CS594: Artificial Intelligence, Fall 2004
Due: 2:10 PM, Monday, September 6, via email to parker@cs.utk.edu

Homework 1

Please note: Because this homework is due on a university holiday,
only electronic submissions are accepted for this homework.

Chapter 1

1. Every year the Loebner prize is awarded to the program that comes closest to passing a version of the Turing test. Research and report (1/2 page) on the latest winner of the Loebner prize. What techniques does it use? How does it advance the state of the art in AI?

Chapter 2

2. Consider the vacuum cleaner agent function described in figure 2.3.

a. Show that this function is indeed rational under the assumptions listed on page 36.

b. Describe a rational agent function for the modified performance measure that deducts one point for each movement. Does the corresponding agent program require internal state?

c. Discuss possible agent designs for the cases in which clean squares can become dirty and the geography of the environment is unknown. Does it make sense for the agent to learn from its experience in these cases? If so, what should it learn?

3. Consider a modified version of the vacuum environment (from question 2), in which the geography of the environment – its extent, boundaries, and obstacles – is unknown, as is the initial dirt configuration. (The agent can go *Up* and *Down* as well as *Left* and *Right*.)

a. Can a simple reflex agent be perfectly rational for this environment? Explain.

b. Can a simple reflex agent with a *randomized* agent function outperform a simple reflex agent? Explain. Describe the design of your randomized agent.

c. Describe an environment in which your randomized agent will perform very poorly. Explain why this environment is bad for your randomized agent.

4. The vacuum environments above have all been deterministic. Discuss possible agent programs for each of the following stochastic versions:

a. Murphy's law: 25% of the time, the *Suck* action fails to clean the floor if it is dirty and deposits dirt onto the floor if the floor is clean. How is your agent program affected if the dirt sensor gives the wrong answer 10% of the time?

b. Small children: At each time step, each clean square has a 10% chance of becoming dirty. Describe a rational agent design for this case.

(*continued on next page*)

Chapter 3

5. Give the initial state, goal test, successor function, and cost function for each of the following. Choose a formulation that is precise enough to be implemented.

a. You have to color a planar map using only 4 colors, in such a way that no two adjacent regions have the same color.

b. A 3-foot-tall monkey is in a room where some bananas are suspended from the 8-foot ceiling. He would like to get the bananas. The room contains 2 stackable, movable, climbable 3-foot-high crates.

c. You have a program that outputs the message "illegal input record" when fed a certain file of input records. You know that processing of each record is independent of the other records. You want to discover what record is illegal.

d. You have 3 jugs, measuring 12 gallons, 8 gallons, and 3 gallons, and a water faucet. You can fill the jugs up or empty them out from one to another or onto the ground. You need to measure out exactly one gallon.

6. Describe a state space in which iterative deepening search performs much worse than depth-first search (for example, $O(n^2)$ vs. $O(n)$).

Chapter 4

7. A *heuristic path alogrithm* is a best-first search in which the objective function is $f(n) = (2 - w)\, g(n) + wh(n)$. For what values of w is this algorithm guaranteed to be optimal? What kind of search does this perform when $w = 0$? When $w = 1$? When $w = 2$?

8. Prove each of the following statements:

a. Breadth-first search is a special case of uniform-cost search.

b. Breadth-first search, depth-first search, and uniform-cost search are special cases of best-first search.

c. Uniform-cost search is a special case of A^* search.

9. Prove that if a heuristic is consistent, it must be admissible. Construct an admissible heuristic that is not consistent.

10. On page 108 is the definition of the relaxation of the 8-puzzle, in which a tile can move from square A to square B if B is blank. The exact solution of this problem defines **Gaschnig's heuristic** (Gaschnig, 1979). Explain why Gaschnig's heuristic is at least as accurate as h_1 (misplaced tiles), and show cases where it is more accurate than both h_1 and h_2 (Manhattan distance). Suggest a way to calculate Gaschnig's heuristic efficiently.