Drexel University
CS510: Intro. AI
Midterm Exam
Fall 2012

Name ____________________

Student ID ____________________

CS510: Introduction to Artificial Intelligence

Midterm Exam

- This exam contains 7 problems, some with multiple parts. The last problem is extra credit. There are 12 pages to the exam.
- This exam has a total of 128 points, not including extra credit. Your grade will be calculated as your total number of earned points divided by 128.
- **Submission:** Please submit your solutions via the associated "assignment" dropbox on the class website. You may either scan in your completed version of this document or you may submit a PDF or text file containing your answers.
- Once you start this exam, please spend no more than three consecutive hours on it. You are on your honor.
- You *may* use the textbook and all lecture notes/slides. Please do not search the Internet for solutions, though.
- If you have a question about this exam, please send it directly to `eas28@cs.drexel.edu`.
- Submission of the exam is due by 18:00, Wednesday October 31.
- Solutions will be posted on Monday.
- If you will be scanning in this document, write your solutions in the space provided. If you need more space, write on the back of the sheet containing the problem. Do not put part of the answer to one problem on the back of the sheet for another problem.
- Note that some problems with lengthy descriptions may have brief solutions (this may be indicated by the number of points assigned to the problem).
- Show your work, as partial credit will be given. You will be graded not only on the correctness of your answer, but also on the clarity with which you express it. Be neat!
- **Good Luck!**

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Problem	Grade	
1a.	/5	
1b.	/5	
1c.	/5	
1d.	/5	
2a.	/10	
2b.	/10	
2c.	/10	
2d.	/10	
3a.	/10	
3b.	/10	
3c.	/10	
4.	/10	
5a.	/4	
5b.	/4	
6a.	/10	
6b.	/10	
7a.	/1	Extra
7b.	/3	Extra
7c.	/1	Extra
Total	/128	

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1. For each of the following statements decide if they are true/false and briefly provide your reasoning.

(5 pts.) a. It is possible to construct a knowledge-based agent that is a pure reflex agent.

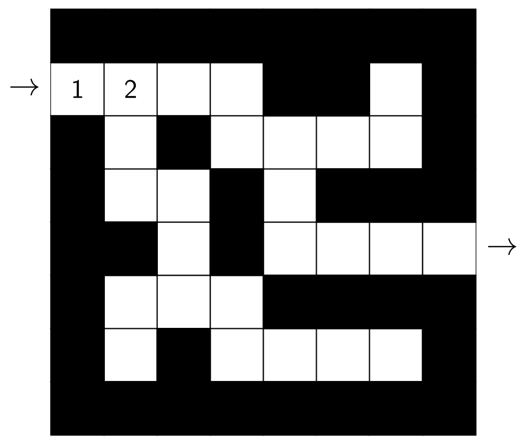
(5 pts.) b. BFS is complete if the state space has infinite depth but finite branching factor.

(5 pts.) c. It is sometimes useful to use A* for bidirectional search.

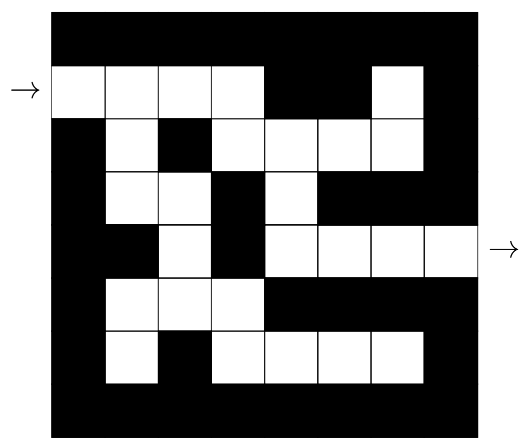
(5 pts.) d. It is possible to write an exact heuristic function for the 8-puzzle. (An *exact heuristic function* is one that always returns the exact minimum cost of getting from the current node to a goal.)

2. You control an autonomous robot that must navigate through an unknown maze. You can only move one cell at a time; either to the left, right, up, or down (but not on a diagonal). Your goal is to travel from the start of the maze to the exit (as noted by the arrows).
For the following problems, assume that the implementations of the search algorithms will, in the event of a "tie" between multiple nodes on the fringe, expand the leftmost node (with respect to the grid) first. In the event that there is still a tie, the algorithms will expand the least recently queued of the tied nodes first.

(10 pts.) a. In the following maze, fill in the order in which the cells would be expanded (*i.e.*, removed from the fringe) if DFS were used. Leave a cell blank if it is never visited. The first two cells have been completed for you.



(10 pts.) b. Repeat the exercise from part a. using BFS.

