Midterm Exam: CISC 481/681

NAME:

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Most of these are short answer questions. Note that there is one page of questions for 481 (undergrad) students only, and one for 681 (grad) students only.

1. (5 pts) If we do A* search with a heuristic function that always returns 0, what other search algorithm does the result act like? Can we say anything about the optimality of the solution found?

   (5 pts) What about A* where we ignore the path cost to the current node—what other search algorithm does this act like? Can we say anything about the optimality of the solution found?

   (5 pts) In terms of completeness and optimality, what happens if I do an iterative deepening search and instead of incrementing my max depth (level) by 1, I instead increment it by 2 each time?

2. (5 pts) The *Robocup* organization sponsers the study of AI through the creation of robotic soccer teams. Two of the three leagues are *simulator*, and *medium robots* (who use a real soccer ball on an approximately 4x8 meter field. Simulated agents play on a simulated grid field and can "see" everywhere. Medium robots must have all cameras on-board.

   Characterize the Robocup environment from the standpoint of a player agent (in terms of accessibility, determinism, episodicness, staticness, and discreteness). Do any of your answers likely differ between the leagues?

	Simulated	Medium Robots
Accessible		
Deterministic		
Episodic		
Static		
Discrete		

3. (5 pts) Consider the following compiler optimization problem:

   > *Given* $a, b, c, andd$, *compute* $x = (ac - bd)$ *and* $y = ad + bc$ *using only THREE multiplication operators.*

   Formulate this as a search problem (don't solve it, please).

4. (6 pts) Describe the relative memory requirements of iterative-deepening, simulated annealing, and A*.

   (6 pts) Given the following assumptions only, in each case, which search algorithm should you use to solve each problem?

(a) No information. No heuristic.

(b) Search space is huge, but guarenteed finite. No hueristic. Optimality not important.

(c) You have an admissible heuristic, and a solution can be found within 5 operations.

5. (12 pts) Using A*, find the solution to the following simple 8-puzzle. Use the Manhattan-distance heuristic. Do not expand repeated states. Clearly draw the search tree and indicate the f, g, and h values.

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Start: 1 2 3          Finish: 1 2 3
       4 8 5                  4 5 6
       7   6                  7 8
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6. (4 pts) What would happen, in this instance, if I didn't check for repeated states?

7. (6 pts) How many states might breadth first search expand (assume that you do NOT check for repeated states)? Give the minimum and maximum.

8. Represent the following English sentences in *first order logic*. Please use CONSISTENT and PROPERLY TYPED predicates!!!

   (a) (2 pts) Spaniels or collies that are trained are good dogs.

   (b) (2 pts) If a dog is good and has a master then he will be with his master.

   (c) (2 pts) No person likes a bad dog.

   (d) (3 pts) There is a barber who shaves all men in town who do not shave themselves.

9. Consider the following questions about models.

   (a) (2 pts) Represent (a) "If it is a warm Saturday then Sam is at the park", using propositional logic (instead of first order logic).

   (b) (2 pt) How many mathematically abstract possible worlds does the PROPOSITIONAL representation of "If it is a warm Saturday then Sam is at the park" have?

   (c) (2 pt) Briefly enumerate them.

   (d) (2 pt) Under how many possible worlds is it satisfiable (i.e. how many propositional logic models)?

   (e) (2 pt) How would the same sentence be encoded in First Order Logic (the predicate calculus)?

   (f) (2 pt) Give one possible first order model of the sentence, assuming that the only constants are SAM, THEPARK, SATURDAY, and the only predicates are AT(x,y) and WARM(x).

10. (12 pts) FOR 481 STUDENTS ONLY. Give a simple example (i.e., a small search graph with start state, goal state, operator costs, and h-values clearly marked) demonstrating that if h is inadmissible, then A* search may not return the optimal solution. Also indicate how the search would proceed (e.g, when are nodes expanded) in your example case.

11. (8 pts) For 481 students only. Why, in an algorithm like Uniform Cost Search or A*, do we test that a state is a goal when it is EXPANDED, and not when it is first GENERATED??

12. FOR 681 STUDENTS ONLY. Consider the following two person game called "Grundy's Game".

> Two players have in front of them a single stack of objects, say a stack of pennies. Player 1 divides the original stack into two stacks that must be unequal. Each player thereafter does the same to *some* stack when it is their turn to play. The game continues until every stack has either 1 or 2 pennies in it—at which point continuation becomes impossible. The player who first cannot play is the loser.

(a) (10 pts) Show the game tree for N=7, from the point of view of the player who moves first. The placement of the stacks is immaterial (e.g., from an initial stack of 3 there is only one move, breaking the stack into a stack of 1 and a stack of 2).

(b) (10 pts) Use minimax search to decide what move to make.