Introduction to Artificial Intelligence

Tutorial Sheet 2

Exercise 1

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

a. Show that the simple vacuum-cleaner agent function is indeed rational under the assumptions:

- The performance measure awards one point for each clean square at each time step, over a “lifetime” of 1000-time steps.
- The “geography” of the environment is known a priori (Figure 2.2 and 2.3 below) but the dirt distribution and the initial location of the agent are not. Clean squares stay clean and sucking cleans the current square. The Left and Right actions move the agent left and right except when this would take the agent outside the environment, in which case the agent remains where it is.
- The only available actions are *Left*, *Right*, and *Suck*.
- The agent correctly perceives its location and whether that location contains dirt.
- The goal of the agent is to have the two squares clean.

b. Describe a rational agent function for the case in which each movement costs one point. Does the corresponding agent program require an 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? If not, why not?

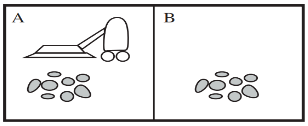

Figure 2.2 A vacuum-cleaner world with just two locations.

Percept sequence	Action
[*A*, *Clean*]	*Right*
[*A*, *Dirty*]	*Suck*
[*B*, *Clean*]	*Left*
[*B*, *Dirty*]	*Suck*
[*A*, *Clean*], [*A*, *Clean*]	*Right*
[*A*, *Clean*], [*A*, *Dirty*]	*Suck*
⋮	⋮
[*A*, *Clean*], [*A*, *Clean*], [*A*, *Clean*]	*Right*
[*A*, *Clean*], [*A*, *Clean*], [*A*, *Dirty*]	*Suck*
⋮	⋮

Figure 2.3 Partial tabulation of a simple agent function for the vacuum-cleaner world shown in Figure 2.2.

a. Show that the simple vacuum-cleaner agent function is indeed rational.

b. Describe a rational agent function for the case in which each movement costs one point. Does the corresponding agent program require an 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? If not, why not?

Exercise 2

For each of the following assertions, say whether it is true or false and support your answer with examples or counterexamples where appropriate.

a. An agent that senses only partial information about the state cannot be perfectly rational.

b. There exist task environments in which no pure reflex agent can behave rationally.

c. There exists a task environment in which every agent is rational.

d. The input to an agent program is the same as the input to the agent function.

e. Every agent function is implementable by some program/machine combination.

f. Suppose an agent selects its action uniformly at random from the set of possible actions. There exists a deterministic task environment in which this agent is rational.

g. It is possible for a given agent to be perfectly rational in two distinct task environments, i.e. where each environment has its own set of characteristics, constraints, and objectives.

h. Every agent is rational in an unobservable environment.
i. A perfectly rational poker-playing agent never loses.
j. For a simple reflex agent in a partially observable environment, a randomized policy can outperform any deterministic policy.
k. There is a model-based reflex agent that can remember all of its percepts.
l. Suppose agent A1 is rational and agent A2 is irrational. There exists a task environment where A2's actual score will be greater than A1's actual score.

Exercise 3

For each of the following activities, give a PEAS (Performance, Environment, Actuators, Sensors) description of the task environment and characterize it in terms of the properties (Section 2.3.2 of the textbook): **Environment observability**: fully vs partially observable; **Environmental predictability**: Deterministic vs. stochastic; **Task structure**: Episodic vs. sequential; **Environmental stability**: Static vs. dynamic; **Action granularity**: Discrete vs. continuous; **Number of agents**: single vs multi-agent.

1. Playing soccer:
2. Exploring the subsurface oceans of Titan:
   investigating the vast liquid oceans believed to exist beneath the icy surface of Saturn's moon which is called Titan (*Titan* is the largest *moon* of *Saturn* the sixth planet from the Sun*)*.
3. Shopping for used AI books on the Internet:
4. Playing a tennis match:
5. Practicing tennis against a wall:
6. Performing a high jump:
7. Knitting a sweater:
8. Bidding on an item at an auction:

Exercise 4

Consider a modified version of the vacuum environment in Exercise 1, in which the agent is penalized one point for each movement.

a. Can a simple reflex agent be perfectly rational for this environment? Explain.
b. What about a reflex agent with state? Design such an agent.
c. How do your answers to A and B change if the agent's percepts give it the clean/dirty status of every square in the environment?
- Can a simple reflex agent be perfectly rational for this environment? Explain.
- What about a reflex agent with state (i.e. a reflex agent that takes into account both the current percept and the history of past actions, so it keeps track of its internal state, which is updated as it interacts with the environment)?

Exercise 5

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

a. Murphy's law: twenty-five percent 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. Can you come up with a rational agent design for this case?