CS 340 Home Work Assignment # 1

Total marks: 100

Q 1. (15 marks) For each of the following activities, give a PEAS description of the task environment and characterize it in terms of the properties listed in Chapter 2 of the textbook.

(a) Playing soccer
(b) Exploring the subsurface oceans of Titan
(c) Shopping for used AI books on the Internet
(d) Playing a tennis match
(e) Practicing tennis against a wall
(f) Performing a high jump
(g) Knitting a sweater
(h) Bidding on an item at an auction.

Many of these can actually be argued either way, depending on the level of detail and abstraction.

A. Partially observable, stochastic, sequential, dynamic, continuous, multi-agent.
B. Partially observable, stochastic, sequential, dynamic, continuous, single agent (unless there are alien life forms that are usefully modeled as agents).
C. Partially observable, deterministic, sequential, static, discrete, single agent. This can be multi-agent and dynamic if we buy books via auction, or dynamic if we purchase on a long enough scale that book offers change.
D. Fully observable, stochastic, episodic (every point is separate), dynamic, continuous, multi-agent.
E. Fully observable, stochastic, episodic, dynamic, continuous, single agent.
F. Fully observable, stochastic, sequential, static, continuous, single agent.
G. Fully observable, deterministic, sequential, static, continuous, single agent.
H. Fully observable, strategic, sequential, static, discrete, multi-agent.

Q2. (15 marks) For each of the following task environment properties, rank the example task environments from **most to least** according to how well the environment satisfies the property. Layout any assumptions you make to reach your conclusions.

(a) Fully Observable: driving; document classification; tutoring a high-school student in calculus; skin cancer diagnosis from images.
(b) Continuous: driving; spoken conversation; written conversation; climate engineering by stratospheric aerosol injection.
(c) Stochastic: driving; sudoku; poker; soccer.
(d) Static: chat room; checkers; tax planning; tennis.

a. *Fully Observable*: document classification > skin cancer diagnosis from images > driving > tutoring a high-school student in calculus.
Document classification is a fairly canonical example of a (non-sequential) observable problem, because the correct classification depends almost entirely on the visible text of the document itself. There might be a slight influence from "provenance" information (date, authorship, etc.) that may not be directly observable. Skin cancer diagnosis can sometimes be done well from an image of the lesion, bot other factors such as patient age, changes in the lesion over time, medical history, and family history can be important. Driving is often considered to be observable because we imagine that we are making decisions based on what we see, but (1) velocity and turn signal status of other vehicles can be judged only from multiple image frames, and (2) assessing the intended actions of other vehicles may require accumulating information over an extended period—e.g., to determine if a vehicle is stopped or broken down, driving slowly or looking for an address or a parking spot, turning left or has forgotten to turn off the turn signal. Other vehicles, hedges, fog, and so on can obscure visual access to important aspects of the driving environment. Tutoring is almost completely unobservable: what matters is the student's level of understanding, learning style, basic math skills, etc. Clues must be gathered over days, weeks, and months.

b. *Continuous*: climate engineering > driving > spoken conversation > written conversation.
Climate engineering by aerosol injection is quintessentially continuous: the engineer must decide how much to inject, where, and when, and all of these are continuous quantities. The control actions of driving are mostly continuous (steering, acceleration/braking) but there are discrete elements (turn signal, headlights). More importantly, the problem is usually handled using discrete high-level actions (change lanes left, take exit, etc.) that have implementations as continuous control problems. This kind of discrete/continuous hierarchy is very common; playing chess in the physical world is a perfect example. Spoken conversation is closer to chess than driving: roughly speaking, we choose the discrete words to say and delegate the saying to continuous motor control routines. Prosody (volume, pitch, and speed variation) is, however, an important continuous element in how we speak that is largely absent from written communication.

c. *Stochastic*: poker > soccer > driving > sudoku.
In poker, nearly everything is determined by the fall of the cards, which is entirely stochastic from the viewpoint of the players. Both soccer and driving contain elements that are fairly deterministic, such as the flight of the ball and the response of the engine, and elements that are stochastic, such as tire punctures and the outcomes of tackles. Yet typically one can make reasonably reliable driving plans over many minutes, whereas it is essentially impossible to predict the state of a soccer game one minute into the future. Sudoku, of course, is entirely deterministic.

d. *Static*: tax planning > checkers > chat room > tennis.
While no human activity is completely static, given the finite length of our lifetimes, tax planning comes close—the typical "deadline" to get it done is often weeks or months, and the relevant aspects of the environment (life/death, number of offspring, tax law) may change even more slowly. In checkers, the world state doesn't change until someone moves, but the clock ticks so the problem is semi-dynamic. In the chat room, long delays in replying are unacceptable, so it is a fairly real-time environment, but not nearly as real-time as tennis, where a delay of a split second often makes the difference between winning and losing a point.

Q2. (10 marks) Consider a simple thermostat that turns on a furnace when the temperature is at least 3 degrees below the setting, and turns off a furnace when the temperature is at least 3 degrees above the setting. Is a thermostat an instance of a simple reflex agent, a model-based reflex agent, or a goal-based agent? Explain your choice.

The thermostat is best understood as a simple reflex agent. Although the temperature setting might be viewed as a goal, the agent has no notion of how its actions will lead to the goal; so it's better to view the temperature setting as part of the agent's percepts. A more complex control system might well have an internal model of the house, the behavior of its occupants, the capabilities of the heating system, and so on, and would be viewed as a goal-based system in much the same way as a self-driving car that tries to reach a specified destination quickly and cheaply.