UNIVERSITY OF EDINBURGH

FACULTY OF SCIENCE

ARTIFICIAL INTELLIGENCE 2

Thursday, 11 September 1986 — 14.00 - 17.00

Examiners: Chairman J A M Howe

External B du Boulay

INSTRUCTIONS TO CANDIDATES

1. Candidates on the third or later years for the degree of B.A. (Arts), B.Com., B.Sc. (Social Science), B.Sc. (Science) and LL.B. should put (3) after their names on the script book.

2. Answer any FOUR questions, writing each answer in a separate script book. All questions carry equal weight.

3. Each question is marked out of 25. The marks at the side of the questions show how these are apportioned.

4. Attach the work sheet provided to your examination script and make sure your name is on it.

1. a) Give a detailed definition of the term 'Expert System'. Be sure to describe the main issues which expert systems builders need to address. Indicate how it differs from a 'conventional' program.

[10]

b) Choose one of the following expert systems. Explain in as much detail as possible how it works. Be sure to address all the points and/or weaknesses of the system you describe.

i. MYCIN
ii. CENTAUR
iii. MECHO
iv. INTERNIST

[15]

2. a) Describe the fundamentals of the following knowledge representation formalisms and their associated inference mechanisms.

i. Production Rules
ii. Structured Objects
iii. Predicate Logic

[10]

b) Suppose you were required to build an expert system whose task was to identify a particular species of mammal, given such information as body size and weight, number of legs, colour, etc. Do an informal preliminary design of such an expert system, taking the following questions into account:

i. Which one (or more) of the above formalisms would you choose to use? Why?

ii. Describe how you would use the chosen formalism(s). You must:

(1) Encode some actual knowledge from the domain into the formalism(s).

(2) Give some example inferences.

(3) Describe how you imagine an actual session with the end user might go and how it can be made to work using the chosen formalism. Use your answers from (1) and (2) to illustrate this.

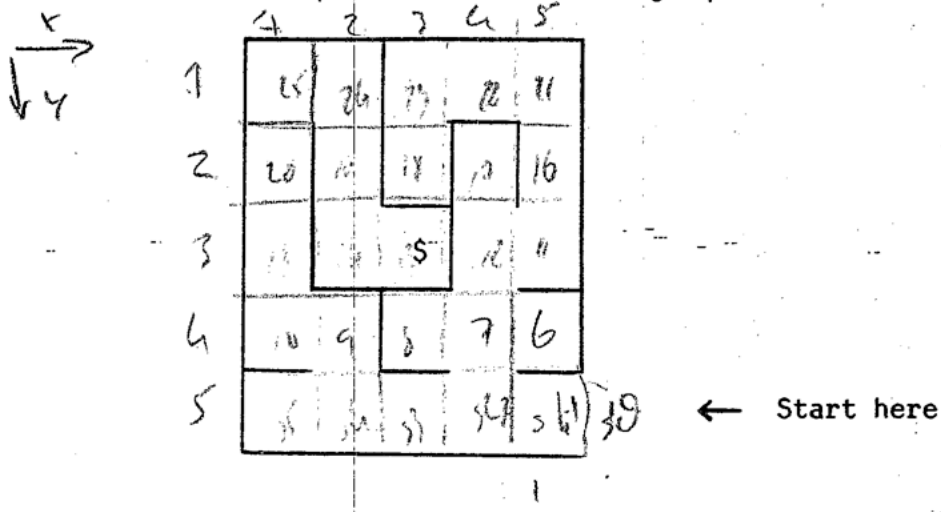
(4) Discuss anything else which you think is important.

iii. Critique your design. What are the advantages and disadvantages of the formalism you chose? Discuss any other tradeoffs implicit in your design.

Give as much detail as possible.

[15]

3. You are to use a state space approach to solve the maze problem in the figure below. The "$" represents the finishing square of the maze.



a) Decide on a formal notation for representing states. NB: You will need to consider the representation of the maze itself.

[3]

b) i. Use the notation from a) to show the initial state.
ii. Give a precise method for detecting whether a given state is a goal state.
iii. Is there more than one goal state for this problem?

[3]

c) Give a formal definition of each conceptually different operator. For each:

i. Describe its preconditions.
ii. Describe its effects.
iii. Give an example.

[5]

d) Describe how the search space can be generated. Illustrate your answer with a diagram of the whole search space. NB: You must include not only the path to a solution, but all possible paths whether they lead to solutions or not.

[5]

e) Two methods which have been developed to reduce the amount of search in problem solving are:

* Using heuristic evaluation functions
* Means-ends Analysis

i. For each of these methods:

(1) Describe how it could be used for this maze problem.

(2) Discuss how effective you think it can be for this problem.

ii. Choose one of these methods and discuss how effective it could be for maze problems in general.

