Graduate Comprehensive Exam
Artificial Intelligence
Fall 1999

Answer all questions on the exam. Total: 100 points. Good Luck.

1. (30 pts) Given the following problem:

   The sliding-tile puzzle consists of three black tiles, three white tiles and an empty space. A tile may move into an adjacent empty location. This has a cost of one. A tile can hop over one or two other tiles into the empty position. This has a cost equal to the number of tiles jumped over. The goal is to have all the white tiles to the left of all the black tiles. The initial configuration is:

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   -----------------------------
   | B | B | B |   | W | W | W |
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   where B is black and W is white.

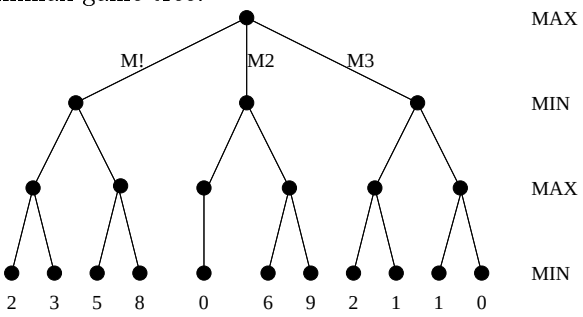
   (a) Formulate it as a state-space search problem (representation of a state, start state, goal test, operators, and path cost).
   (b) How many possible states are there? Explain your answer.
   (c) Devise a heuristic function h. Is your heuristic function admissible? Explain.
   (d) Perform breadth-first search to find a path that reaches the goal. In the interest of time, you may stop if the goal is not reached after four levels. Show the order of visited states and the solution path if found.
   (e) Perform A* to find a path that reaches the goal. In the interest of time, you may stop if the goal is not reached after four levels. Show the order of visited states and the solution path if found.

2. (25 pts) Given the following description:

   Anyone passing his/her history exams and winning the lottery is happy. But anyone who studies or is lucky can pass all his/her exams. John did not study but he is lucky. Anyone who is lucky wins the lottery. Not everyone who studies can pass all his/her exams.

   (a) Represent it in first-order (predicate) logic.
   (b) Use resolution to answer: "Is John happy?" Specify any substitution made.

3. (20 pts) Given the following minimax game tree:



   (a) Perform alpha-beta pruning and cross out the nodes (in the diagram) that are pruned from evaluation.
   (b) What is the minimax value at the root node and which move (M1, M2, or M3) should the player make?

4. (25 pts) Given these data:

Outlook	Temperature	Humidity	Wind	Play Tennis
Sunny	Hot	High	Weak	No
Sunny	Hot	High	Strong	No
Overcast	Hot	High	Weak	Yes
Rain	Mild	High	Weak	Yes
Rain	Cool	Normal	Weak	Yes

   (a) Apply a learning algorithm to build a decision tree to determine the Play Tennis attribute.
   (b) How does the algorithm select the best attribute?
   (c) How does the algorithm determine to stop growing the tree?
   (d) How might the algorithm handle numeric attributes in selecting the best attribute.