

LECTURER: TAI LE QUY

ARTIFICIAL INTELLIGENCE

Who am I?

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- PhD candidate at L3S Research Center – Leibniz University Hannover
 - Topic: Fairness-aware machine learning in educational data mining
 - Project: LernMINT (lernmint.org)
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- More materials: <https://github.com/tailequy/IU-AI-DLMAIAI01>



Who are you?

- Name
- Employer
- Position/responsibilities
- Fun Fact
- Previous knowledge? Expectations?



TOPIC OUTLINE

History of Artificial Intelligence

1

Early Systems in Artificial Intelligence

2

Neuroscience and Cognitive Science

3

Modern Artificial Intelligence Systems

4

Applications of Artificial Intelligence

5

UNIT 1

HISTORY OF ARTIFICIAL INTELLIGENCE



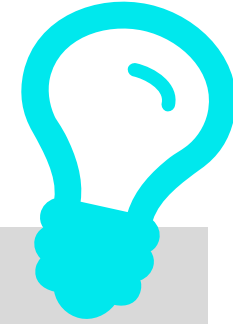
On completion of this unit, you will have learned ...

- ... how artificial intelligence has developed as a scientific discipline.
- ... what paradigms have dominated public perception of the field at different times.
- ... which notable advances are still relevant today.
- ... what the history of artificial intelligence means for you in terms of learning new skills and contributing to society.



1. Explain the term of AI winter using your own words.
2. Name relevant considerations of AI. Why are they relevant?
3. Describe key trends in Artificial Intelligence.

WHAT IS ARTIFICIAL INTELLIGENCE?



“The science and engineering
of making intelligent machines,
especially intelligent computer programs.”

WHAT IS ARTIFICIAL INTELLIGENCE?

The term **Artificial Intelligence** was first introduced in the proposal for the **Dartmouth** summer research project by J. McCarthy (Dartmouth College), M. L. Minsky (Harvard University), N. Rochester (I.B.M. Corporation), C.E. Shannon (Bell Telephone Laboratories), August 31, 1955.

We propose that a 2 month, 10 man study of artificial intelligence be carried out during the summer of 1956 at Dartmouth College in Hanover, New Hampshire. The study is to proceed on the basis of the conjecture that every aspect of learning or any other feature of intelligence can in principle be so precisely described that a machine can be made to simulate it. An attempt will be made to find how to make machines use language, form abstractions and concepts, solve kinds of problems now reserved for humans, and improve themselves. We think that a significant advance can be made in one or more of these problems if a carefully selected group of scientists work on it together for a summer.

WHAT IS ARTIFICIAL INTELLIGENCE?

