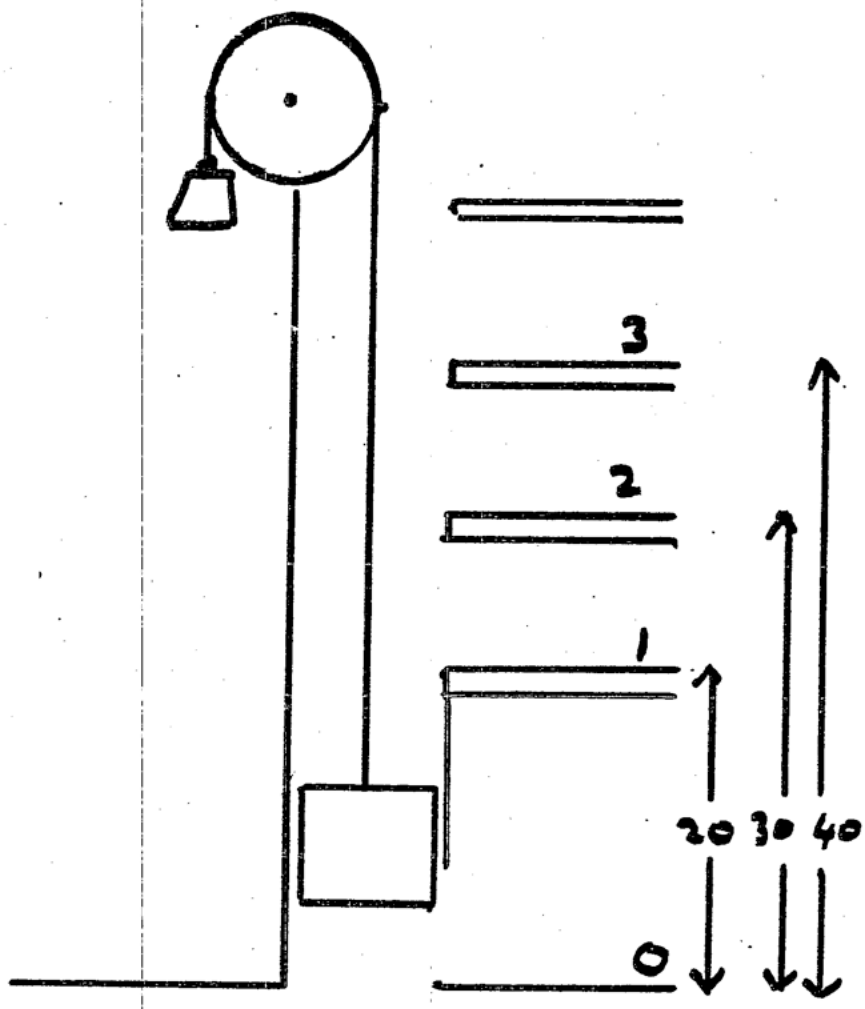

Figure for Question 8

6. a) Translate the following sentences into predicate calculus:

i. Some men are fat.
ii. All sincere men are honest.
iii. Some men are either jolly and honest or fat.
iv. All fat men are jolly and sincere.

[7]

b) Give a context-free grammar for sentences such as those in a).

[6]

c) For each production in your answer to b), give a rule for computing the meaning so that the translations you gave in a) are produced as the meanings of those sentences.

[6]

d) Translate the sentence

Some men are jolly and honest.

and show how it can be proved true from the answers generated in a) using a goal-directed proof.

[6]