Assignment 1: Intelligent Agents, Search
Due September 23 at 12:30pm
49 marks total, worth 5% of final grade

This assignment is to be done individually.

Important Note: The univeristy policy on academic dishonesty (cheating) will be taken very seriously in this course. You may not discuss the specific questions in this assignment, nor their solutions with any other student. You may not provide or use any solution, in whole or in part, to or by another student.

You are encouraged to discuss the general concepts involved in the questions in the context of completely different problems. If you are in doubt as to what constitutes acceptable discussion, please ask! Further, please take advantage of office hours offered by the instructor and the TA if you are having difficulties with this assignment.

Question 1 (10 marks)

Let us examine the rationality of various vacuum-cleaner agent functions.

(a) (3 marks) Show that the simple vacuum-cleaner agent function described in Figure 2.3 of the textbook is indeed rational under the assumptions listed on page 36.

(b) (3 marks) 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) (4 marks) 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?

Question 2 (6 marks)

Develop a PEAS description of the task environment (4 marks) and characterize the environment along the six dimensions given in lecture (2 marks, justify as necessary) for an **automated Translink public transit telephone-based route planning agent**.

Question 3 (8 marks)

Give the initial state, goal test, successor function, and cost function (1 mark each per subpart) for each of the following. Choose a formulation that is precise enough to be implemented.

(a) 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 two stackable, movable, climbable 3-foot high crates.

(b) You have a program that outputs the message "illegal input line" when fed a certain input file. You want to determine what line in the input file is causing the problem.

Question 4 (10 marks)

In this exercise, we consider problems **with** negative path costs.

(a) (2 marks) Suppose that actions can have arbitrarily large negative costs; explain why this possibility would force any optimal algorithm to explore the entire state space.

(b) (2 marks) Does it help if we insist that step costs must be greater than or equal to some negative constant c?

(c) (2 marks) Suppose that there is a set of operators that form a loop, so that executing the set in some order results in no net change to the state. If all of these operators have negative cost, what does this imply about the optimal behaviour for an agent in such an environment?

(d) (4 marks) One can easily imagine operators with high negative cost, even in domains such as route finding. For example, some stretches of road might have such beautiful scenery as to far outweigh the normal costs in terms of time and fuel. Explain, in precise terms, within the context of state-space search, why humans do not drive round scenic loops indefinitely, and explain how to define the state space and operators for route finding so that artificial agents can also avoid looping.

Question 5 (7 marks)

Prove that if a heuristic is consistent, it must be admissible (5 marks). Construct an admissible heuristic that is not consistent (2 marks).

Question 6 (8 marks)

In this exercise, we will examine hill-climbing in the context of planar robot navigation among polygonal obstacles (as in Figure 3.22 of the textbook).

(a) Explain how hill-climbing would work as a method of reaching a particular point goal.

(b) Show how nonconvex obstacles can result in a local maximum for the hill-climber, using an example.

(c) Is it possible for it to get stuck with convex obstacles?

(d) Would simulated annealing always escape local maxima on this family of problems?

Submitting Your Assignment

This assignment is a written one, and is to be submitted on paper (hardcopy) at the beginning of lecture on September 23. Please write legibly or typeset your document using your favourite word processor.