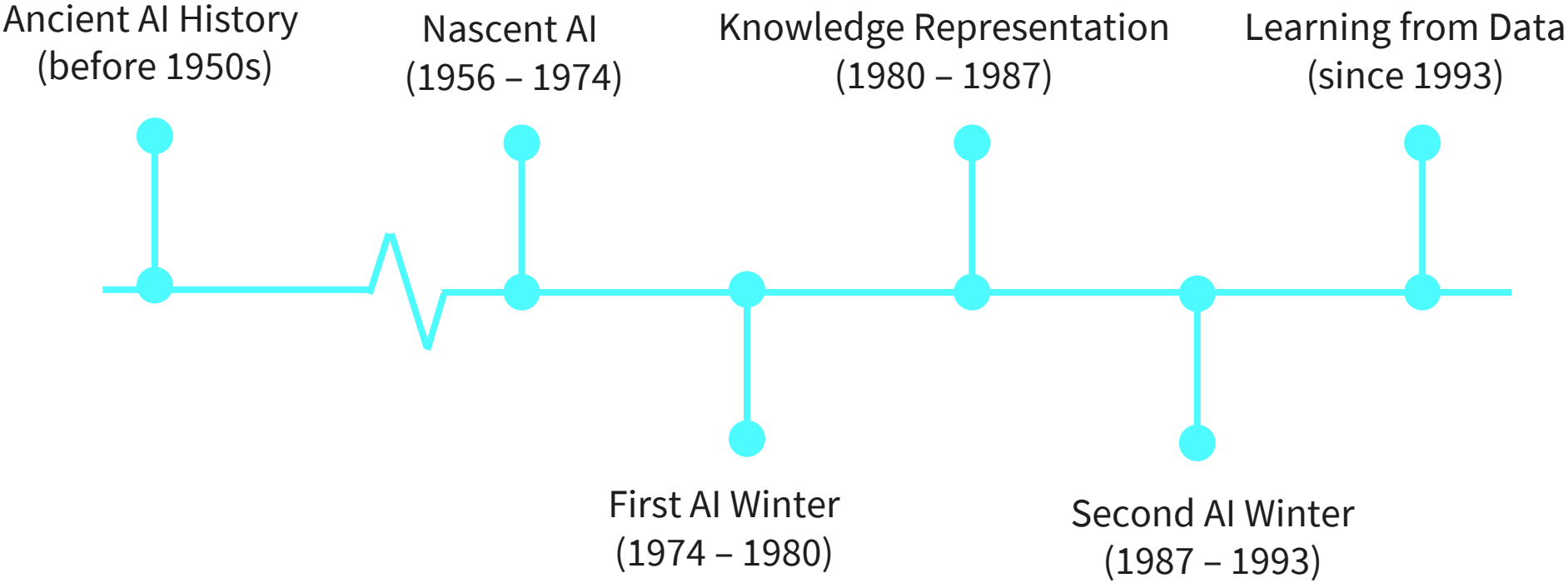
Narrow AI

- Performs specialized functions, in controlled environments
- The capabilities are limited, i.e., cannot generalize from a specific task to a task from another domain

General AI

- Comprises open-ended, flexible, and domain independent forms, have some sort of consciousness and self-awareness
- Still far away

THE HISTORY OF AI



Ancient AI history (before 1950s)

- Aristotle, Greek Philosopher (384-322 BCE)
 - Formalized human thinking in a way to be able to imitate
- Leonardo da Vinci, Italian Polymath (1452-1519)
 - Designed a hypothetical computing machine on paper
- René Descartes, French Philosopher (1596-1650)
 - Believed that rationality and reason can be defined using principles from mechanics and mathematics
- Thomas Hobbes, British Philosopher (1588-1679)
 - Identified similarities between human reasoning and computations of machines
- David Hume, Scottish Philosopher (1711-1776)
 - Fundamental contributions to questions of logical induction and the concept of causal reasoning

Nascent AI (1956-1974)

- “Symbolic” AI: rules from formal logic are used to formalize thought processes as manipulation of symbolic representations of information → implementation of logical calculus (done by a search strategy)
- First attempts for natural language processing, on limited environments and settings
- First theoretical models of neurons (focusing on the interactions between cells to implement basic logical function in networks)

AI winters

- First AI winter (1974-1980)
 - Automatic language translation was one of the major drivers to fund AI research activities, however, there were not enough translators to meet the demand (not accurate, nor faster or cheaper)
- Second AI winter (1987-1993)
 - The collapse of the Lisp machine business
 - It was not possible to develop early successful examples of expert systems beyond a certain point
- Causes of the AI winters
 - Algorithms, computing capacity, the availability of data

Knowledge representation (1980-1987)

- Attempted to solve the problems of knowledge representation (day-by-day situations intelligent behavior is based on general knowledge about the world works)
- Domain-relevant knowledge was systematically stored in databases
- New network models and the use of backpropagation as a training method in layered networks

Learning from data (since 1993)

- Major advances of AI in games (“Deep Blue” was able to beat Garry Kasparov, the world champion in chess, in 1997)
- Significant increase in data storage and computational capacities
- Deep learning was developed based on advances in connectionists machine learning models (2012)
- Well-established learning models, e.g. reinforcement learning, adversarial learning



Key personalities

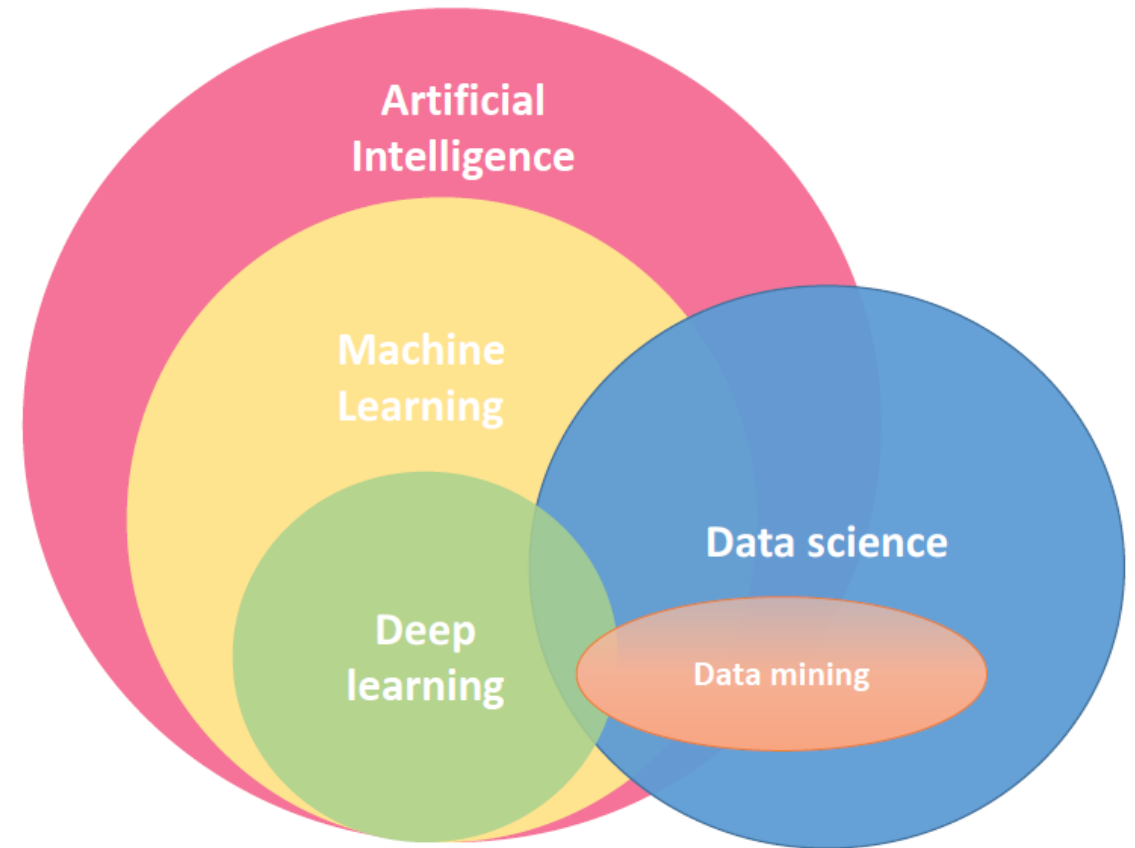
- Alan Turing
 - Conceptualized the well-known Turing Test (1950): if the human cannot identify an AI in a conversation, it is considered a real AI
- John McCarthy
 - Coined the term “artificial intelligence”, invented the Lisp programming language (used in fraud detection, robotics for more than 30 years)
- Marvin Minsky
 - Combined insights from AI and cognitive science
- Noam Chomsky
 - Formal language theory which plays an important role in natural language processing(NLP)

