Name: _____

Student ID: _____

CSE 473 Autumn 2012: Sample Midterm Exam Solutions
(closed book, closed notes except for 1-page summary)
Total: 100 points, 5 questions. Time: 50 minutes

Instructions:

1. Write your name and student ID on the first sheet (once you start, write your last name on all sheets). Write your answers in the space provided. If you need more space or scratch paper, you can get additional sheets from the instructor. Make sure you write down the question number and your name on any additional sheets.
2. Read all questions carefully before answering them. Feel free to come to the front to ask for clarifications.
3. *Hint 1*: You may answer the questions in any order, so if you find that you're having trouble with one of them, move on to another one.
4. *Hint 2*: If you don't know the answer to a question, don't omit it - do the best you can! You may still get partial credit for whatever you wrote down. Good luck!

Do not start until you are given the "go-ahead signal"…

1) **(20 points) Agents and Environments**
   a) Give a PEAS description of the task environment for the following agents:
      i)   A part-picking robot
      ii) An interactive English tutor
   b) For each of the agents above, characterize the environment according to whether it is fully or partially observable, deterministic or stochastic, episodic or sequential, static or dynamic, discrete or continuous, and single or multiagent.

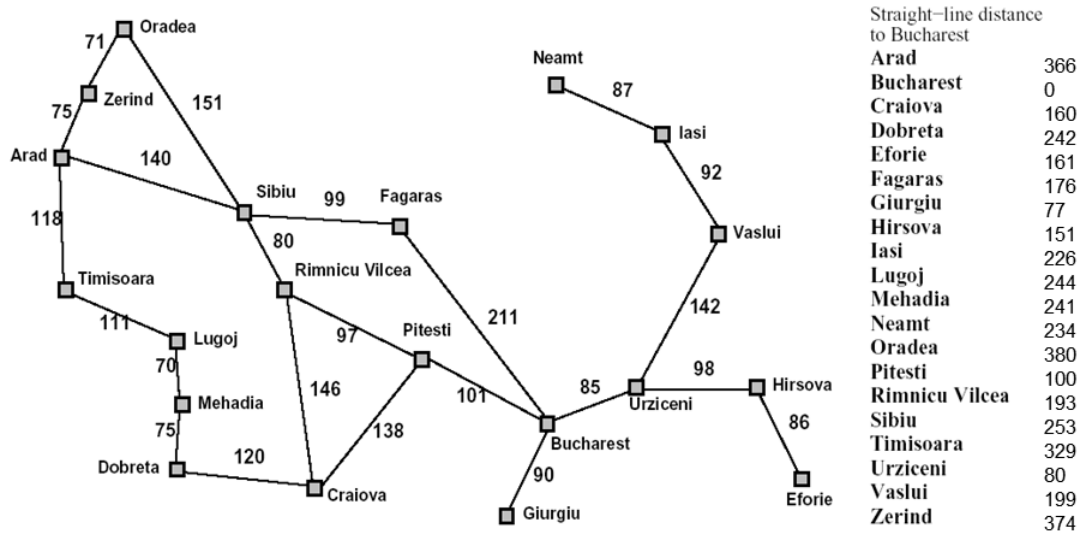   [For a solution, see Figures 2.5 and 2.6 in the text]

2) (20 points) Uninformed Search

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

a) Draw the state space graph for states 1 to 15.
b) Suppose the goal state is 11. List the order in which nodes will be visited for: (i) breadth-first search, (ii) depth-limited search with depth limit 3, and (iii) iterative deepening search.

[Solution: a) Follow the format of the state space graph in Lecture 3, starting at 1 with arrows to 2 and 3, etc. b) (i) 1, 2, 3, …, 10, 11 (ii) 1, 2, 4, 8, 9, 5, 10, 11 (iii) 1, 1, 2, 3, 1, 2, 4, 5, 3, 6, 7, 1, 2, 4, 8, 9, 5, 10, 11.]

3) (20 points) Informed Search

Oradea
71
Zerind 151
75
Arad 140
118
Sibiu 99 Fagaras
80
Timisoara
Rimnicu Vilcea
111
Lugoj 97 Pitesti 211
70
146 101 85
Mehadia 138 Urziceni
75
120
Dobreta Craiova Bucharest
90
Giurgiu

Neamt
87
Iasi
92
Vaslui
142
98 Hirsova
86
Eforie

Straight−line distance to Bucharest

|	
Arad	366
Bucharest	0
Craiova	160
Dobreta	242
Eforie	161
Fagaras	176
Giurgiu	77
Hirsova	151
Iasi	226
Lugoj	244
Mehadia	241
Neamt	234
Oradea	380
Pitesti	100
Rimnicu Vilcea	193
Sibiu	253
Timisoara	329
Urziceni	80
Vaslui	199
Zerind	374

Consider the route-finding problem of computing the cheapest path from Arad to Bucharest in the map depicted above.

For the straight-line distance heuristic, <u>draw the search tree after expansion of each node</u> until the termination of the algorithm for:

a) Greedy best-first search (label all nodes with their h values). What is the solution found by the algorithm?

b) A* search (label all nodes with their f values). What is the solution found by the algorithm?

[For the solution, see lecture slides on Informed Search or Figures 3.23/3.24 in text]

4) (15 points) Adversarial Search
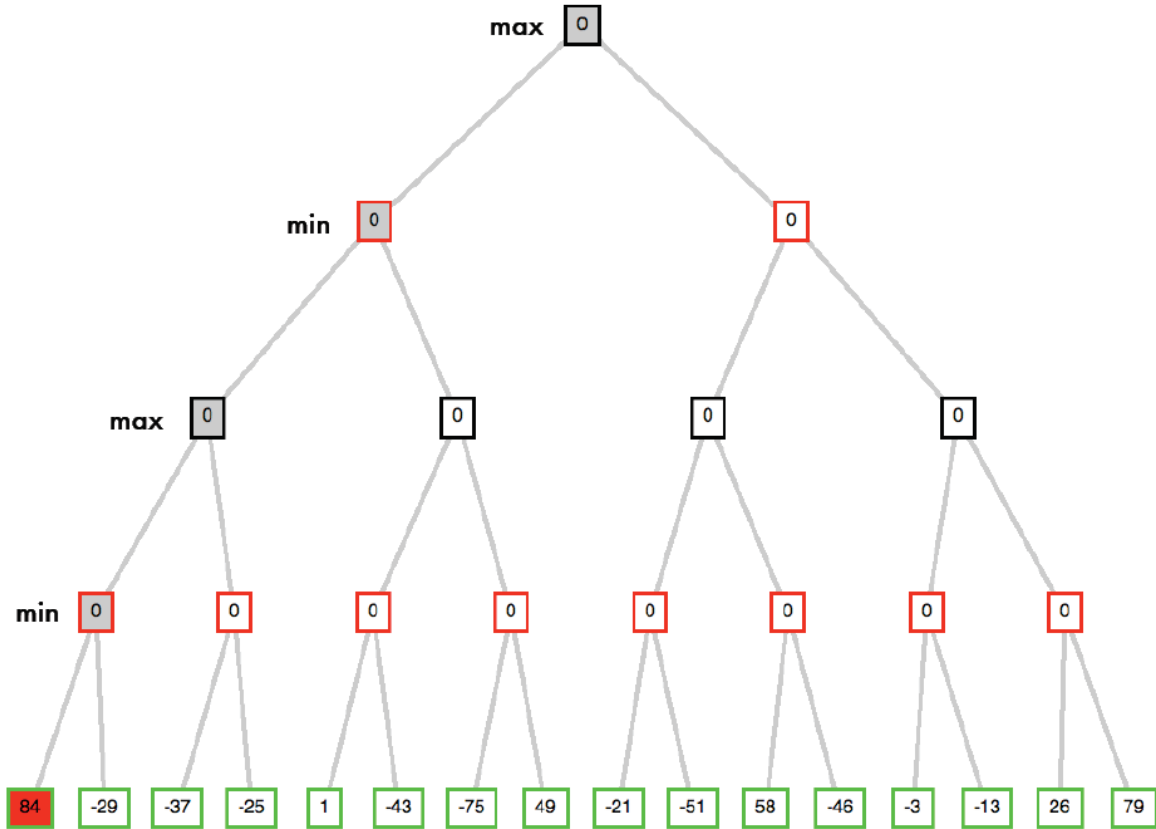
Consider the 4-ply game tree above for a two-person game.
   a) Fill in the minimax values of all nodes marked 0.
   b) Label the path in the tree that results if max and min each make optimal moves.
   c) Draw the tree that results if alpha-beta pruning is used.

[For the solution, see lecture slides on Alpha-Beta Search]

5) (25 points) Logic

Any American who sells weapons to hostile nations is a criminal. The nation Nono is an enemy of America. Any enemy of America is considered hostile. Nono has some missiles. Missiles are weapons. All of Nono's missiles were sold to it by Colonel West. West is American.

a) Convert the statements above to sentences in first-order logic. There should be seven sentences. Use the following vocabulary:

American(x), Weapon(x), Hostile(x), Criminal(x), Missile(x):
predicates satisfied by members of the corresponding categories
Sells(x,y,z): x sells y to nation z
Owns(x,y): nation x owns y
Enemy(x,y): nation x is an enemy of nation y
West: constant denoting Colonel West
Nono, America: constants denoting corresponding nations

b) First, make sure your sentences in (a) are definite clauses (if not, make them so). Then, using forward chaining, infer that West is a criminal: draw the proof tree with initial facts at the bottom, facts inferred on the 1st iteration at the next level, and so on.

c) Convert the sentences in (a) to CNF.

d) Using the CNF sentences in (c), construct a resolution proof that West is a criminal.

[For the solution, see Section 9.3.1, Figure 9.4, Section 9.5.3, and Figure 9.11 in the text]