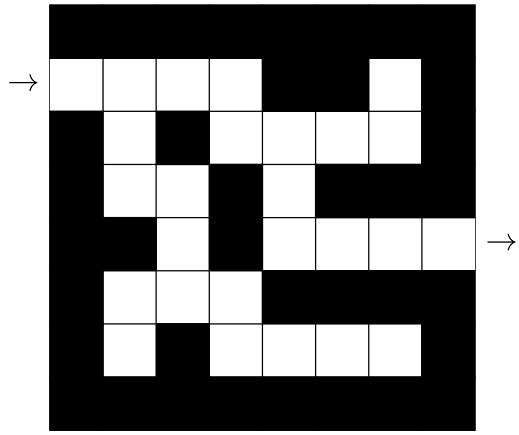


(10 pts.) c. Suppose your robot is given an additional sensor that can determine the number of rows between n and the exit cell. This allows us to create a heuristic, $h(n)$, such that if the exit cell is in row i then:

$$\begin{aligned}
(\forall u \in \text{ row } i : h(u) &\mapsto 0) \\
(\forall v \in \text{ rows } i-1 \text{ and } i+1 : h(v) &\mapsto 1) \\
&\vdots \\
\text{In general,} & \\
(\forall w \in \text{ rows } i-j \text{ and } i+j : h(w) &\mapsto j).
\end{aligned}$$

Is this heuristic admissible? Either prove that it is or provide a counterexample.

(10 pts.) d. Regardless of whether or not it is admissible, use the heuristic from part c. to perform an A* search on the maze. Feel free to draw out the state of the fringe at each iteration; it will help you in running the algorithm, and it also gives me an opportunity to give extra credit.



3. You have won a shopping spree at your favorite store. You are given a shopping cart which you can fill with any quantity of any of the store's k different items. The rules specify that you are able to take as many items as you want, however, you are limited by the capacity of the cart. Each item in the store has a finite weight, and the cart has a known maximum weight limit. Assume that, for all intents and purposes, the store has an infinite supply of each item. Being a greedy agent, your plan is to sell all of the items you win on dBay or Greg's List for a profit. Each item has a *value* that you think you can reasonably earn by selling it. Therefore, you want to maximize the sum of the values of the items you choose. Note, though, that the values might not have any correspondence with the weights, vi&., a kilo of water is worth a lot less than a kilo of gold!

(10 pts.) a. Why might it *not* make sense to encode this problem as a constraint optimization problem?

(10 pts.) b. Suppose you decide to use Backtracking Search. Devise a heuristic for determining which item you should choose to put in your cart next.

(10 pts.) c. A "messy" genetic algorithm is one in which the length of the chromosome may change during execution. Might it be wise to solve this problem using a messy genetic algorithm? Why or why not?

(10 pts.)

4. You are given a problem with a large branching factor, for which you have found an evaluation function, h, that takes on integer values in the range $\{1 \dots 5\}$. Would this search problem be a good candidate for simulated annealing search? Why or why not?

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5. Consider the following non-zero-sum game:

		Player 2		
		D	E	F
Player 1	A	0, 0	50, −10	40, −20
	B	−10, 50	20, 20	90, 10
	C	−20, 40	10, 90	50, 50

Both players are trying to maximize their profits.

(4 pts.) a. List all of the pure-strategy Nash equilibria (Hint: there is at least one).

(4 pts.) b. A strategy is Pareto optimal if there is no other strategy that could provide all of the players a higher profit. Are any of the Nash equilibria Pareto optimal? Why or why not?

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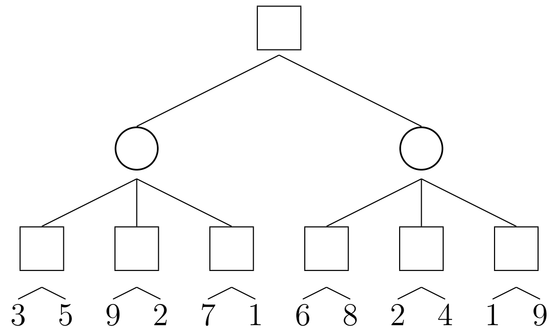
6. Consider the following game search tree in which boxes represent MAX nodes and circles represent MIN nodes.



(10 pts.) a. Fill in the Minimax values for each of the nodes.

(10 pts.) b. Circle each of the leaf nodes that *would* be evaluated if Alpha-Beta pruning were used. Alternatively, you may cross out the leaf nodes that *would not* be evaluated.

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7. This problem is purely extra credit!

(1 pt.) a. What do you get when you divide the circumference of your jack-o-lantern by its diameter?

(3 pts.) b. What does the following Lisp code do, and how does it do it?

```
((lambda (x) (list x (list 'quote x))) '(lambda (x) (list x (list 'quote x))))
```

(1 pt.) c. Why might some computer scientists mistake the due date of this exam for Christmas day?
Hint: It's *not* because you are getting the gift of not having to take the exam anymore!