CS 4300 - Fall 2022 - Minh Nguyen
PEAS Assessment of Problems

I. Self-driving and parking vehicles:

1. Description:

Self-driving and parking vehicles are created to solve our modern world's driving problems. The application of AI in automated vehicles allows them to map out the surrounding area, recognize the space around the vehicle, and make decisions accordingly. The purpose of self-driving cars is, first of all, to reduce crashes and save lives. Unlike humans, computers or programs do not have attention issues while driving, and self-driving cars can avoid accidents by detecting and reacting to hazardous situations on the road ahead of time. Second, self-driving cars help decrease traffic congestion since they can be programmed to travel at constant speeds, which would avoid the slowdowns caused when one driver goes too slowly. Third, they improve safety and make transportation more accessible for people who cannot drive. Many people cannot drive for various reasons, including lack of experience, disability, or age. Automated vehicles can be a much safer mode of transportation for these people, allowing them greater independence. Additionally, a fully automated vehicle makes driving more convenient. People who cannot drive for physical or mental reasons will have more travel options with an autonomous vehicle.

2. The Percepts (Sensors):

a. Lidar (light detection and ranging). This is a float in the range [0, 3] for how close or far an object is.
b. Radar (radio detection and ranging)
    i. Object's angels - an integer in the range [0, 360]
    ii. Object's distance - a float in the range [0, 3]
    iii. Object's velocity - an integer in the range [0, 2000]
c. Sonar (sound navigation and ranging). This is a float in the range [0, 1] for how light or dense an object is.
d. Image sensor:
    i. An input image is broken down into pixels as a 3D array with a blue layer, a green layer, and a red layer.
    ii. Each pixel is an integer in the range [0, 255] from completely black to completely white.

e. The vehicle itself:
    i. Velocity - an integer in the range [0, 2000]
    ii. Gas level - a float in the range [0, 1] (from empty to full)
    iii. Current location:
        1. Longitude - an integer in the range [-180, 180]
        2. Latitude - an integer in the range [-90, 90]
    iv. Desired destination:
        1. Longitude - an integer in the range [-180, 180]
        2. Latitude - an integer in the range [-90, 90]

3. The Actions (Actuators):

a. Accelerate: increase the speed of the car
    i. The speed must be in the range [speed limit - 5, speed limit + 5]
b. Decelerate: decrease the speed of the car (eventually to a full stop)
    i. The decrease of the speed depends on how fast the car is, how far or close an object is from the car, whether the car is turning, and whether there is traffic sign/signal the car needs to follow
c. Turn left and right: change the direction of the car
d. Change modes. The car can choose to: Park, Reverse, Neutral, Drive

4. The Environment:

a. Observability:
    i. Partially observable
    ii. There's a limit to how far ahead and how wide the car can "see." But within that limit, most of the information is available.
b. Uncertainty:
    i. Stochastic.
    ii. Anything could happen at any time when the car is on the road, so it will need to constantly check the surroundings.
c. Duration:
    i. Sequential.
    ii. Since anything could happen, the agent must take new percept, make decisions accordingly, and repeat the process.
d. Stability:
    i. Driving is dynamic.
    ii. Anything from the change in location, the other vehicles velocity and position, the traffic signs, etc will change and must be taken into account.

e. Granularity:
    i. Continuous.
    ii. The car is moving continuously, and it will only stop when it reaches the destination, when it sees traffic signs/signals telling it to stop, or when it detects a close object.
f. Participants:
    i. Multi-agent.
    ii. The agent always needs to watch out for the randomness of the objects appearing and disappearing within its range of vision. For example, a few vehicles come up close to the car then pass by, a pedestrian crossing the road, etc.
g. Knowledge:
    i. Known - The laws, the road, the physics of driving a car, as well as every action's outcome are known.
    ii. Unknown - What could happen during the ride is unknown (number of vehicles, accidents, etc.).

5. The Performance Measure:

a. Reward 100 points if the car reaches the destination
b. The car's speed must be in the range [speed limit - 5, speed limit + 5]
    i. Reward: 1 point per mile
    ii. Penalty: -10 points per second
c. Traffic rules and signs:
    i. +50 points if follow (per rule/sign)
    ii. -500 points otherwise (per rule/sign)

II. Self-driving and parking vehicles:

1. Description:

Intelligent virtual assistants, such as Siri, Alexa, or Cortana, are examples of software that processes inputs from the users (voice/command) and converts them into digital data to analyze. These intelligent agents use speech recognition-algorithm to find the most likely answer and learn over time to improve the reliability and speed of responses. Mainly, intelligent virtual assistants are AI that are known for being able to provide a humanlike experience that can help users or customers quickly reach a resolution. While Siri targets personal usage, virtual assistants can also be used on a larger scale. There is a service called Emma used by the US Citizenship and Immigration Service to manage questions from citizens typed in both English and Spanish. By having this service, the customers can experience a reduction in wait times since the assistant can manage common and mundane challenges without the need for a live agent. At the same time, it does not require sleep or time off, which means that it can provide customers with service at any time of the day.

2. The Percepts (Sensors):

a. Voice/sound: A sound input (e.g.: a command or question from the user) is converted into a digital format like a string.
b. Image: An input image is broken down into pixels as a 2D array where each pixel is an integer in the range [0, 255] from completely black to completely white.

