TD4136 - Introduction to Artificial Intelligence

Assignment 1: Artificial Intelligence Fundamentals and Intelligent Agents

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1. Define artificial intelligence (AI). Find at least 3 definitions of AI that are not covered in the lecture

Definition by Oracle (https://www.oracle.com/artificial-intelligence/what-is-ai/)

“In the simplest terms, AI which stands for artificial intelligence refers to systems or machines that mimic human intelligence to perform tasks and can iteratively improve themselves based on the information they collect. AI manifests in a number of forms. AI is much more about the process and the capability for superpowered thinking and data analysis than it is about any particular format or function. Although AI brings up images of high-functioning, human-like robots taking over the world, AI isn’t intended to replace humans. It’s intended to significantly enhance human capabilities and contributions. That makes it a very valuable business asset.”

Definition by Qualcomm
(https://www.qualcomm.com/products/artificial-intelligence/what-is-ai-faq)

“Artificial intelligence, or AI, is an umbrella term representing a range of techniques that allow machines to mimic or exceed human intelligence.

When humans think, they sense what’s happening in their environment, realize what those inputs mean, make a decision based on them, and then act. Artificially intelligent devices are in the early stages of beginning to replicate these same behaviors.”

Definition by Amazon (https://aws.amazon.com/machine-learning/what-is-ai/?nc1=h_ls)

“Artificial Intelligence (AI) is the field of computer science dedicated to solving cognitive problems commonly associated with human intelligence, such as learning, problem solving, and pattern recognition. Artificial Intelligence, often abbreviated as "AI", may connote robotics or futuristic scenes, AI goes well beyond the automatons of science fiction, into the non-fiction of modern day advanced computer science. Professor Pedro Domingos, a prominent researcher in this field, describes “five tribes” of machine learning, comprised of symbolists, with origins in logic and philosophy; connectionists, stemming from neuroscience; evolutionaries, relating to evolutionary biology; Bayesians, engaged with statistics and probability; and analogizers with origins in psychology. Recently, advances in the efficiency of statistical computation have led to Bayesians being successful at furthering the field in a number of areas, under the name “machine learning”. Similarly, advances in network computation have led to connectionists furthering a subfield under the name “deep learning”. Machine learning (ML) and deep learning (DL) are both computer science fields derived from the discipline of Artificial Intelligence.

Broadly, these techniques are separated into “supervised” and “unsupervised” learning techniques, where “supervised” uses training data that includes the desired output, and “unsupervised” uses training data without the desired output.

AI becomes “smarter” and learns faster with more data, and every day, businesses are generating this fuel for running machine learning and deep learning solutions, whether collected and extracted from a data warehouse like Amazon Redshift, ground-truthed through the power of "the crowd" with Mechanical Turk, or dynamically mined through Kinesis Streams. Further, with the advent of IoT, sensor technology exponentially adds to the amount of data to be analyzed -- data from sources and places and objects and events that have previously been nearly untouched."

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

The Turing Test is a method to determine if a computer can think as a human being or not.

The test consists of a human asking a specific question to two unknown individuals. One of them is a computer and the other one is another human. Both of these respond and the person who asked has to guess which response was from the computer and which one was from the other human. If the person cannot distinguish the answers more than half of the time, the computer passes the test and it is considered to have Artificial Intelligence since it is considered to respond as a human.

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

It is the ability to make the right decision most of the time. If you think rationally, you will make a rational decision almost always. We are humans and sometimes we do not act rationally, but we usually do and we make rational decisions.

It is not, at least for individual decisions. You can think in a non-rational way but take a rational individual decision. But if we talk about collective decisions, I think that it is harder to make rational decisions if you do not think rationally. When the complexity and the number of decisions increases, the chance of making rational decisions without rational thinking about it becomes much harder.

4. Describe rationality. How is it defined?

Cambridge definition: "the quality of being based on clear thought and reason, or of making decisions based on clear thought and reason"

I would say that rationality is when you are able to think about everything that evolves a decision and you make it having in mind that thought.

5. What is Aristotle's argument about the connection between knowledge and action? Does he make any further suggestion that could be used to implement his idea in AI? Who was/were the first AI researcher(s) to implement these ideas? What is the name of the program/system they developed? Google about this system and write a short description about it.

In the book "Nicomachean Ethics" Aristotle wrote "for the things we have to learn before we can do them, we learn by doing them".

It clearly makes a suggestion about how AI works, where machines are constantly learning from the inputs they receive so that they can make the best decision based on what they have learnt.

The first researchers to develop a programming language oriented to problem solving were Herbert Simon, Allen Newell and J. C. Shaw. They developed "Information Processing Language (IPL)". IPL was used to implement some artificial problems, some of them are:

- The Logic Theorist (1956) that could prove theorems in symbolic logic.
- The General Problem Solver (1957) which, as the name says, could solve general problems in several disciplines.
- The Computer Chess Program, NSS (1958) that was able to beat a human playing chess.

