CS 4013: Homework #1

Due on February 14, 2018

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Problem 1

Characterize the environment for each of the following tasks, using the 9 properties listed. Justify each answer, ideally with one complete sentence.

(a) **A smart home that autonomously controls the thermo-stat, humidifier, air-conditioner, lights, etc.**

- Partially observable. While it could be possible to make the system fully observable with enough sensors, realistically it will not be able to detect accurate readings for the entire home.
- Stochastic. There is randomness involved with changes in weather, humans affecting the environment by opening/closing doors, etc.
- Sequential. The actions the smart home decides to take now will affect future temperatures and environment conditions.
- Dynamic. The outside weather and human actions continually affect the environment as the agent thinks.
- Continuous states. We deal with real values, so there are infinitely many values each reading can measure.
- Discrete actions. For the systems listed in the question, they all have two discrete states, being either on or off. While the air conditioner can be set to a range of values, it is usually a set of discrete integer temperature values.
- Continuous time. In the real world, states change with the passing of time which is continuous.
- Unknown physics. As far as the system is concerned, it is not aware of the physics and thermodynamics involved with controlling a home system. It only responds with an action based on the current state and the desired state. It could be argued that it is known physics since the system knows how each action will affect the environment.

(b) **A robotic restaurant server (e.g., waiter or waitress)**

- Partially observable. The robot server cannot see or know everything going on in the restaurant, unless a restaurant-wide vision system was implemented using cameras mounted around the room.
- Stochastic. There is randomess in the needs of the restaurant patrons, and the same person may not want the same thing every time.
- Episodic. Taking care of the needs on one patron should not affect others, though it could be argued that it is sequential since serving a patron one part of their meal will make them want the next (appetizer, then entree, then possibly dessert).
- Dynamic. The needs of patrons can change or increase while the agent is thinking.
- Continuous states. It is the real world, so there are infinitely many places the robot server could be, but the orders and needs of the patrons could be argued to be discrete since the number of things offered by the restaurant are discrete.
- Continuous actions. The robot server can move its limbs at an infinite number of ways in the real world, move at an infinite number of different velocities, etc.

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- Continuous time. In the real world, states change with the passing of time which is continuous.
- Known physics. The robot should be aware of the physics affecting it, which means it knows how to move its limbs and/or wheels in order to perform its desired actions.

(c) **An intelligent coach that plays fantasy hockey. The coach must play in a league against other intelligent coaches, draft its team at the beginning of the season, determine which players should start or be benched each night, and potentially make trades during the season.**

- Fully observable. The coach can see the stats of all the players before making the decisions for who to start/bench and who to trade.
- Stochastic. There is randomess in the outcome of the games which is out of control of the coach.
- Sequential. Making a certain move on a certain round affects following rounds. For example, if Player A was traded, it is no longer in the coach's possession to be traded in the following turns until it receives it again from another trade.
- Static. The coach thinks and executes its move every night before the games proceed.
- Discrete states. The states consist of the current player roster for each coach, which is a large, but infinite, number of states.
- Discrete actions. The coach decides between starting or benching a player, and whether to trade a player or not.
- Discrete time. The rounds take place every night during the season, and progresses by nights.
- Unknown dynamics. The coach cannot know the outcome of the game based on its decision to start/bench/trade players.

(d) **An intelligent algorithm that predicts solar flares several days in advance. The algorithm must predict (a) whether or not a solar will occur; and (b) if so, its severity (class A, B, C, M, or X)**

- Partially observable. If the environment is the current state of the sun, it is only possible to see approximately half of it using current tools (cannot see behind it).
- Stochastic. There is randomess in the chemical reactions within the sun that cannot be determined by the agent.
- Episodic. Making a decision on whether a flare will happen and its severity does not affect the outcome of the next prediction.
- Dynamic. The environment and reactions inside the sun are constantly changing while the agent makes its predictions.
- Continuous states. The states of the reactions inside the sun are infinitely many depending on the positions and states of molecules inside the sun.
- Discrete actions. The agent makes a decision from a discrete number of choices (it will happen or not, and five discrete severity classes).
- Continous time. The state changes smoothly over time since it is in the real world.
- Known dynamics. The dynamics are mostly known since the agent should be programmed with what conditions cause flares, and should make its predictions based on those.

Problem 2

Define each of the following search problems, using the 5 com-ponents listed.

(a) **Guess which playing cards your opponent is holding in their hand (you may assume a standard 52-card deck)**

- Inital state: You do not know any of the cards the opponent is holding.
- Action set: Make a set of five guesses g_1 to g_5 on the cards the opponent is holding c_1 through c_5, determine whether the guess was correct. If g_i matches c_i, mark card as correctly guessed. Keep track of all past guesses so as to not repeat a card in the guesses. For all non-correct guesses, retry guesses. Repeat until g_1 through g_5 are correct.
- Transition model: A transition model would give next possible guesses by removing the current guesses and previously guessed cards from the set of cards it has left to guess.
- Goal test: Are guesses g_1 to g_5 all correct?
- Path cost: The path cost would be determined as the number of turns needed to to correctly guess all five cards in the opponent's hand.

(b) Find the most comfortable empty chair in a room of 1 million chairs (some chairs already have people sitting on them, and youre not allowed to remove the current occupant!)

- Initial state: You have not found the most comfortable empty chair in the room.
- Action set: Assuming the state is modeled as a set of all chairs in the room, the initial action set would be to remove from the set the chairs that are occupied. Then for each attribute in the list attributes of a comfortable chair, filter out all chairs that do not meet those requirements. Once a set of chairs remains that meet all requirements of a "comfortable chair," try each of them and select the most comfortable one.
- Transition model: The transition model based on this modeling of state would be the resulting set of chairs after each time the filter is run for each attribute, and then later the a set of chairs with a comfort rating during sequential trying of chairs.
- Goal test: Is this chair the most comfortable in the room?
- Path cost: The path cost can be determined by the number of chairs tried before finding the most comfortable chair.

(c) Its the middle of the night, and youre hungry. Find the nearest Tim Hortons that is still open.

- Initial state: You are not at a Tim Horton's that is open.
- Action set: The state could be modeled as a graph with intersections being the nodes. The action set would be taking some path attached to the current node to the next node.
- Transition model: The transition model for this state representation would be showing which paths are available from the next node depending on which path is taken from the current node.
- Goal test: Have we arrived at a Tim Horton's that is still open?
- Path cost: The path cost would be determined by the total distance traveled on the roads on the way to the destination.