3. The Actions (Actuators):

a. Interpret the request of the user:
    i. Whether it is a question about the current time in a certain area or a more specific question that the agent needs to look up and find information, the agent should be able to differentiate between different requests in order to move on to making appropriate decisions.
    ii. It would be nice if the agent is also able to detect the user's facial expressions, hand gestures, and body language to perform the tasks accordingly.
b. Look up information:
    i. The agent has a certain amount of knowledge, but in case the user asks for something it does not know, it should be able to find/search for that information.
c. Talk to user:
    i. When the message is interpreted and an appropriate answer is created, the agent will convert the data to speech to speak to the users.

4. **The Environment:**
    a. Observability:
        i. Partially observable
        ii. Most of the required information is available but there could be some unknown factors. The agent cannot tell when and how the user would request something, but when he does, everything would be clear.
    b. Uncertainty:
        i. Stochastic
        ii. The time a user requests something, the type of the request, and the amount of requests the user sends to the agent are random.
    c. Duration:
        i. Sequential
        ii. The agent should take in the request, interpret it, find corresponding answers, give it to the user, and be ready for the next request
    d. Stability:
        i. Dynamic
        ii. As mentioned above, the time a user requests something, the type of the request, and the amount of requests the user sends to the agent change with time.
    e. Granularity:
        i. Discrete
        ii. There is a limit to the knowledge and the information the agent can look up.
    f. Participants:
        i. Single
        ii. Most of the time, typically, only a single user would interact with the agent, unless the agent is sufficient enough to handle multiple requests from different users at the same time.
    g. Knowledge:
        i. Every action's outcome is known.
        ii. The answers are unknown since they depend on the request of the user

5. **The Performance Measure:**
    a. Interpretation:
        i. Reward: + 1 points for interpreting a request from the user correctly
        ii. Penalty: -5 points otherwise
        iii. No reward/penalty if the request cannot be interpreted due to unexpected reasons such as loud background noise.

b. Look up information:
    i. Reward: +5 points for every answer the agent can create that could be used to send to the user, +2 points for the best answer among them (if any).
    ii. Penalty: - 5 points otherwise

III. Robots:

1. Description:

Nowadays, in many households, it is not difficult for one to find a Roomba vacuum, a machine that cleans the floor on its own. Many people choose to use a smart vacuum because it can do almost all the work of cleaning, giving the owners time to do other things. At the same time, it is easy and convenient to use since the users can control it through an app on their phones. The Roomba vacuum applies AI to scan a living area's size, look for objects that might be in the way, and remember the best route for cleaning, whether it is the carpet or a hardwood floor. Additionally, the vacuum bot is capable of identifying how much cleaning it needs to do based on the size of the room, repeating a cleaning cycle three times in smaller rooms or cleaning twice in a medium-sized room. As it goes around the house, it keeps collecting data to learn more about the area and become more efficient in the future runs. A Roomba vacuum is a good example of how AI can be trained and learn to perform tasks for humans.

2. The Percepts (Sensors):

a. Photocell sensor - detect nearby objects to help the vacuum slow down. This is a float in the range [0, 1] for how far or close an object is from the machine.
b. Touch sensor - triggered to stop once the vacuum bumps into an object. This is an integer in the range [0, 1], either hit an object or not, and the object must be immovable.
c. Infrared sensors - point straight to the ground from beneath the machine to prevent it from falling down stairs. This is a float in the range [-1, 1] from downward angle to straight horizontal.
d. Piezoelectric sensors - detect dirty areas. When the dirt particles hit the machine, it knows to reverse so that it can go over the area again, at a slower speed. This is a float in the range [0, 1] from clean to very dirty.
e. Sensor for charging station - can locate the charging station to return after finishing the cleaning tasks or when the battery is low.

3. The Actions (Actuators):

a. Move - the vacuum can choose to go straight, reverse, left, or right
b. Redirect after bumping into an object
c. Vacuum - clean the floor

4. The Environment:

a. Observability:

i. Partially observable
ii. There's a limit to how far ahead and how wide the vacuum can "see." But within that limit, most of the information is available.

b. Uncertainty:
   i. Stochastic
   ii. The cleanliness of a room changes with time. The amount of people in the room is random and their positions, as well as the positions of the objects in the room, are likely to change.

c. Duration:
   i. Sequential
   ii. Ideally, for an area, the vacuum should scan it, figure out how much work needs to be done, make the decision (clean or move), and repeat the process.

d. Stability:
   i. Dynamic
   ii. The cleanliness of a room changes with time. The amount of people in the room is random and their positions, as well as the positions of the objects in the room, are likely to change.

e. Granularity:
   i. Discrete
   ii. No matter how big a room or house is, there will always be a limit to which the vacuum can visit and do its job.

f. Participants:
   i. Single - the ideal case where there is only the vacuum in a room.
   ii. Multiple agents - most likely to be the case if we take into account the people in the room and how their positions or actions can affect the work of the vacuum.

g. Knowledge:
   i. Known - The room dimensions and objects in the room (eventually) and every action's outcome are known.
   ii. Unknown - What could happen when the vacuum runs is unknown (people, more/less dirt in certain areas, etc.).

5. The Performance Measure:

a. Reward:
   i. +5 points for every square foot the vacuum visited and cleaned.
   ii. +5 points if the vacuum returns to the charging station after finishing the cleaning tasks.

b. Penalty:
    i. -20 points for every square foot the vacuum visited but did not clean.
    ii. -5 points for everytime it bumps into an immovable object.
    iii. -20 points if the vacuum does not start making its way back to the charging station when the battery is low.