Introduction to Artificial Intelligence

Morgan Benavidez

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1 Homework 1

1. Please use your own words to define:

   (a) **Artificial Intelligence** - Artificial Intelligence is the attempt at mimicking human beings' ability to reason and think by capturing the processes of the brain in detailed algorithms.

   (b) **Utility Function in AI** - Gives values (weights) to the different actions an AI system can take. The Agent Function will then use the most desirable action determined by the utility function.

   (c) **Agent Function** - An Agent Function is a function that accesses and utilizes a percept sequence to map to an action.

   (d) **Percepts and Actions** - A percept is the input to an AI system. (Cameras, Lidar, Sensors, etc.) An action is what the agent does based on the percept sequence and the agent function.

   (e) **Intelligent Agent** - The agent will use all resources at its disposable (This includes: sensory information, database information, pattern recognition and any other resources it may have) to arrive at the "best" decision.

   (f) **Rational Agent** - The agent will act to try and achieve the best outcome. (Best - acts in an outcome favorable to itself, as defined in Game Theory. I suppose you could also define it as acting in the best interest of a defined whole as well, like society). 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.

   (g) **Turing Test** - The Turing Test is a test used to conclude whether intelligence exists in a machine or not. Also known as the Imitation Game, this is where an interrogator, another human being and a machine are all part of the experiment. There is no physical interaction between them and none can see the other. The goal of the interrogator is to ask questions and use the answers from the

two entities to identify which entity is the machine and which is the human. If the machine is identified as the human, it is said to have passed the Turing Test.

(h) **Strong AI vs. Weak AI** - Weak AI refers to algorithms used to complete specific tasks. This is what we come in contact with most often. (Alexa, Siri, Facebook identification algorithms, etc.) They can appear to be intelligent at times, but only in a limited field. Strong AI is a theoretical intelligence that rivals and/or exceeds that of human beings' intelligence. That is to say, they can think and arrive at decisions in any situation without the aid of a human being or interference.

2. What is PEAS task environment description for intelligent agent?

   What is rational at any given time depends on four things: PEAS. The PEAS task environment description for an intelligent agent is: Performance measure, Environment, Actuators, and Sensors.

   - **P**: The performance measure that defines the criterion of success. (A function the agent is maximizing (or minimizing)).
   - **E**: The agent's prior knowledge of the environment. (A formal representation for world states).
   - **A**: The actions that the agent can perform. (Actions that change the state according to a transition model).
   - **S**: The agent's percept sequence to date. (Observations allowing agent to infer the world state).

   For the following agents, develop a PEAS description of their task environment.

   - Automated Taxi Driver
   - Interactive English Tutor

Agent Type	***Performance Measure***	***Environment***	***Actuators***	***Sensors***
Automated Taxi Driver	Never exceeds speed limit, arrives on time, safe, maximizes profits, obeys traffic lights and other signage, comfortable for passenger	Roads, other vehicles, pedestrians, traffic lights, passengers, signs, speed limits	Accelerator, brakes, turn signals, horn, displays, radio, steering wheel, tires, dials	Cameras, lidar, speedometer, GPS, odometer, gas gauge, accelerometer, engine sensors
Interactive English Tutor	Student understands the tutor, tutor enunciates words, tutor understands questions, answers questions successfully, test scores	Student(s), background of student(s), physical room student is in, database, internet	Speakers, monitors/displays, helpful hints, suggestions, corrections	Microphone, cameras, keyboard, mouse

3. Figure 1 shows the relationship between an AI agent and its environment. Please explain the names and functionalities of the parts marked as A, B, C, and D, respectively.

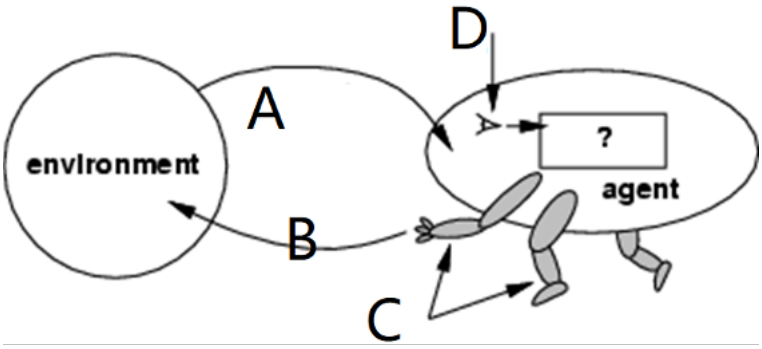
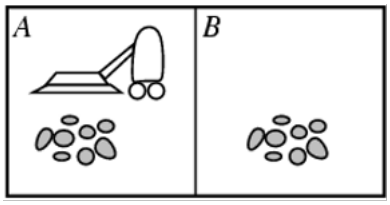