Key disciplines contributing to the development of AI

- Decision theory
 - Combination of mathematical probability and economic utility
- Game theory
 - Important foundation for rational agents to learn strategies to solve games
- Neuroscience
 - Emulate the way the brain stores information and solve problems (artificial neural networks – ANN)
- Natural language processing
 - Combines linguistics and computer science to process written and spoken languages

Artificial Intelligence (AI) vs:

- Data science (DS)
- Data mining (DM)
- Machine learning (ML)
- Deep learning (DL)



Data science

- Data science is the study of the generalizable extraction of knowledge from data
- Studies everything related to data, from data acquisition, data storage, data analysis, data cleaning, data visualization, data interpretation, making decisions based on data, determining how to create value from data and how to communicate insights relevant to the business

Data mining

- Data mining refers to the application of algorithms for extracting patterns from data
- Aims to understand and discover new, previously unseen knowledge in the data

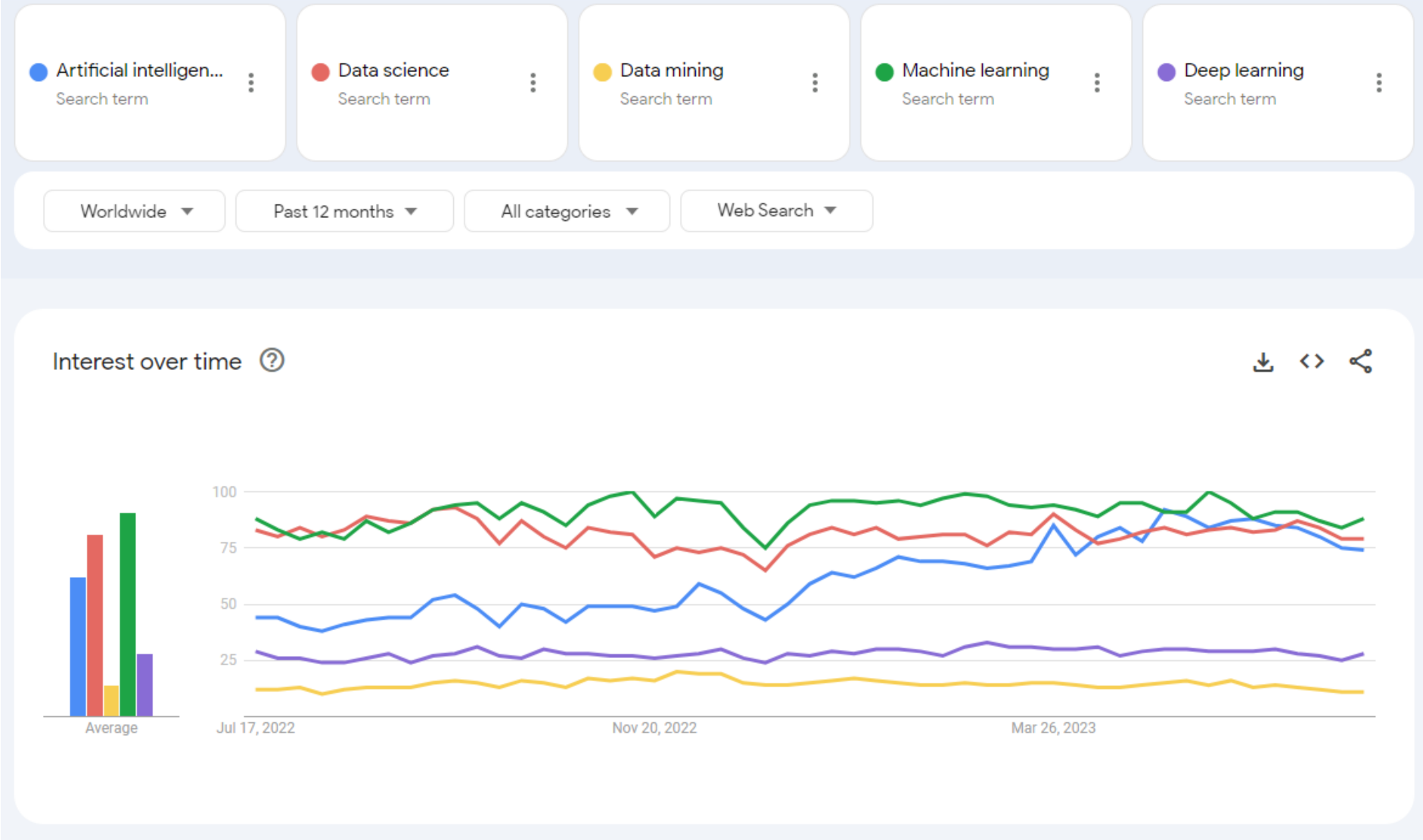
Machine learning

- A subset of AI, aims to develop algorithms that can learn from historical data and improve the system with experience
- *A computer program is said to learn from experience **E** with respect to some class of tasks **T** and performance measure **P**, if its performance at tasks in **T**, as measured by **P**, improves with experience **E** (Mitchell et al. 1990).*

Deep learning

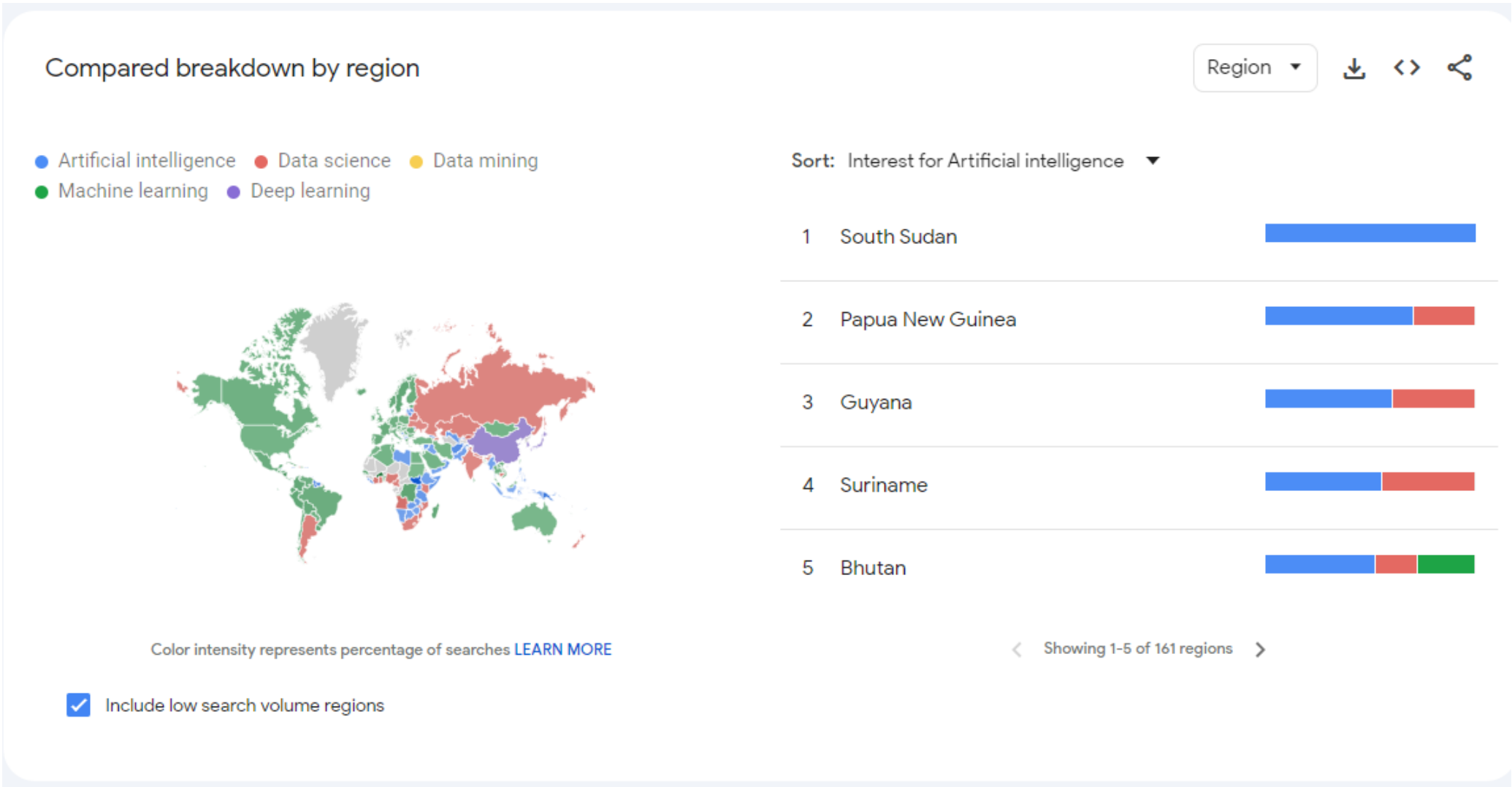
- A subset of ML, data is passed via multiple number of non-linear transformations to calculate an output. The term **deep** refers to many steps.
- Deep learning allows computational models that are composed of multiple processing layers to learn representations of data with multiple levels of abstraction

