Hong Kong University of Science and Technology

COMP221: Fundamentals of Artificial Intelligence

Spring 1997

Midterm Examination

25 March 1997, 7:30–9:00pm

Student Name: ____________________

Student Number: ____________________

Lecture Section: ____________________

Instructions

1. This is a closed-book, closed-notes examination.
2. Check that you have all 9 pages (excluding this cover page).
3. Write your name, student number and lecture section on this page.
4. Answer all questions in the space provided. Rough work should be done on the back pages.
5. Make your answers as concise as possible.

Question 1 (25%): ____________

Question 2 (10%): ____________

Question 3 (10%): ____________

Question 4 (10%): ____________

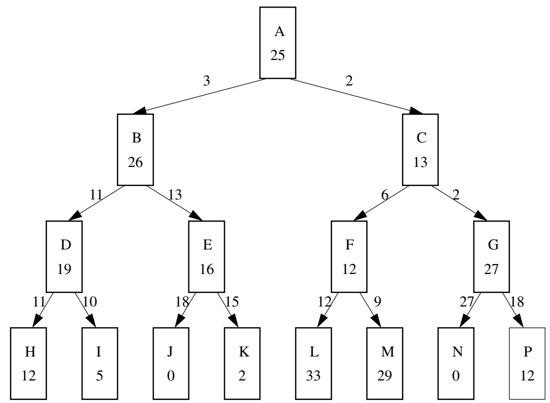
Question 5 (25%): ____________

Question 6 (20%): ____________

TOTAL (100%): ____________

1. (25%) Heuristic Search

   A search tree is shown below where each box represents a node corresponding to a state in the search space. The estimated cost (i.e. h function) for finding a solution from a node is shown in its box. The two nodes with $h = 0$ are goal states and the other terminal nodes are dead-ends (i.e. states that can never reach a goal). Actual link costs are marked on the links between nodes. Thus the path cost (i.e. g function) of a node is equal to the sum of the link costs from the root to that node.



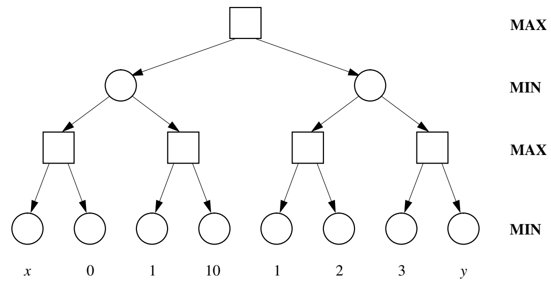
   (a) [8%] Using the greedy search algorithm, give the sequence of nodes expanded before a goal state is reached. What is the solution path and what is its path cost?

(b) [8%] Repeat part (a) using the A* search algorithm.

(c) [9%] Is the heuristic function (i.e. h) admissible? Justify your answer. What can you say about the A* search algorithm in the light of this property of the heuristic function used?

2. (10%) Game Playing

In the following game tree, there are two leaf nodes with unknown evaluation function values. Let us denote the unknown values by x and y. In terms of x and y, give the condition under which MAX should move to the left child from the root node in order to maximize its chance of winning the game.



3. (10%) First-Order Logic

Suppose $Respects(x, y)$ means "x respects y".

(a) [3%] What is the meaning of this FOL sentence?

$$\exists x \, \forall y \, Respects(x, y)$$

(b) [3%] What is the meaning of this FOL sentence?

$$\forall y \, \exists x \, Respects(x, y)$$

(c) [4%] Are the two sentences above equivalent in meaning? Briefly explain your answer.

4. (10%) First-Order Logic

Suppose $Loves(x, y)$ means "x loves y" and $Happy(x)$ means "x is happy". Consider the following two FOL sentences:

$$\forall x \, [\exists y \, Loves(y, x)] \Rightarrow Happy(x)$$
$$\forall x, y \, Loves(y, x) \Rightarrow Happy(x)$$

(a) [6%] Formally prove that the two sentences are logically equivalent.

(b) [4%] What is the meaning of the two sentences?

5. (25%) LOGICAL REASONING

Consider a knowledge base with the following four FOL sentences:

$$\forall x\ Engineer(x) \Rightarrow Wealthy(x)$$
$$\forall y\ Wealthy(y) \wedge Healthy(y) \Rightarrow Happy(y)$$
$$Engineer(Peter)$$
$$Healthy(Peter)$$

(a) [10%] Using generalized modus ponens, prove that $Happy(Peter)$ is true. For each step in your proof, show the sentences involved and the substitution list resulted from unification.

(b) [15%] Using resolution with refutation, prove that $\exists z\ Happy(z)$ is true. Again, show the sentences involved and the substitution list for each step.

6. (20%) MISCELLANEOUS

Define the following concepts in your own words:

(a) [5%] A complete search strategy

(b) [5%] A complete logical inference procedure

(c) [5%] An inaccessible environment

(d) [5%] A nondeterministic environment