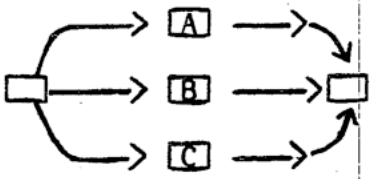
[9]

4. When using the state space approach to solving problems, a plan is a path through world states. An alternate approach to planning is to neglect to carry around these explicit world states, and to represent the plan as a procedural net.

a) What do the nodes and arcs in a procedural net represent?

[4]

b) The following simple procedural net is a concise representation for a plan which leaves some of the execution details undetermined. Give all the possible ways that this plan may be executed.



[3]

c) Suppose the following procedural net represents a partial plan created during problem solving:

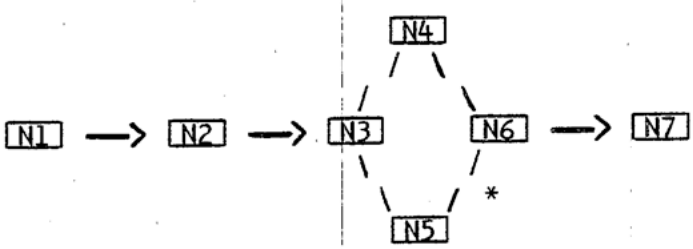
Describe a formal procedure which will determine whether or not an arbitrary assertion 'p' will hold (i.e. be true in the world) at the point in the plan which is marked with an asterisk. You may assume the following:

i. The initial state of the world is known and is represented as a set of predicate calculus assertions.

ii. STRIPS-like Operators are used to model actions.

[6]

d) Can your procedure for part c) be made to work for the following procedural net? If so, describe any changes that may be needed. If not, why not? As before, consider the point in the plan marked with an asterisk.



[6]

e) Give the advantages and disadvantages of creating plans represented as a procedural net without carrying around explicit information about world states.

[6]

5. Explain the difficulties involved in computer understanding of natural language. Your answer may focus on a particular aspect of language understanding (e.g. converting sounds to words) or you may deal with the whole understanding process in a more shallow fashion. Use appropriate examples from English to illustrate your main points. [25]

6. Consider the following four sentences:

   i. Some lecturers teach Artificial Intelligence.
   ii. All students study Natural Language Processing and Prolog.
   iii. Some lecturers and students enjoy Physics.
   iv. All students and lecturers misunderstand Philosophy.

   (a) Give a context-free grammar (including lexical categories) for parsing the sentences i.-iv. above. Make sure that sentences like

   All Physics study students.

   will <u>not</u> be accepted. [8]

   (b) Give predicate calculus translations of the sentences i.-iv. above. [8]

   (c) Is predicate calculus adequate for representing the meaning of sentences like i.-iv. above? Why?

   Discuss the problem of representing the meaning of a sentence like:

   John stopped smoking because it causes cancer. [9]

7. a) What is chain code and why is it useful for 2-D shape recognition? [8]

   b) Explain, in step-by-step fashion, how an image is chain coded. [10]

   c) Discuss the strengths and weaknesses of this approach to object recognition. [7]

