Name ____________________

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CSCI 5582 Midterm

1. These questions address the topic of Intelligent Agents.

   (a) **Points: 5**

   True or False: To be an ideal agent, an agent program must never make a mistake.

   (b) **Points: 15**

   Briefly describe how each of the following kinds of agent decides how to choose an action at any given time.

   - Simple reflex agent
   - Goal-based agent
   - Utility-based agent

2. The following questions address the topic of search.

   (a) **Points: 5**
   What does it mean for a search algorithm to be optimal?

   (b) **Points: 5**
   What does it mean for a search algorithm to be complete?

(c) **Points: 15**

Assume that we have an A* search with the evaluation function $fcost = g + Random() * h$, where g is the actual cost of the path thus far, h is an admissible non-overestimating heuristic, and *Random* returns random real values between 0 and 1. Consider the behavior of an A* search with this evaluation function as compared to the same search without the multiplication by $Random()$. Be sure to discuss the following topics:

- The qualitative effect of the multiplication by $Random()$ on A*'s performance (comparisons to other search algorithms would be appropriate here).
- The effect it has on the optimality of A*.

(d) **Points: 5**

A full 3-ply MiniMax search in game with a branching factor of 3 will apply its evaluation function to how many boards?

a. 27
b. 40
c. 39
d. None of the above

(This is just a multiple-choice. Don't be bothered by all the blank space.)

3. The following questions address the topic of logic.

   (a) **Points: 5** What does it mean for a logical inference method to be *sound*?

   (b) **Points: 5** What does it mean for a logical inference method to be *complete*?

(c) **Points: 10**

Consider an intelligent alarm system that has the following sentence in its knowledge-base:

$((Motion \Rightarrow Intruder) \vee (Noise \Rightarrow Intruder))$

Assume that the propositions $Motion$ and $Noise$ take on their respective truth values directly from information provided by the agent's sensors. Given this sentence, show precisely the circumstances under which this agent can conclude the presence of an intruder (ie. conclude whether or not the proposition $Intruder$ is true).

4. This question combines the topics of logic and search.

   Satisfiability is the name given to the problem of assigning truth values to the propositions that make up a logical sentence in such a way that the sentence as a whole is true. For example, the sentence $A \wedge \neg B$ is satisfied by making A true and B false. Note that if a sentence contains n propositions there are 2^n possible truth assignments; one not very good way to find a satisfying assignment is to simply search through all 2^n assignments for one that works.

   To simplify things, satisfiability problems are often restricted to sentences in conjunctive normal form (CNF). A CNF sentence consists of a conjunction of a set of disjunctive clauses. For example, the following sentence is formed from the conjunction of three disjunctive clauses.

   $(P \vee Q \vee \neg S) \wedge (\neg P \vee Q \vee R) \wedge (\neg P \vee \neg R \vee \neg S)$

   Note that for a sentence in CNF to be satisfied, all of the clauses that are conjoined must be satisfied; within each clause, however, only one of the disjuncts needs to be true. Of course, the propositions have to be given consistent assignments across the entire sentence (you can't assign P to the value true in the first clause and not true in the second).

   One fruitful approach to solving satisfiability problems is with a constraint satisfaction, iterative improvement search.

   (a) **Points: 20**

   Describe a specific application of an iterative improvement approach to the solution of CNF satisfiability problems.

(b) **Points: 5** Is your approach sound? Why or why not?

(c) **Points: 5** Is your approach complete? Why or why not?