UNIVERSITY OF EDINBURGH

Faculty of Science

Artificial Intelligence 2

Monday 16 March, 1987 — 9.00 - 12.00

Examiners: Chairman J A M Howe
External B 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, writing each answer in a separate script book. All questions carry equal weight.

3. Each question is marked out of 100%. 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) Describe 2 of the following expert systems:

- MYCIN
- CENTAUR
- MECHO
- INTERNIST

Address at least the following questions, illustrate your description with examples.

i. What knowledge representation formalism is used?

ii. How is inferencing accomplished?

iii. How does problem solving proceed during a typical session?

[70]

b) Compare and contrast the approaches of the two systems. Indicate their strengths and weaknesses.

10 mins

[30]

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

[30]

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 consider at least the following:

(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.

[45]

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

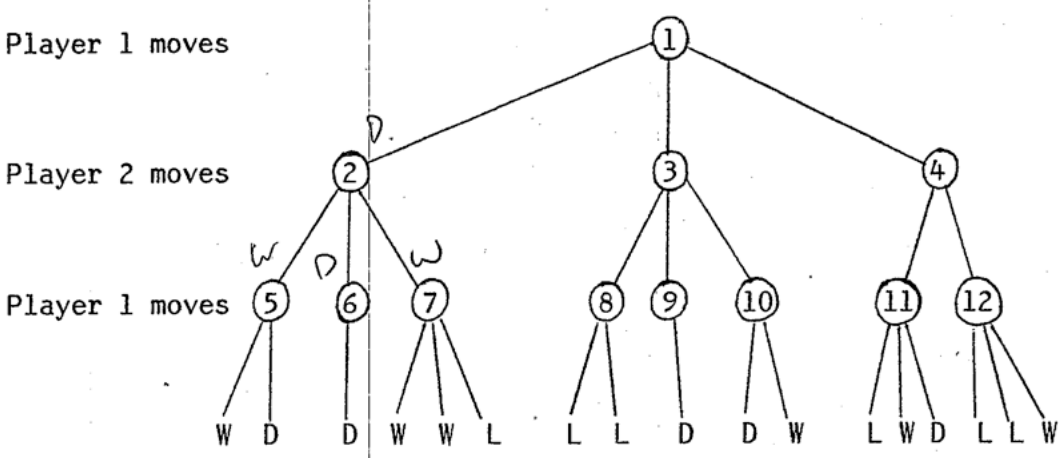
[25]

3. a) Briefly describe the mini-max search procedure.

[10]

b) Illustrate the mini-max search procedure on the following hypothetical game tree to determine whether player 1 has a guaranteed winning strategy.

L = lose
W = win
D = draw
} for player 1



[20]

c) Apply the technique of alpha/beta pruning to the tree and indicate which nodes need not have been examined. Assume nodes are examined left to right. Explain the justification for the pruning done.

[25]

d) In most games (e.g. chess) it is not feasible to look far enough ahead to see final game positions which indicate win, loss, or draw. Describe how games trees can still be used to determine what a player's next move should be. What problems may be encountered?

[20]

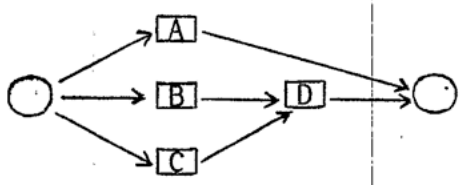
e) Can best-first search of a state space tree be used to solve game problems? Can mini-max search be used to solve the 8-queens problem? Explain why or why not.

[25]

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

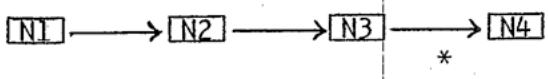
[10]

b) Give all the possible ways that the following plan may be executed:



[15]

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



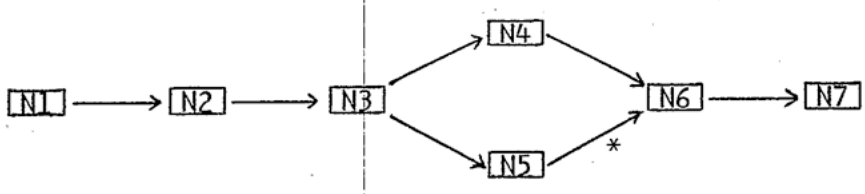
Describe a formal procedure which will determine whether or not an arbitrary assertion 'p' will hold (i.e. be true in the world) at the point in the plan which is marked with an asterisk. You may assume the following:

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.

[30]

d) Consider the point in the plan below marked with an asterisk. Does your procedure for part c work or can it be modified to work? Describe any changes that may be needed. If it cannot be made to work, explain why.



[25]

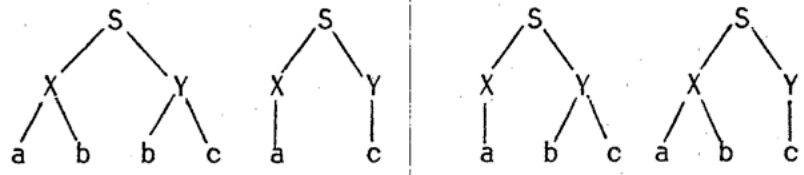
e) Give the advantages and disadvantages of building plans using the procedural net.

[20]

5. a) What is nondeterminism and how does it arise in parsing with RTN's?

[25]

b) Write a context-free grammar for the language containing the following parse trees:



[20]

c) Express the grammar as an RTN. Explain how the recognition algorithm copes with the nondeterminism involved in parsing "a b c" to yield both possible parse trees.

[30]

d) Discuss briefly the problem of ambiguity in understanding English sentences and suggest a mechanism for resolving it.

[25]

6. Consider the sentences:

i. Block1 is big.
ii. There is a small red block on Block1.
iii. Is there a red block on Block1?

a) Using the grammar below, draw a parse tree for each of the above sentences.

Sentence → Assertion . | Question ?
Assertion → NP is Adjs | NP is PP | there is NP | there is NP PP
Question → is there NP | is there NP PP
Np → ProperNoun | a Noun | a Adjs Noun
Adjs → Adj | Adj Adjs
PP → Prep Np
ProperNoun → Block1
Noun → block
Adj → big | red | small
Prep → on

[32]

b) Assign a meaning to each of the above three sentences by translating them into predicate calculus formulae. Indicate briefly how a question-answering system model uses these formulae in updating/querying its database.

[36]

c) Discuss how these meanings could have been formed automatically, using the above sentences as examples.

[32]

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

[30]

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

[45]

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

[25]

8. Using Guzman's link evidence, segment the scene shown on the worksheet (overleaf) into separate bodies.

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

[20]

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.

[50]

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

[30]

Detach the worksheet and fasten it inside your script.

Strong
weak