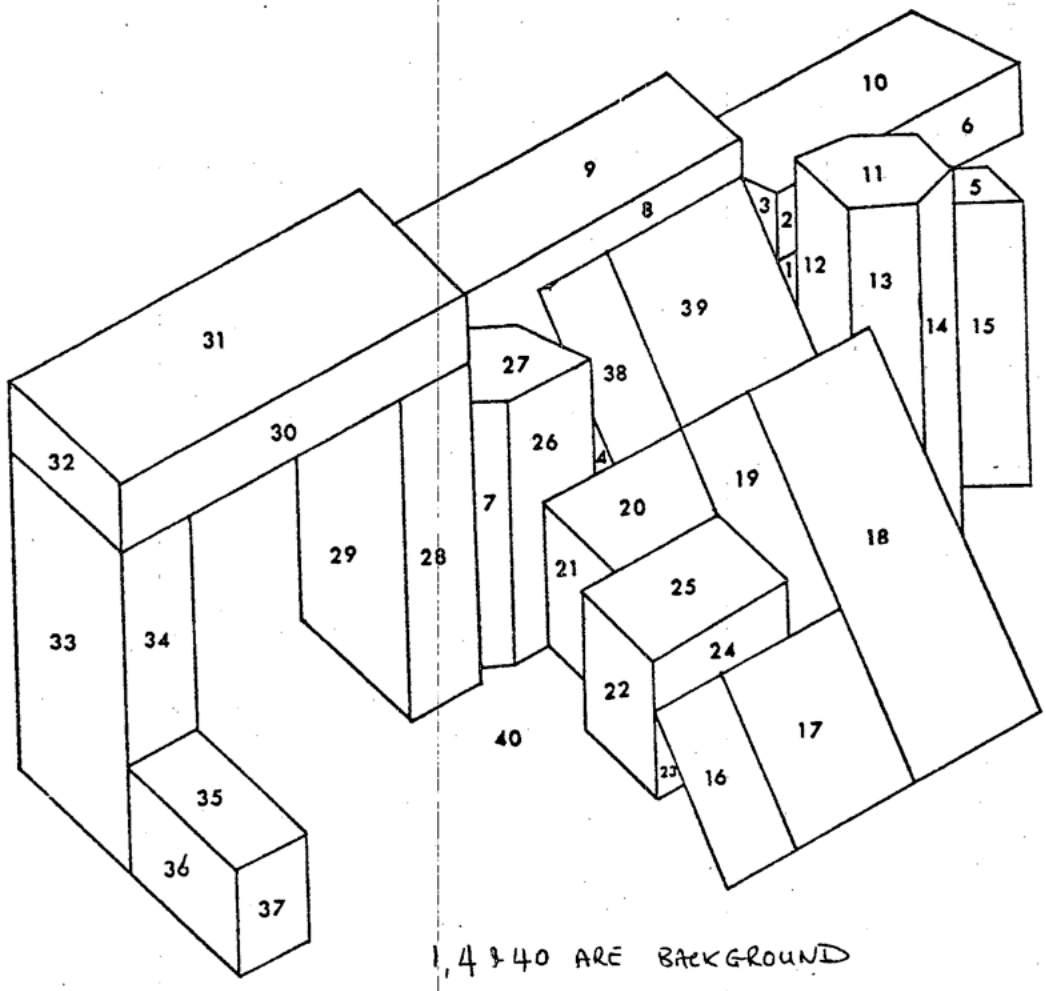
8. Using Guzman's link evidence, segment the scene given below into separate bodies

a) Indicate clearly on the worksheet provided the links between regions (strong and weak). [5]

b) Use a graph to represent the regions and links between regions. Briefly describe Guzman's merge rules and apply them to this graph in a step by step fashion. Write down the bodies, identified as lists of regions. [8]

c) Comment briefly on the strengths and weaknesses of Guzman's approach to scene analysis. [5]

d) Try to construct a scene that cannot be successfully segmented by applying Guzman's techniques. Explain why it fails. [7]



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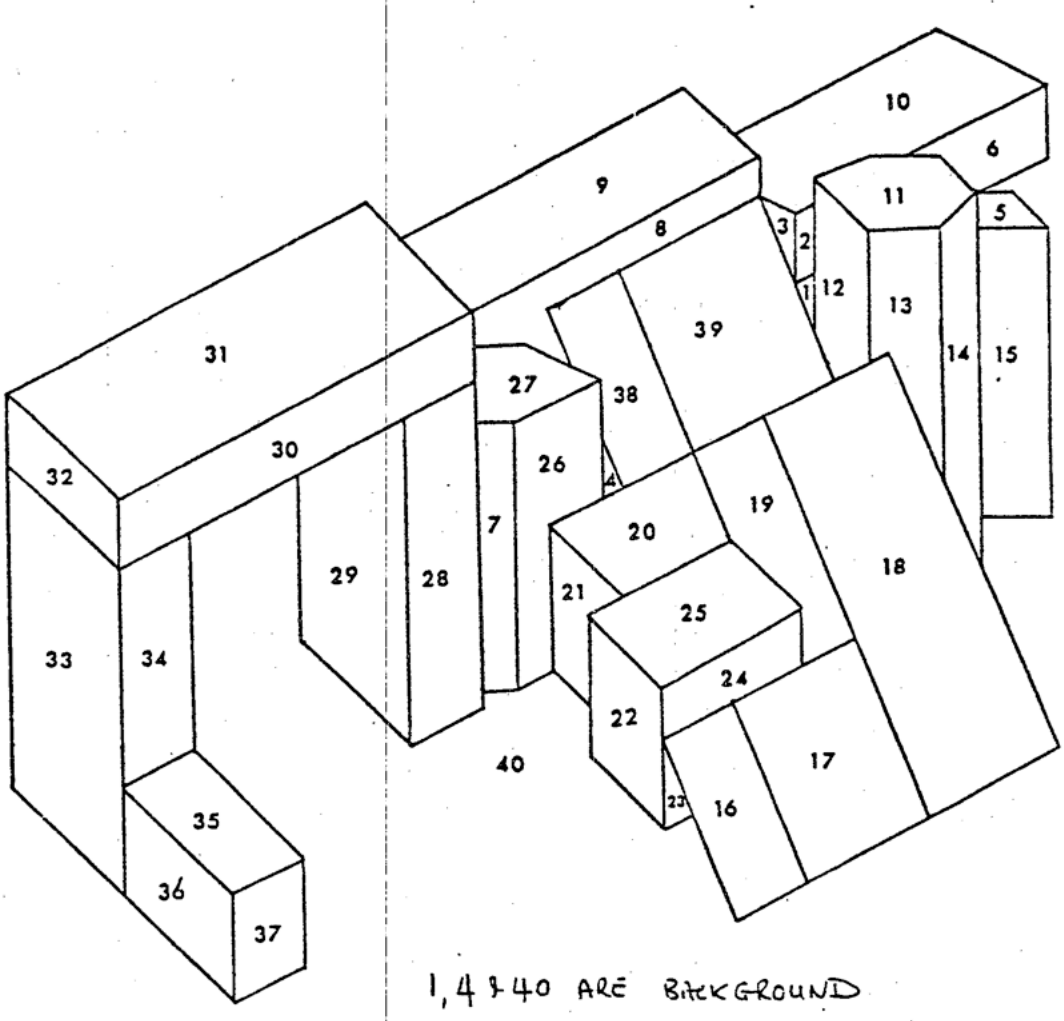
Worksheet for Question 8

