COS30019 - Introduction to Artificial Intelligence
Tutorial Problems Week 1

**Task 1:**

**Explain the relations between different approaches to AI. Would the solutions in one approach be applicable to solve problems in another?**

What are the approaches to defining AI systems? Two dimensions:

- **Thinking vs. Acting** (Thought process/reasoning vs. behavior/action)
- **Human vs. Ideal** (Success according to human standards vs. success according to an ideal concept of intelligence: rationality)

| **Think** like **humans** | **Think rationally** |
|---|---|
| How our brain works?<br>- Does not aim to solve the problem correctly<br>- Does not tell us how the machine should work | Ideal thinking – logic<br>Irrefutable reasoning<br>- Does not account for uncertainty or probability<br>- We think in order to act after |
| **Act** like **humans** | **Act rationally** |
| Perform intelligent human functions<br>Turing Test: human or machine?<br>- Does not make us more productive | Doing the right thing<br>Achieve the best outcome, given the info.<br>+ Involves rational thinking and reflexes |

## Act like humans

It aims to create the machines that perform functions that require intelligence. These are not mechanical functions, but something enough sophisticated to act like humans. The applied methodology is to take an intellectual human task and make a computer do it.

**Examples of tasks:** process the language, recognize faces, play chess, navigate in a building, etc.

**Measure:** How do we know that the system is enough intelligent? Alan Turing test poses a question: Is it a human or machine? If we are unable to distinguish between the two, the AI system is as intelligent as a human.

**Drawback:** It does not make us more productive, but rather tries to beat the test. For instance, if we give a complex mathematical task, the machine can solve it in a few milliseconds, but human may take a couple of minutes. If the machine wants to pass this test, it will have to create a delay to imitate human thinking process.

## Think like humans

Studies how human nervous system (brain in particular) works. It is linked with neuropsychology and neuroscience.

**Drawback:** It aims to reproduce human's reasoning steps, rather than solve the problem correctly. It does not really tell us how the machine has to work, but just studies how the brain works.

## Think Rationally

Ideal "right" thinking – irrefutable reasoning process. The Greek philosopher Aristotle attempted to codify "right thinking". Example Socrates is a man; all men are mortal; therefore, Socrates is mortal. This study initiated the field logic.

**Drawback:** Logic behavior is a part of intelligence, but we may need to deal with uncertainty, probability, etc. Moreover, we usually think and reason in order to act after.

## Act Rationally

Rational behavior: "doing the right thing" – act ideally. It is us who define what is the right thing? which is the course of action that is expected to maximize goal achievement given the available information. If I don't maximize the goal achievement, I don't do the right thing. Acting rationally includes thinking, but in service of rational action. Sometimes acting without thinking (i.e. reflexes) is more rational. For example, if I touch a hot surface a good (i.e. rational) reflex would be to pull my hand out straightaway without spending time deliberating the consequences of leaving my hand there.
It is closest to solving problems (practical for careers).

---

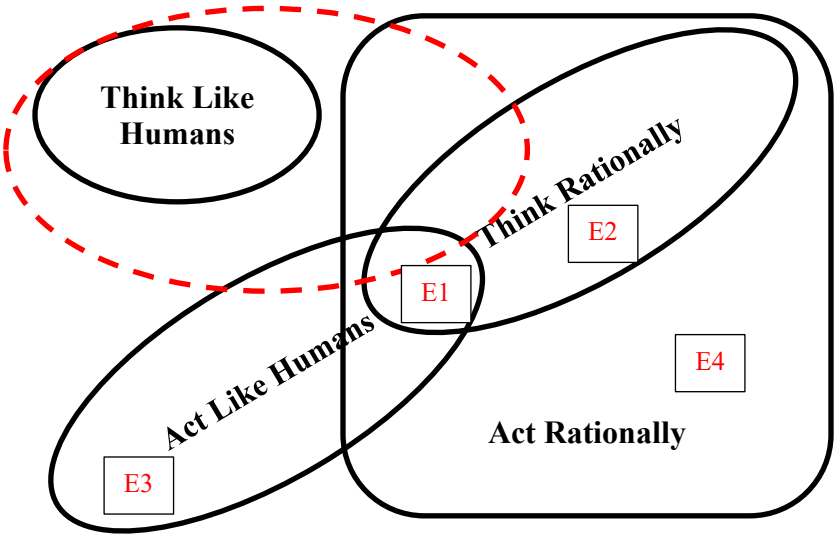


**Figure 1 - Relations between different approaches to AI**

E1: Knowledge can be captured as logical statements and decisions are made by drawing logical conclusions about the state of the world and the actions that take the agent to the desired world state. Humans are capable of logical reasoning too.
E2: Logical reasoning over a VERY large logical knowledge base (exceeding the human ability to store and process) such as billions of facts/statements.
E3 and E4 both require the ability to make decision to do something to change the state of the world and the available data/information is typically complex (e.g. involve uncertainty, complex models of the dynamics of the world, noise, etc.)
E4: When the task fits well to the computer's capability (e.g. process large amount of information from multiple sensors within a very short amount of time), why should the machine mimic the human's computational limitations and perform sub-optimally? Example: For an autonomous car, under a very tight condition,

*The current state of thinking like a human is the black oval (as it hasn't contributed much to the development of the other 3 paradigms due to our limited understanding of how human minds work). Ideally, it will be the dashed red oval and allow us to transfer our*

*understanding/knowledge of how human minds work toward the development of similar/inspired technologies applicable in an AI system.*

**Task 2:**

driverless car, SIRI, expert systems, web search engine, decision support systems:
driverless car: requires the capability of acting
SIRI, expert systems, web search engine, decision support systems: Information processing & thus, thinking would suffice (but does not exclude acting-based paradigms)
For all of these, *thinking like human* is unlikely helpful – e.g. for driverless car – human reaction is known to be much slower than a machine which is the reason for current safety technologies on motor vehicles (e.g., autonomous emergency brake - AEB, Electronic stability control – ESC, even anti-lock braking systems – ABS; i.e. computer taking over human decision-making in critical situations!)
*Thinking rationally* is not suitable for driverless car (stochastic, dynamic and multiagent environment). It is also too limited for SIRI, web search engine and decision support systems. Some expert systems have been implemented using logical rules (thinking rationally) but in general, they require more complex problem solving mechanisms (e.g. to deal with uncertainty and also fuzzy concepts)
That leaves us with *acting* (rationally or like a human). There is no clear advantage acting like a human gives to these tasks except from the current technologies may not be as good as humans (sometimes) e.g. driverless cars in some real-world conditions or SIRI. Thus, human intelligence can still be used as a benchmark for some of these tasks. However, as computing systems evolve (think quantum computing), it is possible that computers will exceed humans in many of these tasks (e.g., drive more safely than all existing human-beings) then acting rationally will be the way to go! In other tasks, the computational power of the machine has shown a clear advantage in fast computation and large memory that can store large amount of data (making them much more suitable for web search engines and expert systems). DSS is still an area where a human decision with the support of a machine is preferred.

Describe your own ideas on how the problem can/should be solved. What knowledge/skills do you lack if you are required to build such applications?
Generally requires: NLP, learning and adaptation, optimization, computer vision, knowledge, reasoning, sensing, making sense of data, etc.

**Task 3:**

Achieve AI: Depends on the definition of AI – if we try to build human-level intelligence, many of these tasks are for human level intelligence such as driving a car, playing soccer. If the solution to the problem can be generalised to other domains, it is a good investment. But if the technique is too specific to a particular challenge, it could hamper the progress of AI as a whole.
This task is mainly for the student to learn about different challenges/competitions within the field and give them some ideas on a problem/project to work on if they want to become more deeply involved in developing AI.