ARTIFICIAL INTELLIGENCE AND OTHER DISCIPLINES



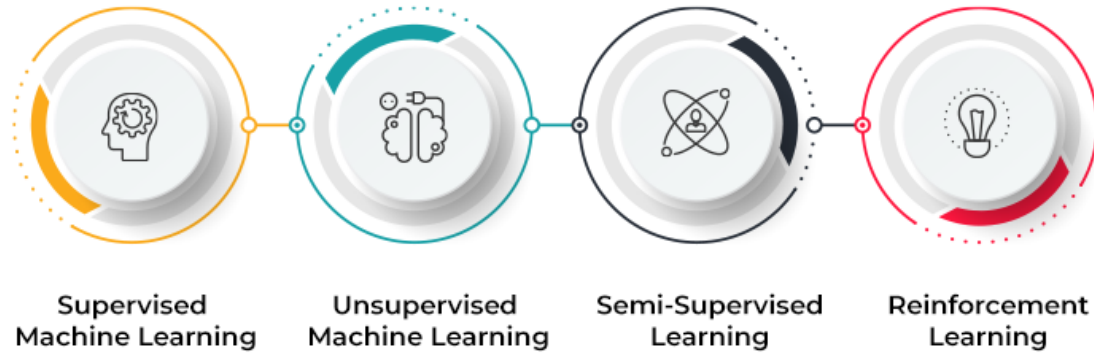
Source: Google Trends (accessed by 12.07.2023)

