CSci 5511 Spring 2008

1st Midterm Exam

Tuesday February 19
75 minutes == 75 points
Open book and notes

1. *20 points*
   You are given an instance of the traveling salesperson problem (TSP). A salesperson has to visit a group of cities, visiting each only once and getting back to the starting city. The objective is to minimize the total distance traveled. Assume each city is directly connected to each other city.

   1. Describe a state-space representation for the problem, specifying initial state, goal state(s), and operators.
   2. For a problem with n cities, how many states are there in the search space? Explain briefly your answer.
   3. Suppose you use A* with the following heuristics: in each city $h(n)$ is the distance to the closest city not yet visited. Is this heuristics admissible? Explain briefly your answer.
   4. Suppose you use the above heuristics in a greedy best-first search algorithm. Are you guaranteed to find an optimal solution? Explain briefly your answer.

2. *10 points*
   In A* the nodes that have been generated but not yet expanded are sorted according to the value of $f(n) = g(n) + h(n)$, i.e. the sum of the cost from the start to node n plus the estimated cost from n to goal using admissible heuristic $h(.)$. Nodes that have the same $f(.)$ value are ordered arbitrarily.

   Are there any domain independent criteria that could be used to re-order nodes with the same $f(.)$ value? Explain your answer.

3. *15 points*
   You are given a state-space search problem, i.e. you are given the initial state, the operators, and a goal state. You come up with your own heuristics, apply A*, and produce an optimal solution.

   1. What property should your heuristics satisfy to guarantee the solution is optimal?
   2. Is the optimal solution unique? if yes, explain why. If not, describe what could cause finding multiple solutions.

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4. *20 points*
   Imagine a futuristic world where numerous types of robots are used. One is an armored transport vehicle whose job is to take a person to a location of that person's choosing. The transport only drives to approved locations and only on special roads dedicated to transport robots. The speed limit is the same for all roads. Traffic is not an issue as all roads are single lane in each direction and all traffic moves at the same speed. There are no issues related to sensing. The robot software is implemented using a goal-based architecture. The following is the PEAS description:

Performance	Get person to location, take shortest route
Environment	Client, enemies, other vehicles, roads
Actuators	Steering, accelerator, brake, speaker
Sensors	Camera, sonar, speedometer, GPS, voice input

   1. Describe the environment. Is it fully or partially observable? Deterministic or stochastic? Static or dynamic? Discrete or continuous? Single or multi-agent? If multi-agent, who are the other agents and are the agent interactions competitive or cooperative?
   2. What in this problem makes a goal-based architecture a good choice? Why isn't the simple or model-based reflex architectures a good choice?
   3. What could you change in the problem to make it suitable for a simple or model-based reflex agent? (Be specific; it is OK to change the type and purpose of the robot).
   4. Under what circumstances would a utility-based agent be appropriate?

5. *10 points*
   Write in Lisp a function that takes two lists and returns a list constructed by interleaving elements of the first list with elements of the second list, so that the resulting list contains one element from the first list, one from the second, etc. in this order. Terminate the process when one list ends by including the rest of the other list in the result. It should work like this:

```
(interleave '(a b c) '(1 2 3)) ==> (A 1 B 2 C 3)
(interleave '(a b c) '(1)) ==> (A 1 B C)
(interleave '(a) '(1 2 3)) ==> (A 1 2 3)
(interleave  nil '(1 2 3)) ==> (1 2 3)
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YOU REACHED THE END OF THE EXAM