Figure 1

- **A** - Percepts. The perceptual inputs an agent receives at any given moment through sensors. Things the agent has perceived. (Sounds, proximity to objects)
- **B** - Actions. Things the agent can do to change or interact with its environment. (Move, grab, clean)
- **C** - Actuators. The objects that allow the agent to interact with its environment. (Hands, motors, wheels)
- **D** - Sensors. Sensors allow the agent to perceive its environment. (Microphones, cameras, ears)

4. When developing a vacuum-cleaner agent as shown in Figure 2, please describe the properties of the task environments, with respect to "Observable", "Agents", "Deterministic", "Episode", "Static", and "Discrete". Please explain your answers.



Percept sequence	Action
$[A, Clean]$	$Right$
$[A, Dirty]$	$Suck$
$[B, Clean]$	$Left$
$[B, Dirty]$	$Suck$
$[A, Clean]$, $[A, Clean]$	$Right$
$[A, Clean]$, $[A, Dirty]$	$Suck$
⋮	⋮

Figure 2

Property	***Vacuum-Cleaner Agent***
Fully-Observable	No
Single-Agent	Yes
Deterministic	No
Episodic	Yes
Static	Yes
Discrete	Yes

- **Fully-Observable** - The task environment is only partially observable because the agent can only sense whether an area is dirty or clean at a particular time. (When it enters the region A or B).
- **Single-Agent** - The agent in this setup is the vacuum-cleaner. It is a single agent.

- **Deterministic** - The environment is not deterministic, it is stochastic. This is because there's no way of knowing if the next state of the environment is clean or dirty until the agent gets there. This is also because the environment is only partially observable.
- **Episode** - Yes, it is episodic. In each episode for this particular agent, the agent first perceives if the floor is Clean or Dirty. It then takes a single action of either: Right, Left or Suck. In a sequential environment, an agent requires memory of past actions to determine the next best actions. (Sequential: The previous decisions can affect all future decisions.)
- **Static** - The environment is static because the environment will not change while the agent is in the process of deciding on an action. The agent is not in tune with time. In a dynamic environment, the environment can change in the middle of an agent's process of responding to a percept sequence.
- **Discrete** - Yes, the environment is discrete because the number of percepts and actions in the environment is limited and distinct. Continuous is an environment in which the actions taken cannot be numbered.