ARTIFICIAL INTELLIGENCE AND OTHER DISCIPLINES

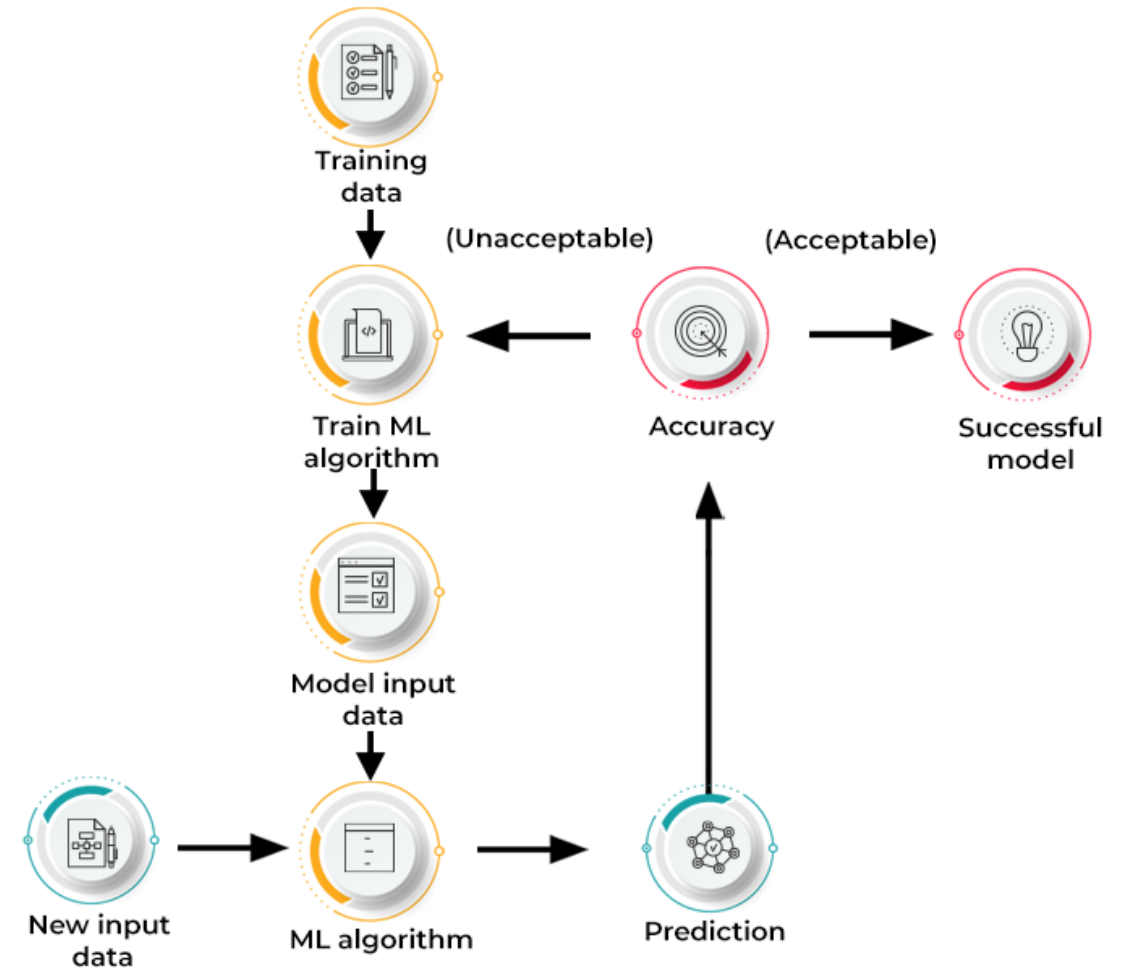


Machine learning

TYPES OF MACHINE LEARNING



HOW DOES MACHINE LEARNING WORK?

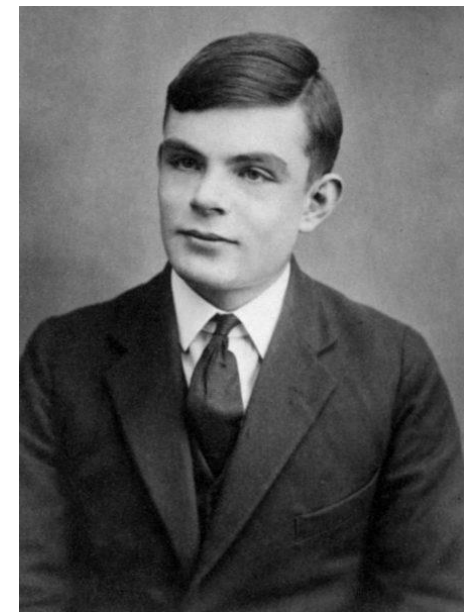


Ancient artificial intelligence history

- Aristotle (*syllogism*)
- David Hume (*learning curve*)

Recent artificial intelligence history

- Alan Turing (*test*)
- John McCarthy (*Automata*)



