

E2025: Declarative Programming and Machine Learning
Exam Paper: January 2000

Attempt TWO questions from four.

- (1) For **the problem** described below:
- (a) By means of a tree diagram with explanatory notes, describe the form of the **search space** for the problem. (You are not expected to describe the whole search space).
[9 marks]
- (b) Describe how the problem can be solved using:
(i) **Depth-first** search
(ii) **Breadth-first** search. [10 marks]
- (c) Briefly describe the advantages and disadvantages of these two search methods.
[6 marks]

The Problem:

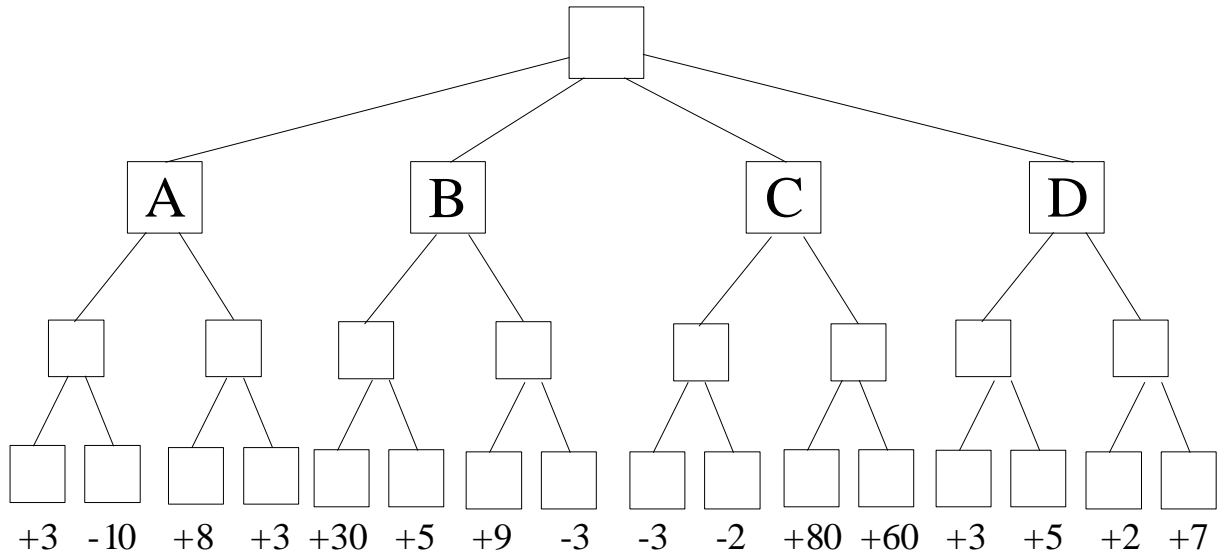
“A hungry monkey finds himself in a room in which a bunch of bananas is hanging from the ceiling. The monkey, unfortunately, cannot reach the bananas. However, in the room there are also a stick and a chair. The ceiling is just the right height so that a monkey standing on a chair could knock the bananas down with the stick. The monkey knows how to move around (which may be denoted as ‘M’; this includes moving to where the stick, chair or bananas are and it includes climbing on the chair), carry things around (‘C’), reach for the bananas (‘R’), and wave a stick in the air (‘W’). How can the monkey get the bananas?”

- (2) (a) Identify the main components of a typical expert system. **Briefly** explain the purpose and function of each component. [5 marks]
- (b) What do you understand by the term ‘antecedent-consequent rule’? Give one or more examples of this kind of rule. [5 marks]
- (c) Using examples, explain the meaning of the terms ‘forward chaining’ and ‘backward chaining’. [7 marks]
- (d) Describe any ONE application of an expert system and assess the strengths and weaknesses of expert systems for this problem. [8 marks]

- (3) (a) For a competitive game between two players describe how to use
- the minimax search procedure
 - minimax with alpha-beta pruning
- to find the 'best' move amongst several alternatives.

[8 marks]

- (b) Consider the following game tree:



Use minimax to find the score of the top node.

[It is your turn to move].

What move is optimal, A, B, C or D?

[6 marks]

- (c) Repeat this search with alpha-beta pruning.
 Show which leaf nodes of the game tree are **not** evaluated?
 Would you still pick the same move as in part (b)?

[11 marks]

(4) (a) Suppose that you have just installed a new carpet in your bedroom. You discover that the bedroom door will not open until you trim between $\frac{1}{4}$ and $\frac{1}{16}$ inch off the bottom. Construct a **possible** difference-procedure table relating a saw, a plane, and a file for the precise amount of wood you need to trim off. **[5 marks]**

(b) You have learned that rules with “unless” and “providing” assumptions are similar to ordinary antecedent-consequent rules.

(i) Recast the following as ordinary antecedent-consequent rules:

Fly Rule:

If	?x	is_a_bird
then	?x	flies
unless	?x	is_a_penguin
providing	?x	is_alive

Bird Rule:

If	?x	flies
then	?x	is_a_bird
unless	?x	is_a_bat
providing	?x	is_alive

[12 marks]

(ii) Explain how the given rules differ from the recast rules from the perspective of a reasoning system operating in ask-questions-later mode. **[8 marks]**

(Questions done: 1, 3)