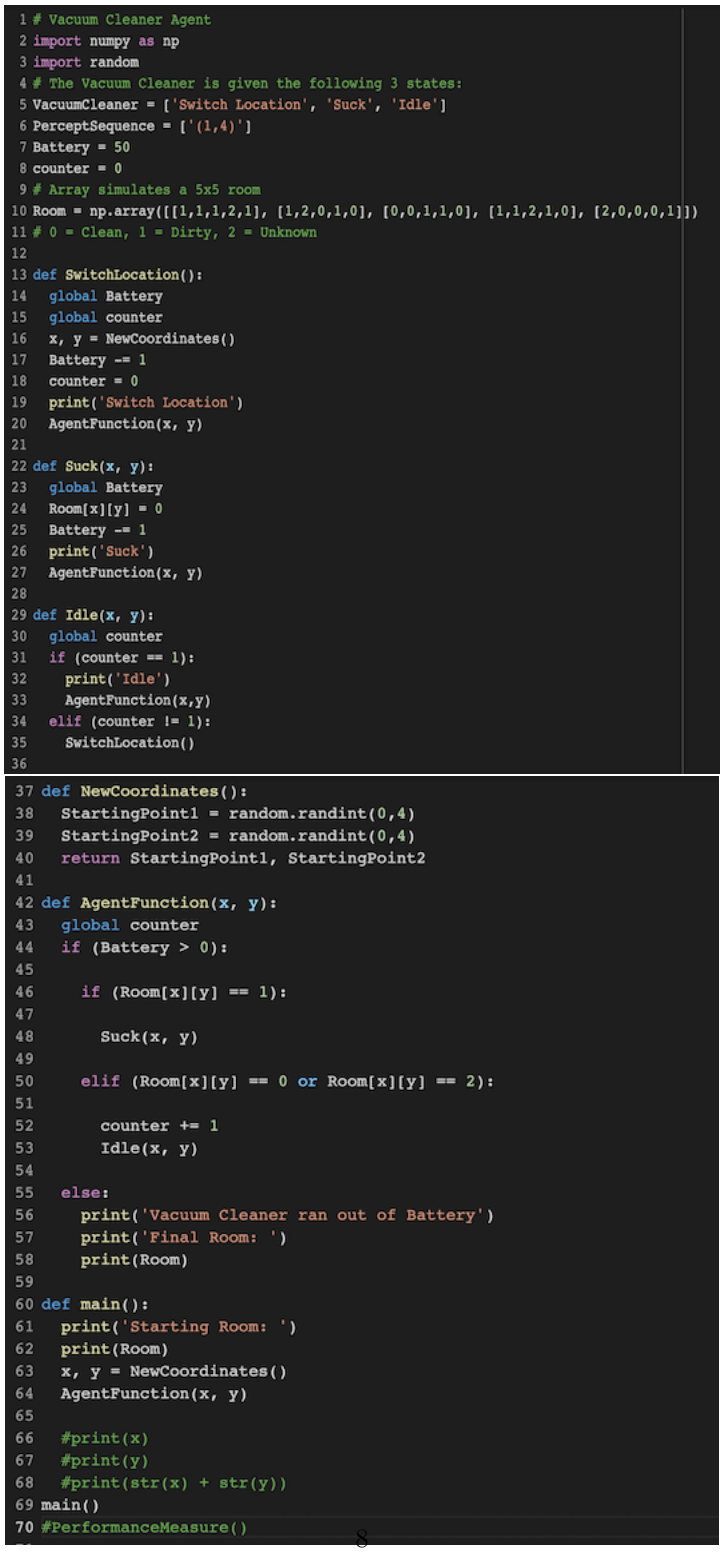
5. Please design pseudo-code of an energy efficient model-based vacuum-cleaner agent as follows:

   - The environment has two locations (A and B) and three states ("Clean", "Dirty", "Unknown").
   - The vacuum-cleaner has three actions "Switch location", "Suck", and "Idle",
   - The vacuum-cleaner will clean the dirt as soon as it senses that the current environment is Dirty,
   - If the vacuum-cleaner senses the current environment is "Clean" or "Unknown", it will remain Idle for one time point, and
   - The vacuum-cleaner will switch location if it senses the current environment is "Clean" for two consecutive time points in a row, and
   - The vacuum-cleaner will switch location if it senses the current environment is "Unknown" for two consecutive time points in a row.

   Please summarize the percept sequences and the corresponding actions as a table and write the pseudo code of the agent.

