THE UNIVERSITY OF PENNSYLVANIA

Points Possible: 100

CIS 521

INTRODUCTION TO ARTIFICIAL INTELLIGENCE

Midterm I – Practice questions

(Time allowed: 80 minutes)

Section		Points	Max
1	**Uninformed Search**		18
2	**Search Strategies**		15
3	**Adversarial Search**		17
4	**Constraint Satisfaction**		25
5	**Not Relevant**		15
6	**Not Relevant**		10
Total			100

1) (15 points) Uninformed Search

Consider a state space where the start state is 1 and the successor function for state *i* returns two states: 2*i*, 2*i*+1.

a) [3] Draw the state space graph for states 1 to 15. Put smaller states to the left.

b) Suppose the goal state is 11. List the order in which nodes will be visited for (In all cases, assume nodes at the same level are visited in left-to-right order.):

(i) [5] breadth-first search

(ii) [5] depth-limited search with depth limit 3

(iii) [5] iterative deepening search

2) (15 points) Search Strategies

Neville Novice wants advice on writing a search routine to solve a set of puzzles. Each puzzle requires finding a path through a maze modeled on English hedge mazes that might look like the maze above. Each maze has one entrance and one exit. The player's game piece starts on a fixed initial square and, at each turn, can either move N, S, E, or W one square as long as there isn't a wall or other obstacle in the way. (At each square, the player's program is informed which directions are legal moves for that square.) If the player's piece enters the exit square, the program is so notified. The program is provided with no other information.

(a) [5] Neville wants to know if he might implement a breadth first search algorithm to solve the problem. Will it work? Why or why not?

(b) [5] What about a depth first search algorithm? Will it work? Why or why not?

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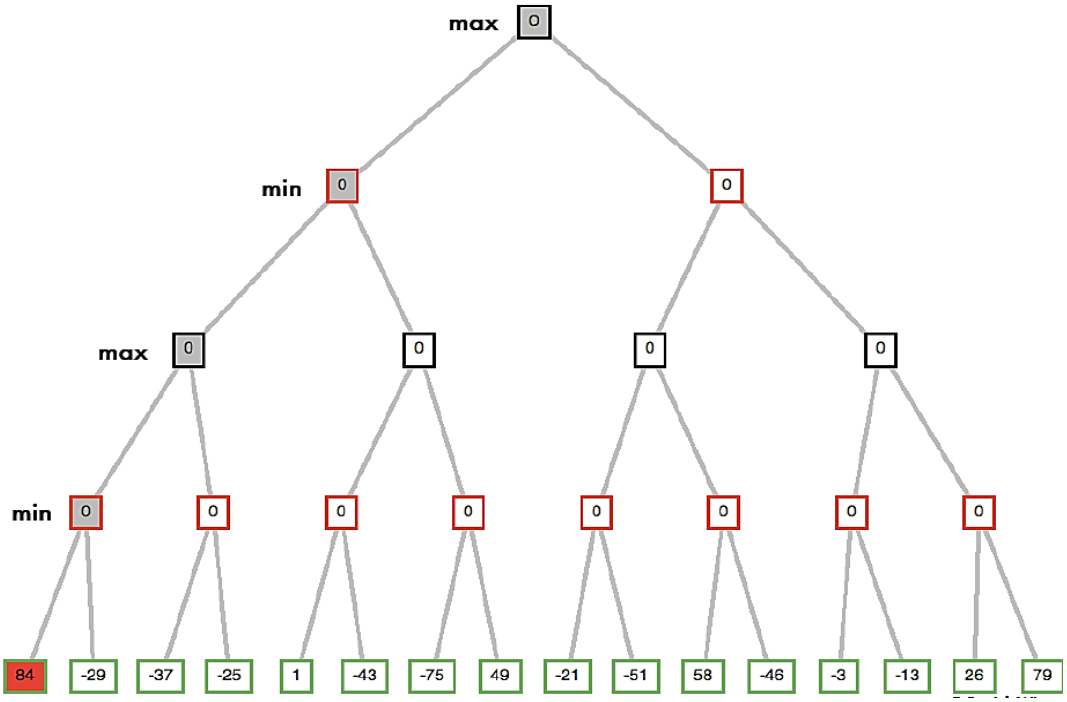
Neville finds a way to have the program provide a signal which is "louder" closer in straight line distance to the exit and "softer" farther away from it. The signal provides a number ranging from 0-100, where 0 means really far from the goal and 100 means right on top of it.

(c) [5] If he uses this signal as a heuristic, can A* provide him with the optimal path? (Hint: think about this! It's tricky!)

3) (17 points) Adversarial Search



Consider the 4-ply game tree above for a two-person game.

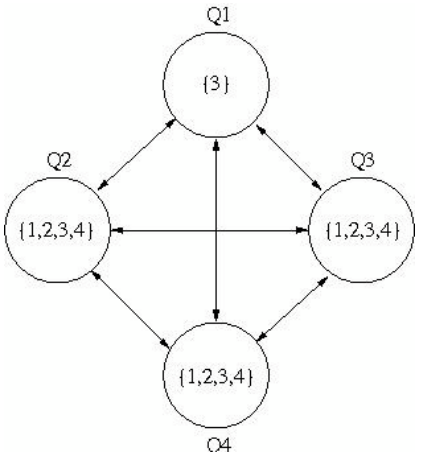
a) [6] Fill in the minimax values of all nodes marked 0.

b) [5] Label the path in the tree that results if **max** and **min** each make optimal moves.

c) [6] Indicate which nodes are pruned if alpha-beta pruning is used.

4) (25 points) Constraint Satisfaction

Consider solving the 4-queens problem as a constraint satisfaction problem. That is, place 4 queens on a 4 × 4 board such that no queen is in the same row, column or diagonal as any other queen. One way to formulate this problem is to have a variable for each queen, and binary constraints between each pair of queens indicating that they cannot be in the same row, column or diagonal. Assuming the i^{th} queen is put somewhere in the i^{th} column, then the possible values in the domain for each variable are the row numbers in which it could be placed. Say we initially assign queen Q1 the unique value 3, meaning Q1 is placed in column 1 and row 3. This results in an initial constraint graph given by (the set of candidate values of each variable is shown inside the node):



(a) [5] Apply **forward checking** and give the remaining candidate values for the variables Q2, Q3 and Q4.

(b) [16] Fill in the table below with the candidate values of each queen after each of the following steps of applying the **arc consistency** algorithm to the figure. An arc "$x \rightarrow y$" is consistent if for each value of x there is some value of y that is consistent with it.

	Q1	Q2	Q3	Q4
Initial domain	3	1,2,3,4	1,2,3,4	1,2,3,4
After Q2 → Q1				
After Q3 → Q1				
After Q2 → Q3				
After Q3 → Q2				

(c) [4] In general, when will the arc consistency algorithm halt?