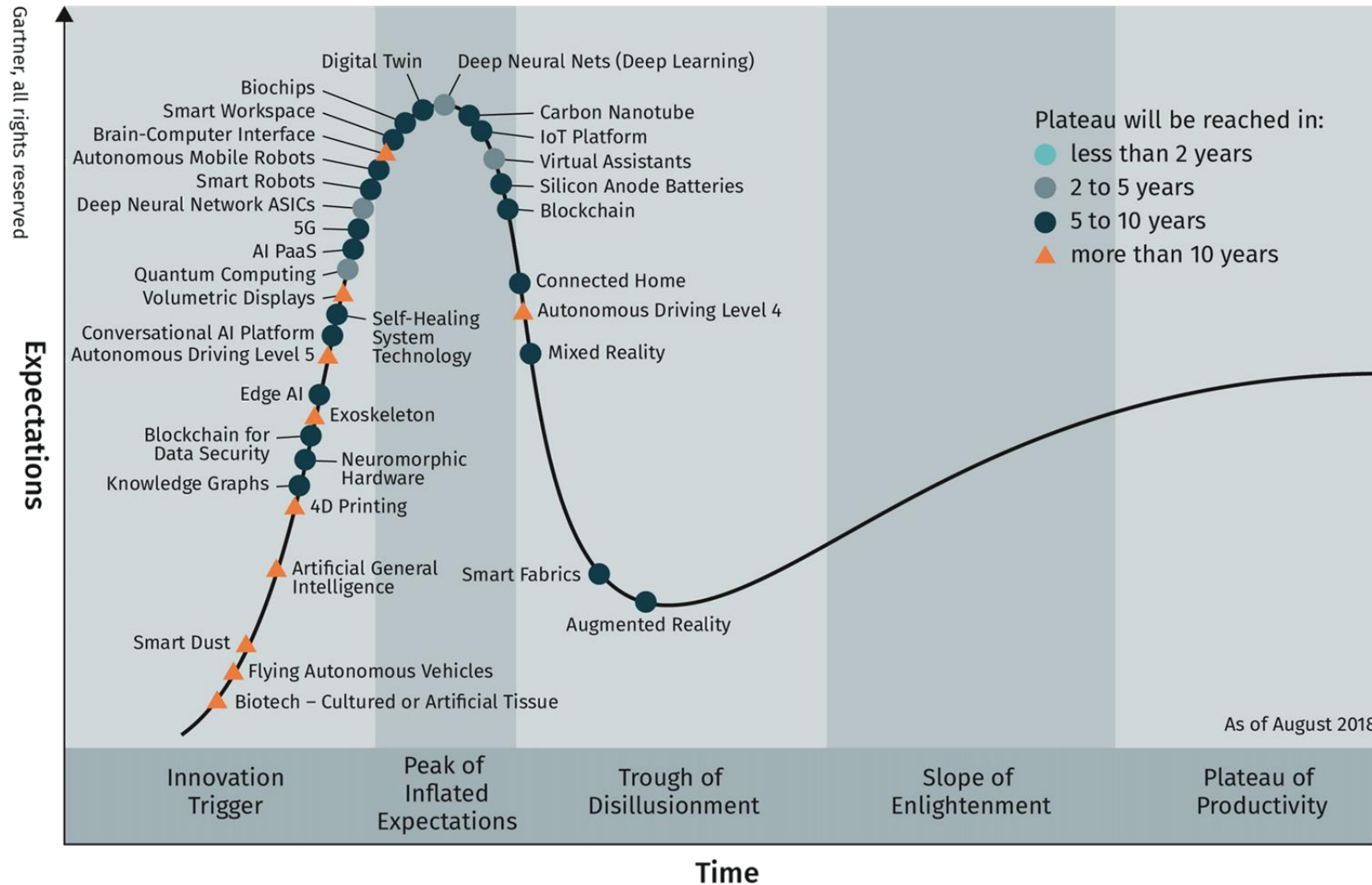
Alan Turing



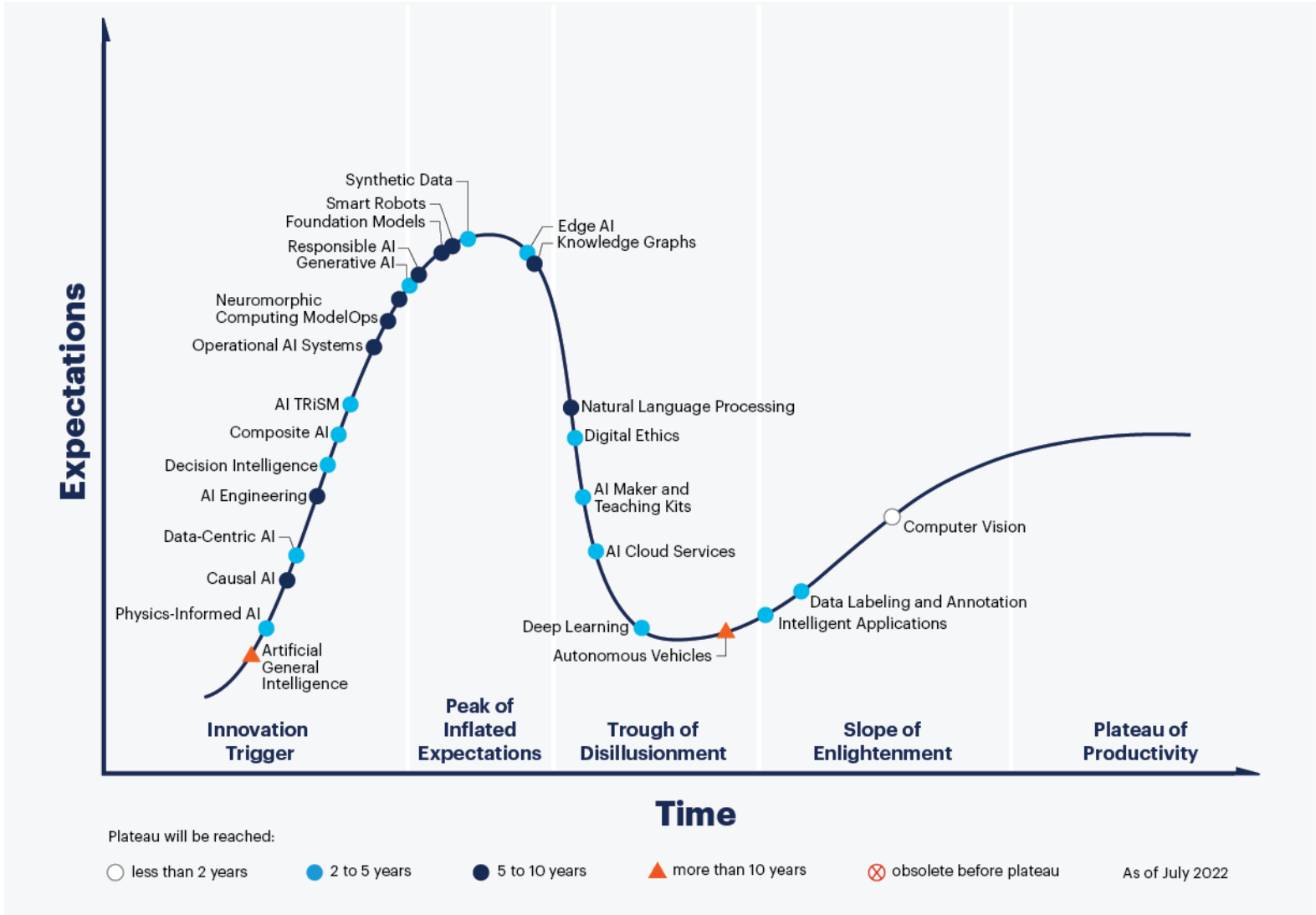
John McCarthy

GARTNER HYPE CYCLE FOR EMERGING TECHNOLOGIES

Gartner captures the history of innovations in the form of a hype curve[^].



THE GARTNER HYPE CYCLE CURVE



Source: <https://emtemp.gcom.cloud/ngw/globalassets/en/articles/images/hype-cycle-for-artificial-intelligence-2022.png>