   Please see Figure 3 below for vacuum-cleaner agent code written in Python

Percept Sequence Previous	***Percept Sequence Current***	***Action***
None	[A, Dirty]	Suck
None	[B, Dirty]	Suck
[A, Clean]	[A, Clean]	Switch Location
[B, Clean]	[B, Clean]	Switch Location
[A, Dirty]	[A, Clean]	Idle
[B, Dirty]	[B, Clean]	Idle
[A, Clean]	[B, Clean]	Idle
[B, Clean]	[A, Clean]	Idle



```python
# Vacuum Cleaner Agent
import numpy as np
import random
# The Vacuum Cleaner is given the following 3 states:
VacuumCleaner = ['Switch Location', 'Suck', 'Idle']
PerceptSequence = ['(1,4)']
Battery = 50
counter = 0
# Array simulates a 5x5 room
Room = np.array([[1,1,1,2,1], [1,2,0,1,0], [0,0,1,1,0], [1,1,2,1,0], [2,0,0,0,1]])
# 0 = Clean, 1 = Dirty, 2 = Unknown

def SwitchLocation():
  global Battery
  global counter
  x, y = NewCoordinates()
  Battery -= 1
  counter = 0
  print('Switch Location')
  AgentFunction(x, y)

def Suck(x, y):
  global Battery
  Room[x][y] = 0
  Battery -= 1
  print('Suck')
  AgentFunction(x, y)

def Idle(x, y):
  global counter
  if (counter == 1):
    print('Idle')
    AgentFunction(x,y)
  elif (counter != 1):
    SwitchLocation()

def NewCoordinates():
  StartingPoint1 = random.randint(0,4)
  StartingPoint2 = random.randint(0,4)
  return StartingPoint1, StartingPoint2

def AgentFunction(x, y):
  global counter
  if (Battery > 0):

    if (Room[x][y] == 1):

      Suck(x, y)

    elif (Room[x][y] == 0 or Room[x][y] == 2):

      counter += 1
      Idle(x, y)

  else:
    print('Vacuum Cleaner ran out of Battery')
    print('Final Room: ')
    print(Room)

def main():
  print('Starting Room: ')
  print(Room)
  x, y = NewCoordinates()
  AgentFunction(x, y)

  #print(x)
  #print(y)
  #print(str(x) + str(y))
main()
#PerformanceMeasure()
```


Figure 3

6. Please summarize task environment types for the following three agents, in terms of “observable”, “deterministic”, “episodic”, “static”, “discrete”, “number of agents”.

Agent	***observable***	***deterministic***	***episodic***	***static***	***discrete***	***num of agents***
Tic-tac-toe	fully	strategic	sequential	static	discrete	multi
Tetris	fully	strategic	sequential	dynamic	discrete	single
Texas hold’em	partial	stochastic	sequential	static	discrete	multi
Robot Soccer	fully	strategic	sequential	dynamic	continuous	multi
Space X Drone	fully	deterministic	sequential	dynamic	continuous	single

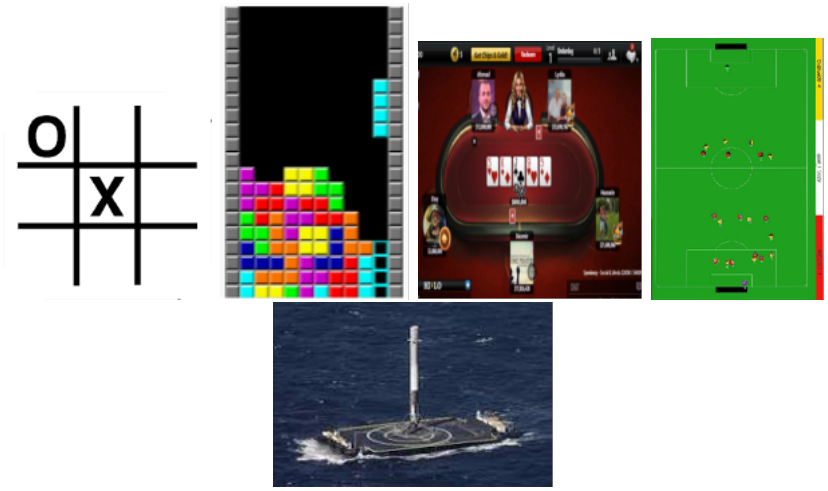


Figure 4

7. Summarize similarities and differences between simple reflex agent and model-based reflex agent. Show one example of "model" in the model-based vacuum cleaner robot agent.

   A simple reflex agent doesn't compute any problems or display any type of intelligence. It just receives a percept and takes an action. A model-based reflex agent uses historical data and makes a computation to arrive at a decision for an action. i.e. In the code I wrote for the vacuum cleaner agent, the vacuum cleaner keeps track of the number of consecutive times it stays in either a clean or unknown state before moving.

8. Summarize main differences between reflex agent (including simple reflex agent and model-based reflex agent) and goal-based agent. Use vacuum cleaner robot as an example, explain how reflex agent vs. goal-based agent may differ in their behaviors.

   The main difference between reflex agents and goal-based agents is that goal-based agents build on reflex agents by adding a goal for the agent to obtain. The actions they choose have the intention to achieve a goal behind them. They may have to consider a lot of different actions or possibilities before arriving at a decision. These considerations are called searching and planning.