Introduction to AI, Assignment 1 - Stian Fjæran Mogen

1. What is Artificial Intelligence (AI)? Include at least 3 definitions of AI that are not covered in the lecture.

- Oxford Dictionary: *The study and development of computer systems that can copy intelligent human behavior* [1]
- Merriam Webster: *A branch of computer science dealing with the simulation of intelligent behavior in computers* [2]
- Cambridge Dictionary: *The study of how to produce machines that have some of the qualities that the human mind has, such as the ability to understand language, recognize pictures, solve problems, and learn.* [3]

2. What is the Turing test? What is its purpose and how is it conducted?

Named after Alfred Turing, the Turing test was a developed to determine whether or not a machine had reached a state of artificial intelligence. In this context defined as the capability of thinking like a human being. The test is conducting using a human interrogator, and a human and machine. The target of the test is for the interrogator to determine whether they are talking to the machine or the human. If the interrogator is unable to distinguish machine from human, the machine is said to have achieved artificial intelligence. With the improvements in Natural Language Processing field, this form of testing is obsolete for determining if a machine can "think" like a human.

3. What is rationality

Rationality is thinking or acting in accordance with reason. In terms of rational agents, we can narrow rationality down to four concepts:

- Performance measure
- An agent's knowledge of its environment
- Actions an agent can do with actuators
- An agents perception sequence with sensors

4. What is the relationship between thinking rationally and acting rationally? Is rational thinking an absolute condition for acting rationally?

Thinking rationally is deducting the appropriate conclusion based on a logic. Acting rationally is acting in accordance with the action that provides the maximum chance for a desired outcome. These two are

not absolutely linked, as there are rational actions that involves no rational thinking, such as involuntary reflexes.

5. What is the connection between knowledge and action according to Aristotle? How can his argument be used to implement his idea in AI?

By using a mathematical model syllogism, Aristotle formalized how to use deductive reasoning and logical argument structure to reach a correct conclusion. If applied correctly, it can be used to determine the most rational action based on logical reasoning. Laws of Thought can be used in artificial intelligence, giving the agent the opportunity for rational actions based on the conditions we define. Leading in the agent to perform actions that will ultimately lead to it reaching its end goal.

   a. Who was (or were) the first AI researcher(s) to implement these ideas?

The book describes Newell and Simon implementing Aristotles algorithm, creating several reasoning program using these ideas.

   b. What is the name of the program or system they developed? Write a short description about it.

Newell and Simon implemented several important programs in the early stages of artificial intelligence. Logical Theorist was written in 1956 and was the first program to use automated reasoning. Some years later in 1961 they made General Problem Solver, which was a computer program that was properly based on the theory of human thought processes and made decisions corresponding to human behavior. This is based on the principles laid out by Aristotle.

6. Consider a robot with the task of crossing the road, and an action portfolio A: A = {lookBack, lookF orward, lookLef t, lookRight, goF orward, goBack, goLef t, goRight}
   a. While crossing the road, an elk crashes on the robot and smashes it. Is the robot rational?

Yes. An elk crashing it is not a scenario one would consider crossing the street given this specific action portfolio. Considering every scenario however unlikely is not reasonable when acting rationally. A rational perception sequence would not include a crashing elk for crossing the road.

   b. While crossing the road on a green light, a passing car drives into the robot and crashes, preventing the robot from crossing to the other side. Is the robot rational?

No. While the green light is an indication that one may cross the road, acting rational would be waiting until the car had passed until proceeding. For such a robot a passing car would be part of its perception sequence. Looking right and left is also part of the robots action portfolio.

7. Consider the vacuum cleaner world described in Figure 2.2 (Chapter 2.1 of AIMA 4th Ed.). Let us modify this vacuum environment such that the agent is penalized 1 point for each movement:
    a. Could a simple reflex agent be rational for this environment? Why?

No. Without an internal state, the robot will not consider whether a square is already clean or not leading it to move back and forth and getting unnecessary penalty points.

    b. Could a reflex agent with state be rational in this environment? Why?

Possibly. It depends on if a square can get dirty again after being cleaned. With a state the robot can track what has already been cleaned, it would most likely stay stationary to avoid penalties, not cleaning potentially dirty squares.

    c. Assume now that the simple reflex agent (i.e., no internal state) can perceive the clean status of both locations at the same time. Why? In case it could be rational, write the agent function using mathematical notation.

Yes. In this example all aforementioned conditions are considered. It knows if the current location is dirty, it knows if the neighboring square is dirty, and it considers squares becoming dirty again.

We have certain conditions, that will lead to actions by the agent. If the current square is dirty, we clean. If the right or left is dirty, we move in the given direction. If the current clean, and we consider the state, we may look until the state changes in any given square. Mathematically we write:

P = {currentDirty, rightDirty, leftDirty}
A = {clean, moveRight, moveLeft}
From this we can define the function: $f : P^* -> A$

8. Consider the original vacuum cleaner environment shown in Figure 2.2. Describe the environment using the properties from Chapter 2.3.2 (e.g. episodic/sequential, deterministic/stochastic, etc.) Explain why you chose such values and properties.

- Partially observable: the agent does only have access to a limited part of the environment.
- Single agent: There is only one agent to consider.

- Deterministic: The state is fully dependent on the actions performed, without uncertainty.
- Episodic: The agent performs actions episodically, then moves on to the next condition.
- Dynamic: The environment changes based on the actions of the agent.
- Discrete: There is a set number of possible distinct states.
- Known: The actions and its outcomes are known to the agent.

9. Write both advantages and limitations of the following types of agents:
    a. Simple reflex agents

A simple reflex agent is simple and may have a small and concise program. It has a limited number of potential actions. While it is too simple for more complex issues, the condition-action rule is widely used as parts of larger environments.

It interprets the environment and creates rule for a given environment leading to actions. Its limited intelligence makes it dependent on a fully observable environment. Deviations from this may often lead to infinite loops, due to it not being able to adapt to new conditions. Randomized actions may prevent this, however this is not a rational solution.

    b. Model-based reflex agents

Mode-based reflex agents aims to handle partially observable environments, with an internal state considering the following: The environment influences the agent, and the agent influences the environment. It is however a difficult task to track this accurately, leading to high levels of uncertainty.

    c. Goal-based agents

A goal-based agent considers the target as well as the state of the environment. This means that the agent will know what a desirable state for its given goal is, and therefore considers the future. They are more complex and less effective, but more flexible when adapting to new information.

    d. Utility-based agents

For most environments a goal is not sufficient for reaching optimal quality of decision making. When a goal can be reached in several ways, utility values can be used to determine the best option. It scores option based on utility, and rational agents chooses based on the option given the optimal predicted utility from the given score. This is a more flexible option than a goal-based agent, but then again more complex and difficulty to create.

Sources:

1. “artificial intelligence.” *Oxford Learners Dictionaries* retrieved 8.25.2022 from https://www.oxfordlearnersdictionaries.com/definition/english/artificial-intelligence
2. “artificial intelligence.” *Merriam-Webster* retrieved 8.25.2022 from https://www.merriam-webster.com/dictionary/artificial%20intelligence
3. “artificial intelligence.” *Cambridge Dictionary* retrieved 8.25.2022 from https://dictionary.cambridge.org/us/dictionary/english/artificial-intelligence