CS331 (Spring 2017): Introduction to Artificial Intelligence
Written Assignment #1

Date handed out: April 5, 2017
Date due: April 12, 2017 at the start of class
Total: 25 points

The written portion of this assignment is to be done individually. Please hand in a hardcopy. Assignments done on a word processor are preferred but not mandatory. For handwritten assignments, if we cannot read your writing, we cannot mark your assignment.

1. You will be answering parts (a)-(c) for a smart home assistant like Google Home or Amazon’s Alexa. These agents listen for keywords (e.g. “Okay, Google”), and when addressed, respond to questions and perform tasks (e.g. adding an item to a list, answering a question through the speaker). If they are unable to understand or respond to a query, the systems announce this to the user [11 pts].

a) Develop a description of the task environment using the PEAS description i.e.:
   - Performance
   - Environment
   - Actuators
   - Sensors

   A suitable performance measure might be the number of queries to which the system is able to respond successfully, divided by the total number of queries.
   - The environment is the home of the user, which is linked to their Google/Amazon account information.
   - The actuators are the speaker. Some devices also have lights. The systems are can also send search queries and access other systems through the internet.
   - The primary sensor is an always-on microphone, waiting to hear the keywords.

b) Then describe the environment according to the following properties:
   - fully vs partially observable
   - deterministic vs stochastic
   - episodic vs sequential
   - static vs dynamic
   - discrete vs continuous
   - single vs multi-agent

Note that in some cases, both answers might be correct. Justify each answer to the task environment properties with a one sentence explanation.
• Partially observable (the system doesn’t know who is addressing it, nor the exact context of some questions)
• Could accept either answer here. After answering a query, the system will go back to listening (deterministically). If we consider whether the user was satisfied with the response to be part of the state, the environment would appear stochastic.
• Episodic – each query is a stand-alone event
• Could accept either answer here. Static – only answers one query at a time. Dynamic – the user’s interest could change if the agent takes too long to respond. Semidynamic – if the user’s wait time is part of the performance measure.
• Time is continuous. States, percepts, actions are better described as discrete (though potentially very large spaces).
• Could accept either answer here. Single agent – just one smart home system. Multi-agent – the smart home system could interact with other agents on the internet (e.g. a list-making app, a weather app).

c) 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 one sentence explanation.

Could accept simple reflex agent or model-based reflex agent. Simple reflex agent – the system takes one of a few actions based on what kind of query it receives. Model-based – the system could maintain some internal state to assist its choice of action (e.g. knowledge about the user).

2.(Exercise 2.3f-i in the book) For each statement, say whether it is true or false. Provide a one-sentence example, counterexample, or justification.

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. [2 points]

True. If it doesn’t matter which action you take, selecting randomly is rational.

g) It is possible for a given agent to be perfectly rational in two distinct task environments. [2 points]

True. For example, we can arbitrarily modify the parts of the environment that are unreachable by any optimal policy as long as they stay unreachable.

h) Every agent is rational in an unobservable environment. [2 points]
False. Some actions are stupid—and the agent may know this if it has a model of the environment—even if one cannot perceive the environment state.

i) A perfectly rational poker-playing agent never loses. [2 points]

False. Unless it draws the perfect hand, the agent can always lose if an opponent has better cards. This can happen for game after game.

3. (From Exercise 2.11 in the book) Consider a modified version of the vacuum environment:
   - Performance measure: one point awarded for each clean square at each time step
   - Environment: geography of the environment (its extent, boundaries, obstacles, etc.), dirt distribution, and initial location are unknown. Clean squares stay clean.
   - Actuators: Suck cleans dirt, Left moves left, Right moves right.
   - Sensors: Location and dirt sensors.

a) Can a simple reflex agent be perfectly rational for this environment? [2 points]

Because the agent does not know the geography and perceives only location and local dirt, and cannot remember what just happened, it will get stuck forever against a wall when it tries to move in a direction that is blocked—that is, unless it randomizes.

b) Can a simple reflex agent with a randomized agent function outperform a simple reflex agent with a deterministic agent function? Explain why or why not. [2 points]

Yes. For example, the randomized agent could clean up dirt and otherwise move randomly, thus avoiding getting stuck.

c) Can a reflex agent with state outperform a simple reflex agent? Explain why or why not. [2 points]

Yes. A reflex agent with state can build a map.