CS4710 Artificial Intelligence HW1

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1 Agent Types Using PEAS

1.1 Fitness Tracker

- Performance:
  - User Weight (Increase vs. Decrease)
    - User decides if they want to weigh more or less, penalize Agent based on rate-of-change.
  - User Strength (Increase vs. Decrease)
    - User decides they want to get stronger, penalize Agent based on rate-of-change.
  - Resting Heart-Rate (Cardiovascular Strength)
    - User decides they want to lower their resting heart-rate, penalize Agent based on rate-of-change.
- Environment:
  - Set of possible workouts and activities(running, weightlifting, swimming, rowing, etc..)
  - Activities might include walking or walking up stairs etc..
- Actuators:
  - Workout generation and recommendations based on user defined goals. User wants lower heart-rate potentially recommend cardio activities or if the user wants strength recommend weightlifting.
  - Send notifications to motivate user.
  - Workout modification based on performance. Is heart rate too high today? Lower the intensity etc..
- Sensors:
  - Heart-rate tracker, step-tracker, workout-timer
  - User feedback systems as well, users could rank they're favorite workouts

1.2 Wildlife Monitoring Drones

- Performance:
  - Number animals detected (wildlife count)
  - Count of individual animals (number of deer vs number of doe etc)
  - Accuracy of Animal Detection (we want to maximize confidence)
- Environment:
  - Weather Conditions (Rainy, Windy, Clear Skies)
  - Time of Day (Morning, Afternoon, Night)
  - Terrain (Mountainous, Urban, Rural)
- Actuators:
  - Notify wildlife authorities of decline/rise in specific animal
  - Notify wildlife authorities of decline/rise in general animal population
  - Automated data collection by drone video
  - Automated flight modifications, move to areas of recently detected animals
  - Sending data to external data-store for further processing
  - Tracking animals to keep tabs on them
- Sensors:
  - Cameras with Computer Vision detectors (ML)
  - Motion Detectors
  - Night vision video with ability to detect animals
  - Thermal video to detect animals
  - Environment sensors for weather, humidity, etc..
  - GPS to allow positioning of both drone and animals to be tracked.

2 Four Task Environments:

(Y) = Yes, (N) = No, (D) = Depends

NOTE: I put actual answers beside all depends responses just in case the rubric is more strict than I expected.

2.1 Solving Classical Minesweeper

- **Discrete (Y):**
  - Explanation: There are a distinct and countable number of possible state and action pairs once a game has begun. There are the remaining clickable squares and the action to click any one of them. This square count can only decrease with a given action.
- **Episodic (Y):**
  - Explanation: Each given board state is self contained and need not "remember" or be dependent on previous board states. You have the given number or lack of a number within every square and can from that determine what square to choose next.
- **Single-Agent (Y):**
  - Explanation: There is a single player(agent) playing minesweeper and choosing squares.
- **Deterministic (N):**
  - Explanation: Because of the characteristics of minesweeper there do exist possible state configurations where there is no deterministic way to know which square contains a mine and which does not. This scenario may require a given AI to make what is effectively an educated guess which definitely moves minesweeper into a Strategy environment from a Deterministic one.
- **Fully-Observable (N):**
  - Explanation: Some squares will be covered until the game is won or lost so the environment is partially-observable for the agent.

2.2 IKEA Robots that Assemble Bookshelves

- **Discrete (Y):**
  - Explanation: If we assume the states are the variable possible configurations of the bookshelf between not-built and built there have to be a limited number of possible configurations and thus the environment is Discrete. It is possible there are incorrect configurations

that raise this number of possibilities but regardless the possibilities are still countable and Discrete.

- **Episodic (N):**
  - Explanation: As the bookshelf is built each subsequent step will be different and will depend on the step that preceded it meaning this environment is Sequential and not Episodic.
- **Single-Agent (D, answer=N):**
  - Explanation (Y): If this is a single multi-faceted robot that can assemble the entire bookshelf this environment would be single-agent.
  - Explanation (N): If there are multiple robots in an assembly-line configuration where each robot performs one task/step this would be a multi-agent environment.
- **Deterministic (Y):**
  - Explanation: Each step in building the bookshelf will deterministically lead to the next logical step in the process. If we put one shelf in the bookshelf the next state of the bookshelf will be guaranteed to be the original bookshelf plus another shelf for that state action pair.
- **Fully-Observable (D, answer=N):**
  - Explanation (Y): If the environment is single-agent then the given robot will be able to see the entire bookshelf and all remaining pieces to construct it making the environment fully-observable.
  - Explanation (N): If the environment is multi-agent then any one robot may only be able to see the part it is designed to add thus making the environment partially-observable.

2.3 Playing Hanabi Game

- **Discrete (Y):**
  - Explanation: There are a fixed number of cards in a deck and in each hand and thus a fixed and countable number of possible state action configurations making the environment Discrete.
- **Episodic (N):**
  - Explanation: Because every turn depends on the turn that preceded it and the turn that preceded that we will call the environment sequential.
- **Single-Agent (N):**

- Explanation: There are multiple agents by default, both players of the game.

