CS331 (Spring 2018): Introduction to Artificial Intelligence
Written Assignment #1

Date handed out: April 4, 2018
Date due: April 11, 2018 at the start of class
Total: 25 points

This assignment is to be done individually. Please hand in a pdf through Canvas. Assignments done on a word processor are preferred but not mandatory. For hand written assignments, if we cannot read your writing, we cannot mark your assignment.

You will be answering questions 1-4 for a fraud detection agent operating on your credit card purchases. This agent monitors everything bought on your credit card and emails or text messages you if it detects a potentially fraudulent purchase.

1. Describe the following aspects of the task environment:
a) Environment [1 point]
The environment is a virtual environment consisting of the history of credit card purchases that you make.

b) Actuators [1 point]
The actuator is the action of sending you a notice of potentially fraudulent credit card charge via email or text message.

c) Sensors [1 point]
The sensors are basically sensing the credit card purchases

2. You’ll notice that Performance is left out of the PEAS description above. What performance measure should you use for your fraud detection agent? Be as specific as possible (eg. write down the performance measure as a formula). Be careful, this one is tricky! [4 points]

There are 3 important criteria and if you got 2 out of the 3, you got full credit.
1) Out of the number of alerts the fraud detection agent raised, how many were truly fraudulent? This is called precision in machine learning.
2) Out of the number of fraudulent transactions, how many did the fraud detection agent detect? This is called recall in machine learning.

Notice that fraud is typically rare and most of your credit card transactions are usually legitimate. If you had an agent that said that all your purchases were fraudulent, you would have a very high score for (2) but a very low score for (1). You want to trade off both (1) and (2).

3) How quickly did the agent detect the fraudulent transactions?
3. Describe the environment according to the following properties:

a) fully vs partially observable [1 point]
   Partially observable. You don’t actually know if a transaction is fraudulent or legitimate.

b) deterministic vs stochastic [1 point]
   Stochastic due to the partially observability

c) episodic vs sequential [1 point]
   Could be either. It is sequential if the credit card fraud occurs over a series of transactions and episodic if the fraud involves isolated incidents.

d) static vs dynamic [1 point]
   The environment is typically static. The credit card transactions typically occur on the order of minutes or hours apart. This allows the agent to “think” once a transaction is received.

e) discrete vs continuous [1 point]
   Since the agent deals with currency, you could consider it to be continuous.

f) single vs multi-agent [1 point]
   Could be either. It is single agent if there is only one computer agent reasoning about a sequence of credit card transactions made by other human beings. It could be multi-agent if other agents are involved in trying to deceive the fraud detection agent.

Note that in some cases, both answers might be correct. Justify each answer to the task environment properties with a one sentence explanation.

4. Suggest the most appropriate agent design by choosing the most appropriate of the following agent types:
   - simple reflex agent
   - model-based reflex agent
   - goal-based agents
   - utility-based agent

Justify your answer with a few sentences. [2 points]

Some credit card companies use a simple reflex agent that only looks at the current transaction. A better design is a model-based agent which builds a model of fraud and combines this knowledge with the current percept.

5. The following question deals with the vacuum-cleaner agent described below:
   - 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 apriori 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.

Consider a modified version of this vacuum-cleaner environment in which the agent is penalized one point for each movement.

a) Can a simple reflex agent be perfectly rational for this environment? Explain. [2 points]
No it can’t. The simple reflex agent has no memory of where it has it been and it will gets stuck in a loop, lowering its performance measure.

b) Claim: a reflex agent with state can be perfectly rational in this environment (where this state is in addition to the current percept – note that this state makes the agent a model-based reflex agent). Describe how you can design a reflex agent with state that can act rationally in this environment. You may modify the actions performed by your agent to include a “Do nothing” action. [4 points]

Design a model-based reflex agent that builds a map of the environment and where it has been. The agent would need to explore the environment in order to build the map. The agent should have a policy that minimizes the amount of movement it needs to do to explore the environment and clean the squares. If all squares are clean, the agent does nothing.

c) How do your answers to 5a and 5b change if the agent’s percepts give it the clean/dirty status of every square in the environment? [4 points]
This modified percept would in essence be equivalent to the map of part 5b. With this modified percept, a simple reflex agent can operate rationally and not wander aimlessly when all squares are clean (provided the Do Nothing action is available).