Artificial Intelligence 2



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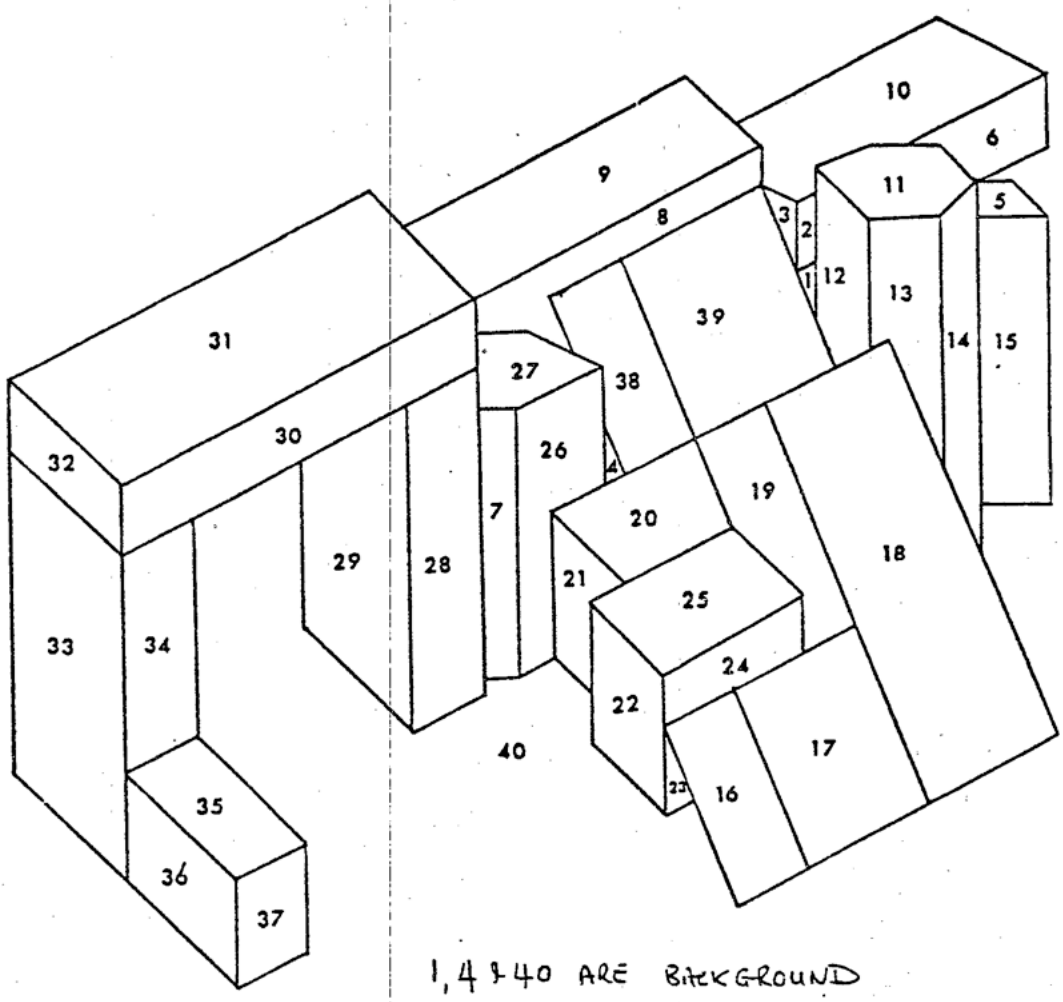
Worksheet for Question 8

Artificial Intelligence 2



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