6. Consider a robot whose task it is to cross the road. Its action portfolio looks like this: look-back, lookforward, look-left-look-right, go-forward, go-back, go-left and go-right.

(a) While crossing the road, a helicopter falls down on the robot and smashes it. Is the robot rational?

Yes. There's no way that anybody can predict a helicopter falling down in this situation and the robot doesn't have any action to avoid the crash, so if the robot was crossing the road on a green light, it was rational.

(b) While crossing the road on a green light, a passing car crashes into the robot, preventing it from crossing. Is the robot rational?

It depends. It would be rational in a situation where the robot could do nothing to dodge the car and has taken all the possible actions to prevent any accident, but if even there's a green light, the robot didn't look both sides while crossing to assure that it's safe to pass or didn't try to prevent the crash going back after spotting the car, it wouldn't be rational.

7. Consider the vacuum cleaner world described in Chapter 2.1 of the textbook. Let us modify this vacuum environment so that the agent is penalized 1 point for each movement.

(a) Can a simple reflex agent be rational for this environment? Explain your answer

No. If the agent is penalized 1 point for each movement, it should do nothing when both squares are clean, but the robot doesn't have any sensor or mechanism to know when both locations are clean, only moving toward the particular square that he wants to check.

(b) Can a reflex agent with state be rational in this environment? Explain your answer.

No. The agent has to move to know the state of the environment, if it is penalized 1 point for each movement, it can happen that the agent moves but the environment is clean and that is not rational.

(c) Assume now that the simple reflex agent (i.e., no internal state) can perceive the clean/dirty status of both locations at the same time. Can this agent be rational? Explain your answer. In case it can be rational, design the agent function.

Yes, the robot should do nothing and stay restful while both locations are clean. Now that the vacuum cleaner can perceive the status of both locations, it will only move if one of the areas are dirty, resulting in a rational agent.

```
def reflex_vacuum_agent_rational(location, A_status, B_status):
    if A_status == dirty:
        if location != A:
            move(right)
        suck()
    elif B_status == dirty:
        if location != B:
            move(left)
        suck()
    else:
        do_nothing()
```

8. Consider the vacuum cleaner environment shown in Figure 2.2 in the textbook. Describe the environment using properties from Chapter 2.3.2, e.g. episodic/sequential, deterministic/stochastic etc. Explain selected values for properties in regards to the vacuum cleaner environment.

Environment	Observable	Agents	Deterministic	Episodic	Static	Discrete
Vacuum-cleaner robot	Partially	Single	Nondeterministic	Episodic	Dynamic	Discrete

Partially Observable:
Our vacuum-cleaner robot doesn't have access to the complete state of the environment at each point in time. It has only access to the square where it's at the moment.

Single Agent:
The robot is doing its job by itself, and it's not competing or cooperating with any other agents.

Nondeterministic:
At any moment, a square previously cleaned by the robot can become dirty, and the vacuum-clear won't know until it's placed in this particular square again. So, the next state is not determined by the current state and the action executed by the agent. It's not stochastic because we can't assign probabilities in this environment.

Episodic:
It's an episodic environment because the robot performs a single action depending on the input that it's receiving at that moment, and the current action won't affect the future ones.

Dynamic:
As we said earlier, at any moment dirt can appear in every square while the robot is sucking dirt in another location, or while it's moving. So the environment will constantly ask the agent what it wants to do.

Discrete:
In our particular case, the robot has a discrete set of percepts and actions, and also the state of the environment has a finite number of distinct states, 4 to be exact.

9. Discuss the advantages and limitations of these four basic kinds of agents:

	Advantages	**Limitations**
Simple reflex agents	Simple reflex agents have the admirable property of being simple, selecting actions on the basis of the current percept, ignoring the rest of the percept history.	Limited intelligence, even a little bit of unobservability can cause serious trouble. Infinite loops are often unavoidable for simple reflex agents operating in partially observable environments.
Model-based reflex agents	Unlike simple reflex agents, model-based have the ability to keep track of the part of the world it can't see now. To achieve this objective, they maintain some sort of internal state that depends on the percept history and thereby reflects at least some of the unobserved Internal state aspects of the current state, allowing them to handle partial observability in an efficient way.	Regardless of the kind of representation used, it is difficult for the agent to determine the current state of a partially observable environment exactly. This results in the agent making decisions in an uncertain current state.
Goal-based agents	Goal-based agents have many advantages in terms of flexibility and learning because the knowledge that supports their decisions is represented explicitly and can be modified.	Many action sequences will achieve the goal, but some are quicker, safer, more reliable, or cheaper than others. So, generally they are less efficient.
Utility-based agent	Utility-based agents have the same advantages as goal-based agents but a utility-based agent can still make rational decisions, allowing him to resolve conflicts between goals or prioritizing some goals over others, depending on their importance or chance of success.	Requires ingenious algorithms to model and keep track of its environment, and choosing the utility-maximizing course of action. Even with these algorithms, perfect rationality is usually unachievable in practice because of computational complexity.