

### CSC4444(AI) Homework 1, Due Wednesday September 6, 2017

1[50%].

This problem is similar to question 2.10 in the text book, except the environment configuration is slightly different.

Consider the following vacuum-cleaning world which has 3 squares:

A	B	C
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We assume the following:

- The vacuum-cleaning agent knows the configuration of the 3 squares, but does not know which square it is in initially. The initial dirt distribution is not known either.
  - A clean square remains clean and a dirty square remains dirty unless the agent cleans it up.
  - The agent has two sensors:  $Loc(x)$  and  $Status(x)$ .  $Loc(x)$  returns the identity ("A" or "B" or "C") of the square  $x$  that the agent is located, and  $Status(x)$  returns either "Dirty" or "Clean" for the square  $x$ . Assume that the sensors are 100% reliable.
  - The actions available for the agent are: *Left*, *Right*, *Suck*, *NoOp*. Each action takes place in one time "step".
  - The actions are perfectly reliable - perform "Suck" in dirty square will change it to become clean, and moving left when in square C will get the agent to square B.
  - The agent will be penalized by  $-1$  point for each movement *Left*, *Right*, *Suck*. The agent gets  $+10$  points reward for each dirty square cleaned.
  - For a time horizon  $T$  (say  $T = 100$ ) steps, the agent is penalized by  $-2$  points per dirty square per time step. (If a square is dirty at the "start" of time step  $t$  and the agent performs "Suck" at this time step, the square becomes "clean" at the "end" of step  $t$ . Thus for time step  $t$  for this particular square, no penalty should be applied to the agent).
  - The agent's performance is measured by the total number of points (positive or negative) over  $T = 100$  time steps.
- (a) Design a simple reflex agent (without states) for this problem - provide pseudo-code for the agent and define the "condition-action" rules. Can such an agent be perfectly rational (i.e., maximizing the expected performance measure) for any initial agent location and dirt distribution? Explain your answer.
- (b) What about a reflex agent with states (i.e., an agent which has an internal state representation of the world environment)? Can such an agent be perfectly rational under the current assumptions? Design such an agent (pseudo-code, rules, or look-up table, etc.).
- (c) Now assume that the agent's dirt sensor is more powerful which provides complete information about dirty/clean status of *every* square in the environment. Can a simple reflex agent be perfectly rational now? And if so, design such an agent (pseudo-code, rules, or look-up table, etc.).

2[30%].

Implement (in Python, Java, or whatever programming language you are comfortable to use) the agents corresponding to Question 1(a), 1(b) and 1(c), and run simulation of each agent (with  $T = 100$ ) for 3-4 different initial configurations of dirt/agent location. For each run, print out the initial configuration, the sequence of (percept, action) pairs and the final performance score for the agent.

3[20%].

Assume that the vacuum-cleaning agent's environment is the same as Question 1, except that the location sensor of the agent is broken. Thus the agent can only know the dirty/clean status of the current square without knowing the identity of the current square.

- (a) Can a simple reflex agent be perfectly rational in such an environment? Explain your answer.
- (b) Can a simple reflex agent with a randomized agent function do better compared to a deterministic simple reflex agent? Design (and implement) such an agent as well as the simple reflex agent. Run a number of experiments (with different initial dirt/agent location settings) and compare the performance scores of this randomized agent with that of the simple reflex agent.