- **Deterministic (N):**
  - The next state of the game is not only determined by a single agent as the turns rotate, this is a Strategic environment.

- **Fully-Observable (N):**
  - Explanation: The agent cannot see the cards that it has and therefore the environment is Partially-Observable.

2.4 Dental X-Ray Image Analysis

- **Discrete (D, answer=N):**
  - Explanation (Y): If we predefined every possible diagnoses and a fixed confidence threshold required for each we can somewhat force the problem to be in a Discrete environment regardless of the practicality and effectiveness.
  - Explanation (N): Because much of what can be detected in an X-Ray can operate on a continuous scale the number of possible states may not be directly countable and discrete. Say for example that a bone appears nearly fractured but could be fine the environment may require some level of continuous spectrum of a state for that scenario.

- **Episodic (D, answer=N):**
  - Explanation (Y): If we are performing analysis on individual images we can certainly constrain the problem to be Episodic and based on a single image at a time.
  - Explanation (N): If we are performing analysis on multiple images for a given patient it is certainly possible that subsequent images could expand on knowledge acquired in earlier ones making the environment Sequential.

- **Single-Agent (D, answer=N):**
  - Explanation (Y): Assuming we have a single agent that can evaluate multiple images this would be a Single-Agent environment.
  - Explanation (N): Assuming that each individual dental image requires an agent, it is possible that the scenario will require multiple agents that combine their diagnoses to a final result. This would be a Multi-Agent environment.

- **Deterministic (N):**

  - Explanation: Because of the inherent randomness in human genetics and physical structures the environment almost certainly has characteristics on non-determinate scenarios and would likely become a more Strategic problem of diagnosing with some level of confidence and providing information to doctors/patients.

- **Fully-Observable (D, answer=N):**
  - Explanation (Y): Provided one agent can view the image(s) and they are the only data provided to the agent then the environment is Fully-Observable.
  - Explanation (N): If their is more data necessary than just the contents of the X-Ray images (Patient history/symptoms) then the agent cannot see the entire environment and we have a Partially-Observable environment.

3 Choose TRUE or FALSE

Rational Agents:

- For each possible percept sequence, a rational agent should select an action that is expected to maximize its performance measure, given the evidence provided by the percept sequence and whatever built-in knowledge the agent has

3.1 Reflex Agents:

- Reflex agents cannot be rational
  - **FALSE**
- Reflex agents do not make decisions based on percept from the previous time step
  - **TRUE**

3.2 Model-Based Reflex Agents:

- Model-based agents maintain some internal states to model the changes of the world
  - **TRUE**
- Model-based reflex agents are always rational
  - **FALSE**

3.3 Goal Agents:

- Goal-based agents explicitly represent the knowledge needed to support decisions
  - **TRUE**
- Goal-based agents only require information about the current state of the environment to decide which action to take
  - **FALSE**

3.4 Utility Agents:

- Utility agents are rational when they choose actions to maximize their utility function, even if the external performance measure and internal utility function are not in agreement
  - **FALSE**

  - Explanation: Based on our definition of rationality where an agent is only rational if it maximizes its performance metric if the agent chooses to maximize the utility metric and that metric disagrees with the performance metric, the agent is not rational.

- A utility agent can be rational under uncertainty.
  - **TRUE**

4 Problem Formulation

Write the complete problem formulation (initial state, state space, actions/costs, successor function, goal test)

4.1 Search Problem:

A crow is on a balcony with a water-filled tube that has a peanut floating in it. The peanut is 3 inches from the top of the tube (where the crow will be able to reach it). The crow would like to get the peanut. On the balcony are 6 identical pebbles. Each pebble raises the water level in the tube by $\frac{1}{2}$ inch, and each pebble can be picked up, moved, and dropped by the crow.

- Initial State:
  - The crow does not have the peanut.
  - Peanut is 3 inches from top of the water filled tube.
  - 6 Identical pebbles sit on the balcony reachable by the crow.
- State Space:
  - All configurations of the water tube and the peanut where the peanut is between 0 and 3 inches from the top of the tube.
  - The number of identical pebbles on the balcony, in the tube, and lost (dropped off of the balcony).
- Actions/Costs:
  - Actions: Pick up a pebble, move a pebble, and drop the pebble.
  - Costs: The cost for an individual move, 1 move = 1 cost.
- Successor:
  - If a pebble is dropped into the tube, the peanut rises a 1/2 inch in the tube and we subtract one from the available identical pebbles.
  - If a pebble is dropped, misses the tube but remains on the balcony, nothing happens to the peanut and the number of available pebbles remains the same.
  - If a pebble is dropped, misses the tube and falls from the balcony, nothing happens to the peanut but we subtract one from the available pebbles.
- Goal Test:
  - The peanut has reached 0 inches from the top of the tube and can be reached by the crow.