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1. (25 points) Define in your own words:
    a. Intelligence - The ability to process information and make decisions based on the information.
    b. Artificial intelligence - Machines that simulate human intelligence. Informed conclusions are outputted based on complex algorithms.
    c. Agent - A software program that performs tasks on behalf of another user.
    d. Rationality - The design of algorithms that are efficient and effective in achieving the desired outcome.
    e. Logical reasoning - Using the principles of logic while designing algorithms so that they work as intended.
    f. Agent function - The agent function perceives how an intelligent agent would behave given the current conditions/information.
    g. Agent program - The program that executes the agent function.
    h. Autonomy - The ability of a system to operate on its own without human intervention.

2. Are reflex actions (such as flinching from a hot stove) rational? Are they intelligent?

    Reflex actions are neither rational nor intelligent. This is because they do not involve reasoning or deliberation, and are just preprogrammed with no decision-making. This makes them not rational. Reflex decisions also do not apply past knowledge, as their purpose is an immediate reaction, meaning they are not intelligent.

3. Many of the computational models of cognitive activities that have been proposed involve quite complex mathematical operations, such as convolving an image with a Gaussian or finding a minimum of the entropy function. Most humans (an certainly all animals) never learn this kind of mathematics at all, almost no one learns it before college, and almost no one can compute the convolution of a function with a Gaussian in their head. What sense does it make to say that the “vision system“ is doing this kind of mathematics whereas the actual person has no idea how to do it?

    The model aims to replicate certain functions of human cognition. While most humans are unable to use these complex mathematical operations, the model is still mimicking human ability. It understands the tasks and performs them in the same way a human would.

4. Consider the following assumption regarding the vacuum-cleaner agent we discussed in class:
    a. Prove that the simple vacuum-cleaner agent function described in class and given the assumptions above is indeed rational.

        The agent performs three functions, clean if dirty, move right if in clean cell A and move left if in clean cell B. This is rational because it ensures the goal will be completed - all squares are cleaned. This agent also maximizes performance, yet again showing it is rational.

    b. Describe a rational agent function for the case in which each movement costs one point. Does the corresponding agent program require an internal state?
        i. The agent would require an internal state. This would allow it to remember which squares are clean.
    c. Discuss possible agent designs for the cases in which clean squares can become dirty and the geography of the environment is unknown. Does it make sense for the agent to learn from its experience in these cases? If so, what should it learn? If not, why not?
        i. Learning makes sense in this scenario, as the agent needs to learn the geography of the terrain, along with how the dirt appears in order to optimally perform. Learning will help this occur without the agent having to guess the geography.

5. For each of the following activities, give a PEAS description of the task environment and characterize it in terms of the dimensions listed in class
    a. Playing Soccer

        Performance: dribbling the ball, scoring goals
        Environment: soccer field, ball, weather conditions
        Actuators: legs, feet
        Sensors: eyes, ears

        Partially Observable: sun or sweat gets in your eyes
        Stochastic: outcome is unpredictable, depends who your playing
        Sequential: actions depend on previous actions
        Dynamic: players moving around
        Continuous: occur in continuous space and time
        Multi-agent: multiple players with conflicting goals

    b. Exploring the subsurface of oceans of the planet, Titan

        Performance: Collecting data
        Envoirnemt: unknown terrain, aliens
        Actuators: rockets, sensors

Sensors: cameras, pressure and temperature sensors

Partially Observable: limited visibility, unknown environment
Stochastic: unpredictable environment
Sequential: actions depend on previous actions
Dynamic: environmental conditions change
Continuous: movement and data collection occur in continuous space
Multi-agent: lots of explorers, vehicles

c. Shopping for used AI books on the Internet

Performance: Finding cheap quality books
Envoirnemt: Online store
Actuators: keyboard input
Sensors: screen

