CPE/CSC 480 ARTIFICIAL INTELLIGENCE

MIDTERM SECTION 1

FALL 2005

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This is the Fall 2005 midterm exam for the CPE/CSC 480 class. You may use textbooks, course notes, or other material, but you must formulate the text for your answers yourself. The use of calculators or computers is allowed for viewing documents or for numerical calculations, but not for the execution of algorithms or programs to compute solutions for exam questions. The exam time is 80 minutes.

Student Name:

Signature: **Date:**

PART 1: MULTIPLE CHOICE QUESTIONS

Mark the answer you think is correct. I tried to formulate the questions and answers so that there is only one correct answer. Each question is worth 3 points.

[30 points]

a) Which statement characterizes a *rational agent* best?
- ❑ An agent that performs reasoning steps to select the next action.
- ❑ An agent that can explain its choice of an action.
- ❑ An agent that always selects the best action under the given circumstances.
- ❑ An agent that is capable of predicting the actual outcome of an action.

b) What is the most significant aspect that distinguishes an agent with an *internal state* from a reflex agent?
- ❑ An agent that selects its actions based on rules describing common input-output associations.
- ❑ An agent that also considers relevant information from previous percepts when it makes a decision.
- ❑ An agent that tries to reach a desirable state.
- ❑ An agent that tries to reach the most desirable state, according to some metrics that measures the degree of desirability for states.

c) Which of the following statements is the best characterization of a *static* environment?
- ❑ an environment that does not change while the agent is deliberating
- ❑ an environment that does not change through the lifetime of an agent
- ❑ the agent does not perceive any changes during a certain time, although changes may occur that the agent is not capable of picking up with its sensors
- ❑ an environment that can only be changed through actions of the agent itself

d) In the context of search algorithms, which of the following issues indicates if an agent is guaranteed to find a solution, provided that one exists?
- ❑ time complexity
- ❑ space complexity
- ❑ completeness
- ❑ optimality

e) On the basis of the general tree search method as described in the textbook, which simple strategy results in *depth-first search*?
- ❑ append newly generated nodes at the beginning of the fringe (search queue)
- ❑ append newly generated nodes at the end of the fringe (search queue)
- ❑ insert newly generated nodes in the fringe (search queue) according to their path cost (lowest values first)
- ❑ insert newly generated nodes in the fringe (search queue) according to their heuristic function (lowest values first)

f) On the basis of the general search method as described in the textbook, which simple strategy results in *greedy best-first search*?
- ❑ append newly generated nodes at the beginning of the fringe (search queue)
- ❑ append newly generated nodes at the end of the fringe (search queue)
- ❑ insert newly generated nodes in the fringe (search queue) according to their path cost (lowest values first)
- ❑ insert newly generated nodes in the fringe (search queue) according to their heuristic function (lowest values first)

g) The *recursive best-first algorithm* is a variation of A* with the following properties:
- ❑ the nodes within a given contour are explored in a depth-first manner, and the contour is expanded step by step
- ❑ in addition to the current path, it stores the information about the best alternative to explore in case the current path doesn't lead to the goal
- ❑ it drops the least promising nodes from the fringe (search queue) when it runs out of memory
- ❑ it utilizes contours to reduce the number of nodes to explore

h) Which of the following search methods has the best (lowest) time complexity (worst-case)?
- ❑ depth-first
- ❑ breadth-first.
- ❑ bi-directional
- ❑ A*

i) What is the best description of *local beam search*?
- ❑ a local search method that "looks ahead" several steps
- ❑ a local search method that keeps a limited number of states in memory
- ❑ a search method where sets of nodes serve as "beams" in analogy to the support beams in a house
- ❑ a search method named by its inventor after a popular brand of cars since its speed reminded him of the driving style associated with such cars

j) What constitutes a *(full) solution* to a constraint satisfaction problem?
- ❑ the set of all variables used in the specification of the problem
- ❑ the set of all variables together with their respective potential values
- ❑ an assignment of values to some or all variables
- ❑ an assignment of values to *all* variables

PART 2: SHORT QUESTIONS

In this part of the exam, you should answer the questions in about one paragraph per sub-question.

