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### Written Assignment #1

1.
  - a) The environment for the fraud detection agent would be my credit card's usage history.
  - b) The agent's actuators would be SMS/email messages to me.
  - c) The agent's sensors would include some sort of network interface for receiving credit card purchase information and SMS/email for receiving feedback regarding potential fraud.
2. Although the numbers would need fine-tuning from statistics and testing, a potential performance measure for this agent would be:
  - +1 point every day
  - -10 points for every hour between fraud occurring and me being notified
  - -10 points per false positive
  - -1000 points for missed fraud
3.
  - a) I would say the environment is partially observable because the agent does not have access to pertinent information to detecting fraud like my current location or whether I have recently reveal my credit card information to another person or the reputation of a vendor.
  - b) The environment is stochastic because it is impossible for the agent to predict what I will purchase and when with absolute certainty using only my prior purchase history.
  - c) I would argue the environment is sequential because fraud could be discovered through a pattern of purchases and not just a single purchase. It may also be reasonable for the agent to be more suspicious of fraud if it has already occurred once.
  - d) The environment is clearly dynamic because the purchase history will change over time as purchases are made using the credit card.
  - e) Although, strictly speaking, the state and time of the environment are discrete (the data is digital), we should treat them as continuous since purchases can occur at any time in just about any location and for just about any amount. The percepts and actions of the environment, on the other hand, are discrete because there is

always a finite number of purchases in the history and the only actions the agent can take are to notify me of potential fraud or do nothing.

- f) The environment is multi-agent in that myself and the fraud detection agent are cooperating because we share the performance measure of detecting fraud quickly and accurately and feedback from me regarding potential fraud can impact the fraud detection agent's performance measure. The fraud detection agent could also be said to be competing with those who would commit credit card fraud.
4. For the fraud detection agent, I think a model-based reflex agent would be the most appropriate because, as mentioned previously, the environment is only partially observable (making a simple reflex agent inadequate) and the model would allow the agent to recognize suspicious patterns in purchases instead of limiting its decision to the most recent transaction. A goal-based agent is not appropriate because the goal is unchanging (detect credit card fraud) and a utility-based agent is not appropriate because the agent's goal is essentially singular and would not require extensive utility deliberation.
- 5.
- a) A simple reflex agent cannot be perfectly rational for this environment because the vacuum-cleaner agent cannot know the cleanliness state of every square using only its current percept. As a result, it must choose between continuously moving to ensure all squares are clean and thus incur the movement penalty or face the risk of other squares being dirty and thus lose much its potential points.
  - b) I would design the agent to do sweep of the entire environment, first moving all the way left until it no longer can (can be detected by simply comparing its current location against the known geography) and then moving all the way right until it no longer can, cleaning every dirty square it encounters along the way. Once it can longer move right, the agent would do nothing.
  - c) My answer to 5a would change from no to yes because now the environment is fully observable with just the current percept. However, this assumes that the time to move is negligible and thus the decision for whether it is beneficial to leave a square dirty does not depend on the number of time steps that have already passed. For example, moving 500 times to clean a single dirty square is only rational if there will be at least 500 time steps left by the time the agent cleans it. If this assumption is incorrect, some state for recording the number of time steps that have passed would be required for the agent to be perfectly rational.
- My answer to 5b would change because now that the agent has access to the geography, its location, and the clean/dirty status of every square, the rational behavior would be to perform calculations to determine what's the last square it should initially move to before turning around (if it all) and the square it should stop at to maximize points. This is because dirty squares that require more than 1000 additional movements to get to are not worth cleaning because the most points a clean square can earn is a 1000 according to the problem definition. Thus,

the agent should first create a 2D table populated with the number of net points gained for each possible (turn around square, stop at square) pair. Once the maximum has been found, that movement strategy would be employed.