1st Midterm Exam

Thursday March 2
75 minutes – Open book and notes

1. *10 points*
   Answer these questions briefly but precisely:

   1. Can an agent who keeps no history of its percept sequence be rational?
   2. Why it is important to know if an agent's environment is fully observable or if it is partially observable?

2. *20 points*
   A robot has to deliver two identical packages to locations A and B in an office environment. The robot starts in location S holding both packages. The environment is a grid of squares, some of which are free (so the robot can move into them) and some of which are occupied (by walls, doors, etc.). The robot can move in the horizontal or vertical direction into neighboring squares, one square at a time, and can pick up and drop packages if they are in the same square as the robot.

   Formulate this problem as a search problem, specifying the initial state, states, actions, goal test, and cost function.

3. *15 points*
   Explain what search algorithm you would use in each of the following cases and why. Be short but precise.

   1. A search space with a large branching factor and possibly infinite paths. No heuristic. You want to find the shortest path (i.e. with the minimum number of links) to the goal.
   2. A search space with possibly infinite paths. The links connecting states have different costs. No heuristic. You want to find the lowest cost path(s).
   3. The search space is a very wide tree of fixed but unknown depth. All the goal states are at the leaves of the tree. You have a heuristic. You want to find a goal as quickly as possible.

4. *10 points*
   Consider a four-player game with observable states, no randomness, and no alliance between any pair of players. Can a player use the minimax algorithm to decide which move to make? If yes, does the minimax algorithm need to be modified? How? If not, why not? Does the evaluation function need to be changed?

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5. *15 points*
Show the backed-up values for the nodes in the following game tree and show the branches that are pruned by alpha-beta pruning. For each branch pruned, write down the condition that is used to do the pruning. Follow the convention to examine the branches in the tree from left to right.
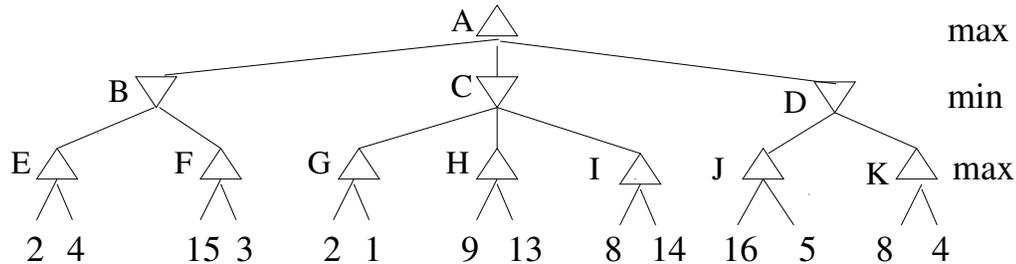
6. *10 points*
Suppose you are given a CSP problem (for instance, a map coloring problem) and you are interested in finding ALL the possible assignments of values to variables that satisfy the constraints.

1. What algorithm would you use? Please explain.
2. What representation (incremental formulation or complete-state formulation) do you think would work best? Why?

7. *20 points*
Answer these questions explaining your reasoning briefly but precisely.

1. Suppose you have several admissible heuristic functions for a problem. Can you produce a better heuristic using the heuristics you have? How? Give at least one example.
2. What are the disadvantages of using a heuristic function for A* which is NOT consistent?
3. Why any heuristic which is an optimal solution to a relaxed problem is admissible and consistent?
4. Why hill climbing with memory is effective for online search?

8. Extra Credit *10 points*
Given a CSP with a finite number of variables and a finite domain for each variable, answer the following questions briefly but precisely:

1. How does the number of variables affect the size of the search space?
2. How does the size of the domains affect the size of the search space?

YOU REACHED THE END OF THE EXAM