1. Which search method is the result of running *greedy search* with the heuristics given below? Explain your answers!

[10 points]

   a. the path cost, *g(n)*, as heuristic function

   b. the negative path cost, *-g(n)*, as heuristic function

2. Explain the main aspects of and discuss the difference between a *rationa*l agent and an *omniscient* agent.

[10 points]

   a. Rational Agent:

   b. Omniscient Agent:

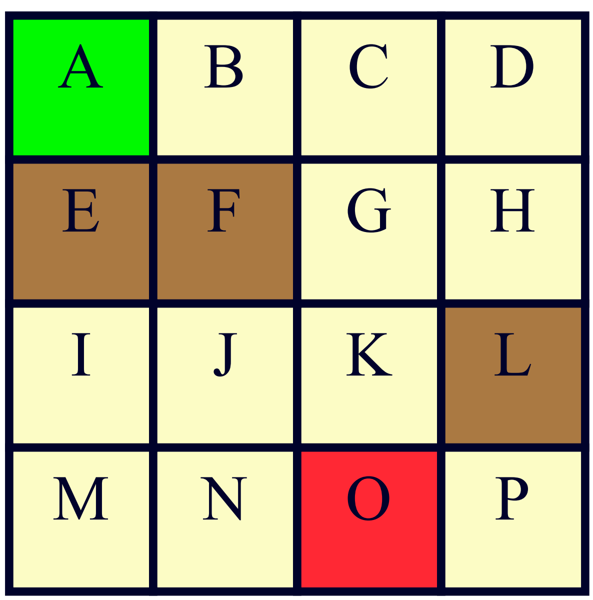
PART 3: GRID SEARCH

In this scenario, an agent is exploring a grid from the tile **A** designated as the starting point to the goal point, tile **O**. The shaded tiles are blocked. At each step, the agent can proceed from the current tile to one of the vertically or horizontally adjacent tiles; the agent can not move diagonally. If there are multiple successor tiles for a tile, the agent examines those tiles in alphabetical order.

In the following parts, you need to apply different search algorithms to solve this traversal problem. For each of the algorithms, you need to do the following tasks:

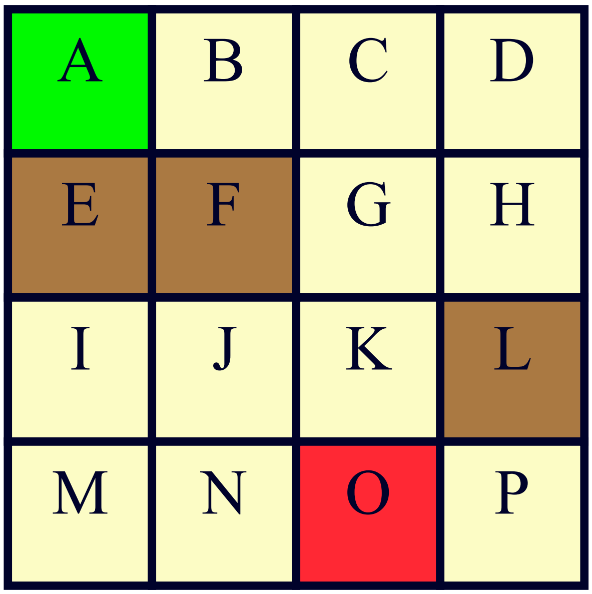
- Mark the sequence in which the tiles are visited. You can do this directly in the copy of the grid provided for each algorithm by numbering the tiles in the order in which they are visited.
- Draw the corresponding search tree, up to and including the first instance of the goal node. There should be enough space to the right of the diagram and the table below. If your writing tends to be large, it might be advisable to draw the complete search tree first on a separate sheet of paper, and then copy the relevant parts to the exam sheet.
- Fill in the table with the information about the search trace. Mark the newly added tiles in the fringe (frontier, search queue), e.g. by underlining them. (Note: The size of the table does not necessarily relate to the number of steps to find a solution. Extend the table if necessary.)

You can assume that your algorithms avoid cycles by not re-visiting previously inspected tiles. For your convenience, the environment configuration is repeated on the next pages.



1. Traverse the environment from the starting point **A** to the goal **O** according to the *Depth-First Search* method.

[15 points]



Step	*Current Tile*	*Fringe*
0		
1		
2		
3		
4		
5		
6		
7		
8		
9		
10		
11		
12		
13		
14		
15		

2. Traverse the environment from the starting point A to the goal O according to the *Breadth-First Search* method.

[15 points]

A	B	C	D
E	F	G	H
I	J	K	L
M	N	O	P

Step	*Current Tile*	*Fringe*
0		
1		
2		
3		
4		
5		
6		
7		
8		
9		
10		
11		
12		
13		
14		
15		

3. What are possible improvements for the above (uninformed) search methods for this type of environment (with a grid-based topology)?

[10 points]

4. What kinds of heuristics can be considered in *informed* search methods for this type of environment (with a grid-based topology)?

[10 points]

Total Points: