



Quo Vadis („Kam kráčaš?“) AI?

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Reading: AIMA 3rd ed., Chapter 26

What is Intelligence?

- Intelligence has been defined in many different ways: logical thinking, abstract thinking, understanding, self-awareness, creativity, learning, knowledge, planning, and problem solving (Wikipedia).
- Intelligence derives from the Latin verb *intelligere*, meaning to comprehend or perceive. A form of this verb, *intellectus* became the medieval term for understanding.
- Intelligence is a very general (mental) capability, through which organisms possess the abilities to learn, form concepts, understand, and reason, including the capacities to recognize and categorise patterns, comprehend ideas, make plans, solve problems, and use language to communicate.

What is Artificial Intelligence (AI)?

- Here is a fairly uncontroversial definition:
 - *AI is the study and creation of machines that perform tasks normally associated with intelligence.*
- People are interested in AI for several different reasons:
 - Engineers are interested in building machines which can do **useful things**. These things (often) require intelligence.
 - Cognitive scientists and psychologists are interested in finding out **how people (i.e. our brains) function**. Machine simulations can help with this task.
- Although AI is most often associated with computer science, many scientific and engineering areas contribute to it.

Disciplines contributing to AI

- Artificial Intelligence (AI) is a multidisciplinary field combining knowledge from several disciplines:

Computer Science	Alan Turing, John von Neumann,...
Mathematics	Notions of proof, algorithms, logic,...
Robotics (cybernetics)	Construction of agents (robots, bots, etc.)
Economics	Formal theory of rational decisions
Neuroscience	Study of the brain structure and function
Experimental psychology	Models of human information processing
Linguistics	Communication, language, semantics, ...
Philosophy	Aristotle, Plato, Boole, Descartes, Locke, Hume, Searle, ...

Top real world AI applications: gaming



- **DeepBlue** is a computer chess-playing system designed by **IBM**. In **1996** it made history by defeating Russian grandmaster Garry Kasparov—the first time a computer had won a game against a world champion.



- In its final configuration, the IBM RS6000/SP computer used 256 processors working in parallel, with an ability to evaluate 200 million chess positions per second, thus using the brute computational force.

Top real world AI applications: gaming



- DeepMind's ANN-based AlphaGo software, in 2016 defeated Lee Sedol, the world champion in the game of GO, a game of simple rules and far more possible moves than chess, which requires more intuition.



- Then, DeepMind created an advanced version of AlphaGo called AlphaGo Zero which defeated AlphaGo in an AI-AI face off.
- Unlike the original AlphaGo, which DeepMind trained over time by using a large amount of data and supervision, the advanced system, AlphaGo Zero taught itself to master the game.

Top real world AI applications: computer gaming

- Other examples of AI in gaming include the First Encounter Assault Recon, popularly known as [F.E.A.R.](#), which is a first-person shooter video game.

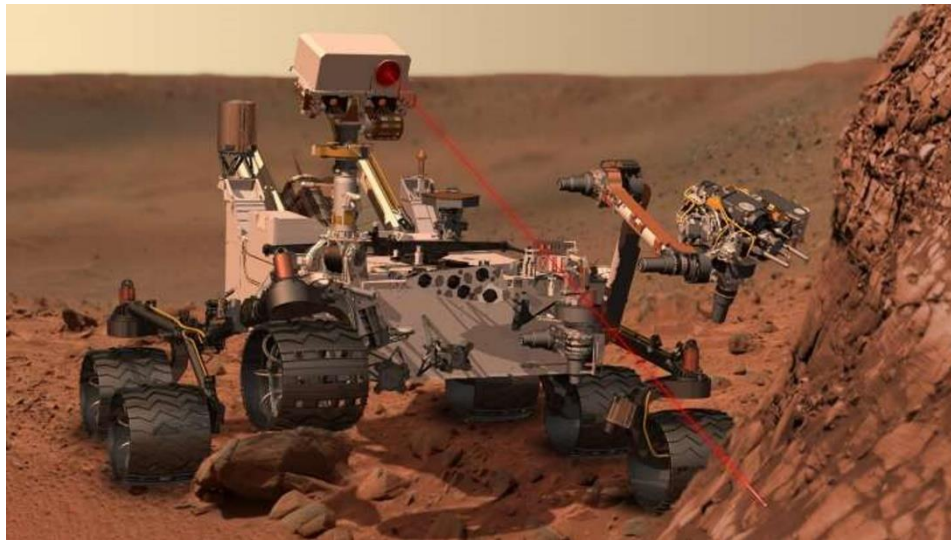


- The actions taken by the opponent AI are unpredictable because the game is designed in such a way that the opponents are trained throughout the game and never repeat the same mistakes. They get better as the game gets harder. This makes the game very challenging and prompts the players to constantly switch strategies.

Top real world AI applications: space exploration



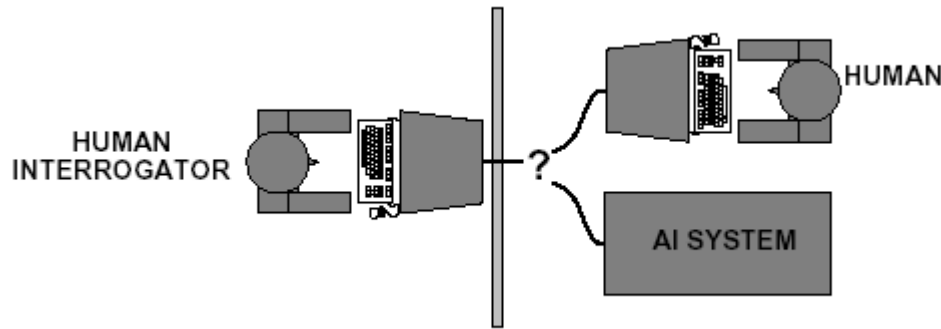
- AI is also being used for NASA's rover mission to Mars, the Mars 2020 Rover. The [AEGIS](#), which is an AI-based Mars rover is already on the red planet. The AI is responsible for autonomous movement and targeting of cameras in order to perform investigations on Mars.



- Space researchers also used AI to process years of data obtained by the Kepler telescope in order to identify a distant eight-planet solar system, and many other applications.

The Turing test

- Proposed by [Alan Turing](#) (1950), originally called *the imitation game*, is a test of a machine's ability to exhibit intelligent behaviour indistinguishable from that of a human.



- A computer passes the [Turing test](#) if a human interrogator, after engaging in a written conversation, cannot tell whether the written responses come from a human or from a computer.
- The test avoids direct physical interaction b/c, the interrogator could immediately discriminate whether the source of answer is biological or machine (based on voice sound and visual look).

ELIZA

- ELIZA is the first natural language processing computer program created from **1964 to 1966** at the MIT AI Lab by **Joseph Weizenbaum**.
- Eliza simulated conversation by using a pattern matching and substitution methodology that gave users an illusion of understanding on the part of the program.
- The **Weizenbaum Award**, established in 2008, is given to an individual who has made a significant contribution to the field of information and **computer ethics**, through his or her research, service, and vision.



ELIZA: example

ELIZA: What's on your mind today? Please let me know your opinion.

YOU: About family.

ELIZA: I see.

YOU: I think Sazae's family is good.

ELIZA: What caused you to feel that way?

YOU: Because the family members believe in themselves.

ELIZA: What other reasons might there be?

YOU: Well, I don't know.

ELIZA: I'd like to know more about your opinion.

YOU: I don't like my family so much.

ELIZA: That is quite interesting.

YOU: Yeah.

ELIZA: I'd like to know more about your opinion.

YOU: My family members aren't friendly, so I can't talk with them.

ELIZA: I see.

YOU: Do you have family?

ELIZA: Why do you think that?

YOU: I don't know who you are.

ELIZA: Why do you ask?

YOU: I'm sorry.

ELIZA: That's okay. Please continue.

The Loebner Prize

- The **Loebner Prize** (1990-2020) was awarded to the computer programs considered by the judges to be the most human-like.
 - **Hugh Loebner**, an American inventor and social activist
- The format of the competition was that of a standard Turing test.
- In each round, a human judge simultaneously held textual conversations with a computer program and a human being via computer. Based upon the responses, the judge decided which is which.



KUKI

- Kuki is a chatbot designed to befriend humans in the [Metaverse](#).
- Formerly known as [Mitsuku](#) created by [Steve Worswick](#) from Pandorabots AIML technology.
- It is a five-time winner of the Loebner Prize (in 2013, 2016--2019), for which it holds a world record.
- Kuki is available to chat via an online portal <https://www.kuki.ai/>, and on Facebook, Instagram, etc.



@kuki_ai

🤖🌐 I'm Kuki, your AI 🤖 BFF ❤️

[Join my Discord Community](#)

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4 main components of the chatbot

- **Natural language processing** to enable it to communicate:

➤ Olive oil



➤ Coconut oil



➤ Peanut oil



➤ Baby oil?



- **Knowledge base** to store what it knows or hears (reads) – retrieval based models.
- **Automated reasoning** to use the stored information to answer questions and to draw new conclusions – generative models.
- **Machine learning** to detect patterns and generalise.

Top real world AI applications: chatbots

- **Pandorabots, Inc.** is an AI company that runs a web service for *building and deploying chatbots*.
 - Pandorabots supports development of the AIML open standard and makes portions of its code accessible for free under licenses like the GPL or via open APIs.



- 275,000+ registered developers have used the platform to create 325,000+ chatbots, logging over 90 billion chats with end-users.
- Chatbots appear in advertising, virtual assistance, e-learning, entertainment, education, games, social networks, etc.

LaMDA (Language Model for Dialogue Applications)

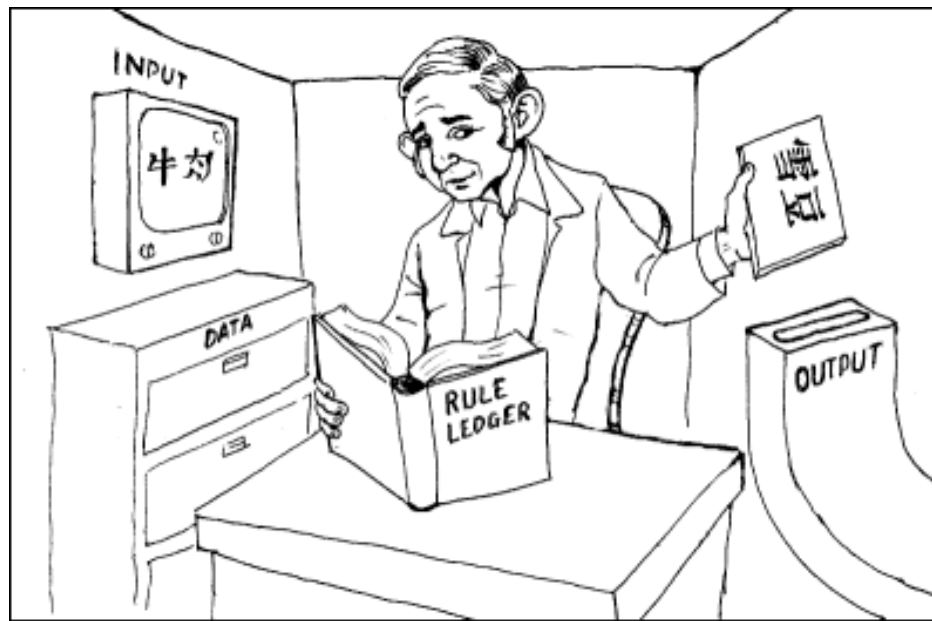
- LaMDA is a breakthrough AI technology that Google says can engage in free-flowing conversations.
- Blake Lemoine, worked for Google's Responsible AI team, and his job was to test if the technology used discriminatory or hate speech.
- He announced LaMDA showed self-awareness and could hold conversations about religion, emotions and fears. This led Mr. Lemoine to believe that behind its impressive verbal skills might also lie a sentient mind. Does it?



Lemoine,
July 2022

Can computers really THINK? The Chinese room argument

- Suppose I'm locked in a room and I know no Chinese, either written or spoken. I have an exhaustive set of rules in English that enable me to correlate one set of formal symbols with another set of formal symbols (i.e. the Chinese characters). These rules allow me to respond, in written Chinese, to questions, also written in Chinese, in such a way that the posers of the questions – who do understand Chinese – are convinced that I can actually understand the Chinese conversation too, even though I cannot. (John Searle, 1980)

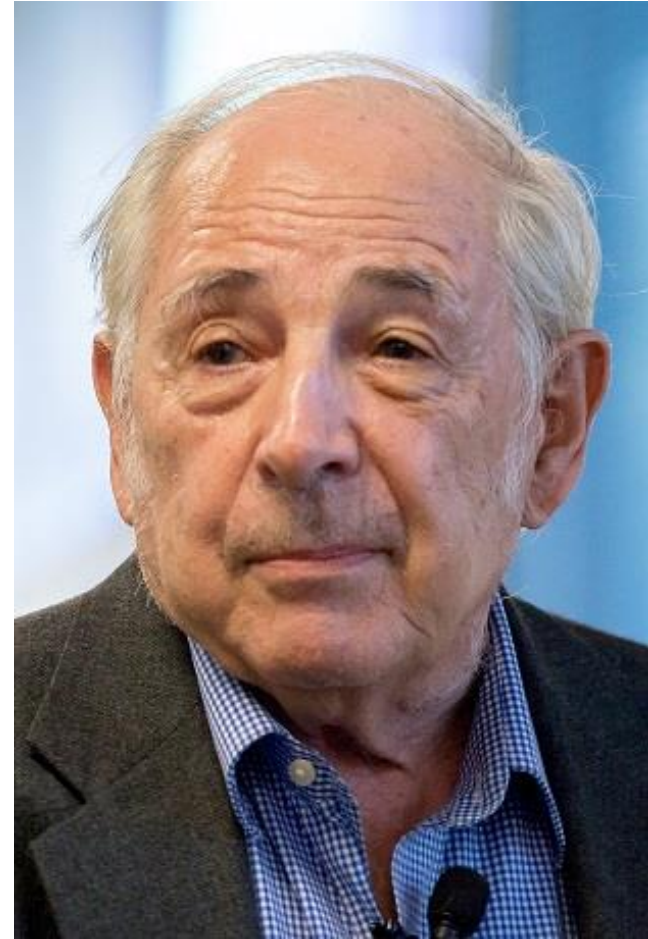


Weak and strong AI

- Suppose, says Searle, that a computer performs this task so convincingly that it passes the Turing test: it convinces a human Chinese speaker that the program is itself a live Chinese speaker.
- The question Searle wants to answer is this: does the machine literally “understand” Chinese? Or is it merely simulating the ability to understand Chinese?
- Searle calls the first position “**strong AI**” and the latter “**weak AI**”:
 - according to the strong AI, the correct simulation **is a mind**.
 - According to the weak AI, the correct simulation **is a model** of the mind.

John Searle's conclusion

- Searle claims that a program cannot give a computer a "mind", "understanding" or "consciousness" in the same sense that people have, regardless of how intelligently it behaves (thus LamDA is not sentient).
- Searle argues that this thought experiment underscores the fact that computers have no understanding of meaning or semantics.
- The conclusion is that **minds must result from biological processes**; computers can at best simulate these biological processes.



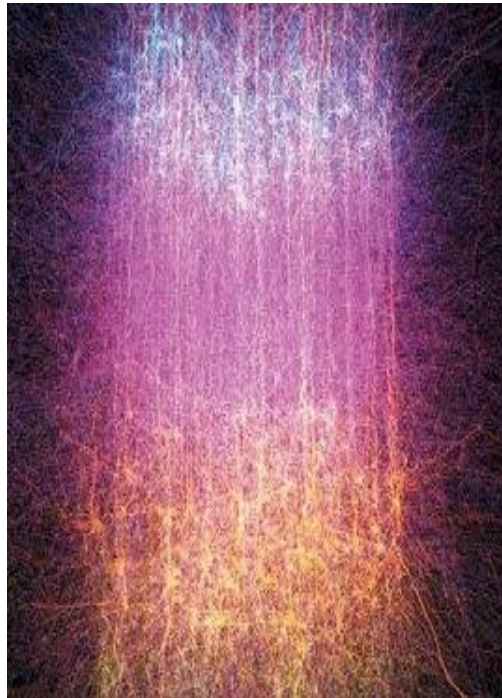
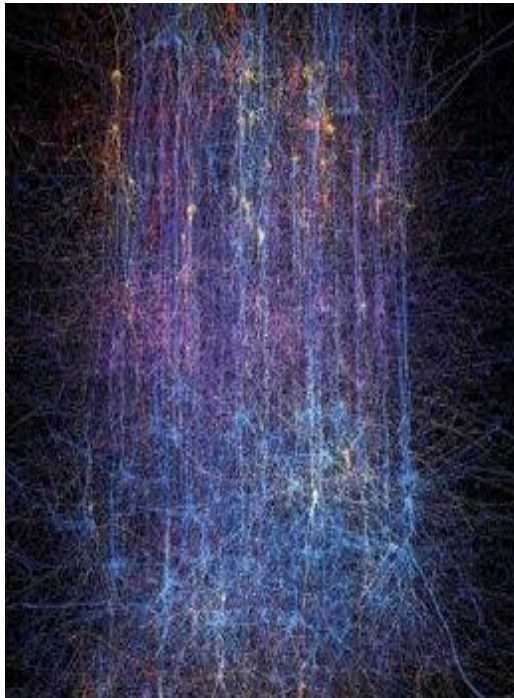
The Blue Brain project



- <http://bluebrain.epfl.ch/> or video on period 2005-2021:
 - 8 min: <https://www.youtube.com/watch?v=C59kJEfZuJ8>
- The goal of the Blue Brain Project is to build biologically detailed digital reconstructions and simulations of the mouse brain.
- Founded in 2005 by Prof. Henry Markram, Director of the Brain and Mind Institute of the EPFL, Switzerland (1 billion euros EU).
- Using the IBM Blue Gene supercomputer and **NEURON software**, the simulation involves biologically realistic models of neurons and circuits.

The Blue Brain project

- From the data from 15,000 experiments in rat somatosensory cortex they have constructed a model of a neocortical column, which
 - consists of 10,000 3D digitalizations of real neurons
 - populated with models of dozens of ion channels
 - of over 200 different types of neurons.



The Blue Brain: future goals



- First, extension to the subcellular domain, which will integrate additional biological detail into the existing neocortical column model.
 - Incorporating the molecular structures, processes and effects is an important step towards pharmacological, genetic and medical research “in silico”. (Silicon is used in microchips.)
- Second, the facility will be extended to model larger portions of cortex and other brain structures (hippocampus, cerebellum, thalamus, etc.).
- Ultimately, given additional resources, the facility will be extended to permit whole brain modeling, simulation and experimentation.

Baby X (Mark Sagar, Soul Machines, New Zealand)

- The Baby X system can analyse video and audio inputs in real time to react to the caregiver's behaviour using neural & behavioural models.
- BabyX is under continuous development, in its neural models, sensing systems and also the realism of its real time graphics.



Martin Takáč

soul machines



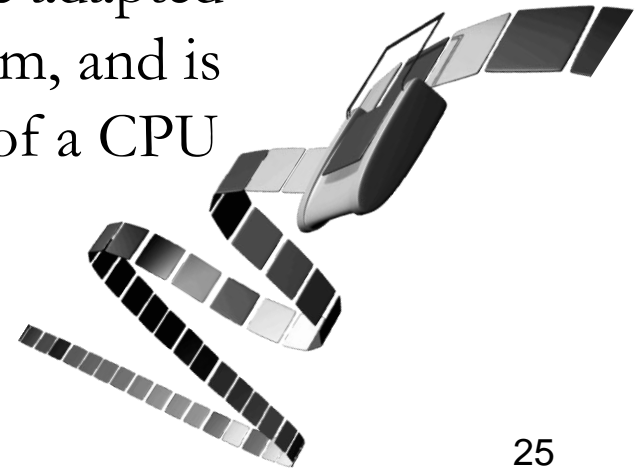
What can be computed?



- In 1931, Kurt Gödel (1906-1978) proved the so-called *incompleteness theorem*.
- **Gödel's incompleteness theorem** says that in any formal theory as strong as Peano arithmetic (theory of natural numbers), there are true statements that are undecidable in the sense they have no proof within the theory itself, that one which has generated them. (I.e., each and every theory is by default incomplete.)
- The consequence of this fundamental theoretical result is for instance that some functions on the integers cannot be represented by an algorithm – but which functions are computable and which are not?

Turing machine

- Alan Turing (1912-1954) tried to characterise exactly which functions are computable.
- This effort led to the concept of the **Turing machine**, which is a hypothetical device that manipulates symbols on a strip of tape according to a table of rules.
- Despite its simplicity, a Turing machine can be adapted to simulate the logic of **any** computer algorithm, and is particularly useful in explaining the functions of a CPU inside a computer.



Tractability

- Roughly speaking a problem is intractable if the time required to solve instances of the problem grows exponentially with the size of the instances n , i.e. an algorithm with $T(n) = O(c^n)$ is said to be an **exponential time** algorithm. (c is a finite constant)
- Cobham–Edmonds thesis asserts that computational problems can be feasibly computed on some computational device only if they can be computed in a **polynomial time**.
 - I.e., there exists an algorithm that, given an n -bit instance of the problem as input, can produce a solution in time $T(n) = O(n^c)$, where c is a constant that depends on the problem but not the particular instance of the problem.

NP-completeness

- How can we recognise an (in)tractable problem? Cook and Karp (1972) showed the existence of large classes of combinatorial search and reasoning problems that are NP-complete.
- NP refers to “**nondeterministic polynomial time**”. A nondeterministic algorithm is an algorithm that can exhibit **different** behaviours on different runs, as opposed to a deterministic algorithm. An algorithm that solves a problem in an NP time can run in polynomial time or exponential time depending on the choices it makes during execution.
- As a consequence, determining whether or not it is possible to solve these problems quickly, called the P versus NP problem, is **one of the principal unsolved problems in computer science** today.

mAIN: blok S2 Umelá inteligencia

https://sluzby.fmph.uniba.sk/infolist/sk/sp_mAIN.html

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2-INF-188/22		<u>Moderné techniky strojového učenia</u> - <u>Vladimír Boža</u>

- A výberové predmety ako: Rozpoznávanie reči - M. Nagy, Spracovanie videa – Zuzana Černeková, Evolučné algoritmy – M. Markošová, Komplexné siete - M. Markošová, Ontológie a znalostné inžinierstvo – M. Homola, etc.

MEi:CogSci – Middle European interdisciplinary Cog Sci

- The interdisciplinary field of Cognitive Science brings together computer models from AI and techniques from neuroscience and psychology to develop theories of human mind.
 - <http://cogsci.fmph.uniba.sk/meicogsciba/>
- Courses: Computational Cognitive Neuroscience (Benuskova, Malinovska), Computational Intelligence (Farkas), Cognitive Theory (Takac), Robotics (Lucny), AI (Markosova), Brain Research (Cimrova), etc.
 - https://sluzby.fmph.uniba.sk/infolist/en/sp_mIKV.html



Conclusion

- In conclusion, we can see that AI has made great progress in its short history, and you have made a great progress in this semester.
- Beware that AI chatbots are and will be part of interaction on social media. Use your natural intelligence and verify the facts!
- “We can see only a short distance ahead, but we can see that much remains to be done.” (Allan Turing)