Fully Observable: can see all items
Deterministic: search has predictable outcomes
Episodic: each book search and purchase is independent
Dynamic: prices may change
Discrete: clicking and typing are discrete
Single-agent: only one shopper

d. Playing a tennis match
Performance: scoring points, winning
Envoirnemt: Tennis court, opponent, weather conditions
Actuators: Arms, legs
Sensors: eyes, ears, body

Partially Observable: sun in the eyes
Stochastic: the outcome depends on the opponent's actions
Sequential: each shot will depend on the previous one
Dynamic: you and your opponent are always moving
Continuous: play occurs happen in a continuous state
Multi-agent: two players

e. Practicing tennis against a wall

Performance Measure: improving technique, consistency.
Environment: Wall, tennis court, tennis ball.
Actuators: Arms, legs, body
Sensors: Eyes, ears, body

Fully Observable: no opponent, wall doesn’t move

Deterministic: the ball has predictable movement patterns
Sequential: each shot depends on the previous one
Dynamic: ball movement changes
Continuous: play occurs in continuous space
Single-agent: practicing alone

f. Performing a high jump
Performance Measure: Clearing the bar
Environment: bar, landing mat
Actuators: Legs, body, arms
Sensors: Eyes, body

Fully Observable: athlete can see the bar he or she needs to clear
Deterministic: based on the athlete's jumping ability
Episodic: usually each jump is independent of the others
Static: The environment doesn't change during the jump
Continuous: movement occurs in continuous space
Single-agent: one jumper at a time

g. Knitting a sweater
Performance Measure: completing the sweater, lack of bad knots
Environment: Yarn, knitting needles
Actuators: Hands, fingers
Sensors: Eyes, fingers

Fully Observable: everything is visible for the person knitting
Deterministic: outcome is based on the action of the person knitting
Sequential: each stitch depends on the previous one
Static: yarn and needles stay the same
Discrete: completing a stitch is a discrete action
Single-agent: one knitter

h.
Performance Measure: Winning the item you want, not spending more money than you planned
Environment: Auction house, auctioneer, other bidders
Actuators: Voice
Sensors: Eyes, ears

Partially Observable: don't know anything about other bidders
Stochastic: the outcome depends on other bidders actions
Sequential: each bid depends on the previous one
Dynamic: bids and the items up for bid change
Discrete: bidding is discrete

Multi-agent: multiple bidders competing

6. Define in your own words the following terms:
    a. Reflex agent
        i. A reflex agent operates based on without considering the past or predicting the future.
    b. Model-based agent
        i. A model-based agent models it's environment, meaning it can make informed decisions based on how the world works.
    c. Goal-based agent
        i. A goal-based agent makes decisions with the idea of achieving a specific goal. When considering possible actions, it cares only about their ability to achieve the desired state.
    d. Utility-based agent
        i. A utility-based agent evaluates the potential utility or actions and chooses the one that maximizes performance.
    e. Learning agent
        i. A learning agent improves its performance over time by learning from its experiences. It adjusts based on feedback and improved over time.

7. The vacuum environment has been considered deterministic up to this point. Discuss possible agent programs for each of the following stochastic versions:
    a. Murphy's Law: Twenty-five percent of the time, the Suck action fails to clean the floor if it is dirty and deposits dirt onto the floor if the floor is clean. How is your agent program affected if the sensor gives the wrong answer 10% of the time?
        i. In this scenario, the agent needs to handle unreliable actions. An agent could suck repeatedly until the dirt is confirmed to be removed. If the sucking is repeated enough times, the sensor's errors can be overcome.
    b. Small Children: At each time step, each clean square has a 10% chance of becoming dirty. Can you come up with a rational agent design for this case?
        i. In this environment, the agent must handle the dynamic nature of dirt appearing on clean squares. One method could be that the revisits previously cleaned areas, even after they are confirmed clean, to ensure they remain clean. If possible, the agent could track where it hasn't been in the longest, as that has the highest probability of being dirty without knowing.