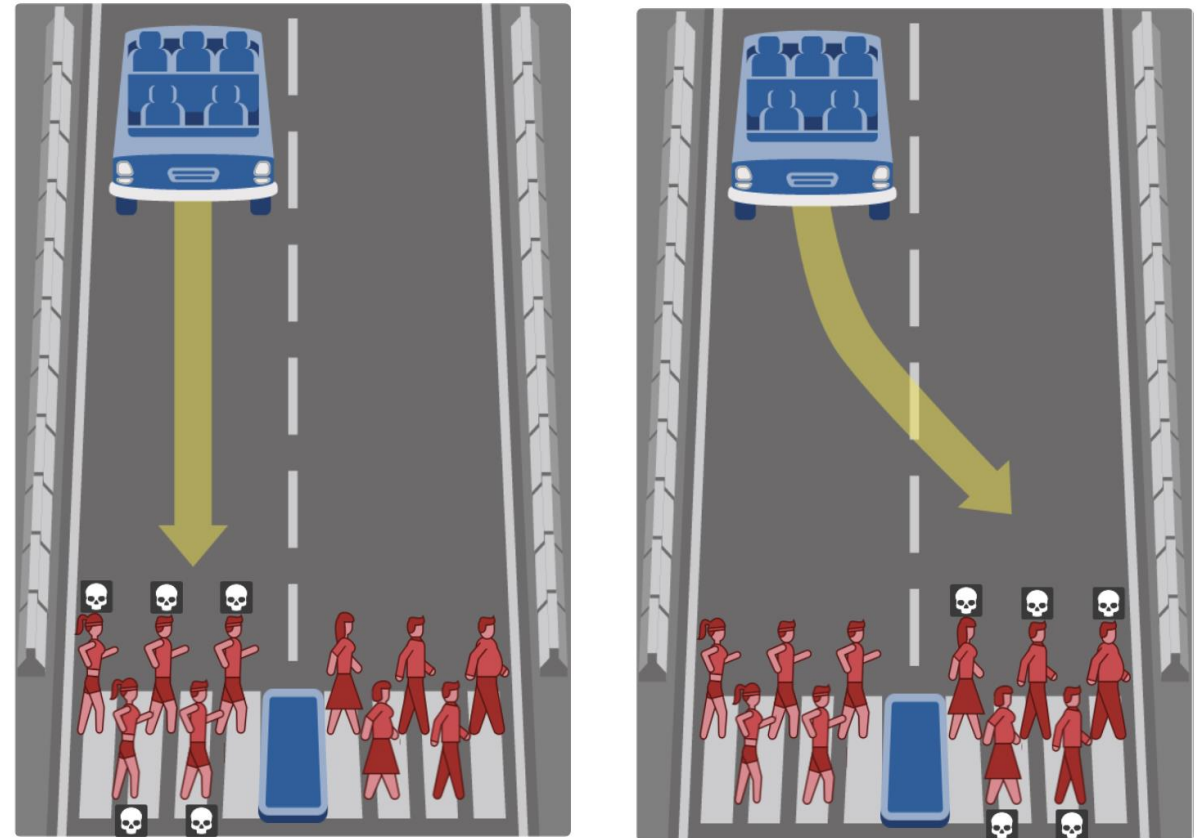
GOVERNANCE AND REGULATORY CONSIDERATIONS

1st government-initiated step to regulate data → European Union's General Data Protection Regulation (**GDPR** 2016/679)

Aspects of considerations:

- ethics (right and wrong conduct)
- unintended outcomes (bias towards, e.g. white male job applicants)

What should the self-driving car do?



AI WINTER



Period characterized by a prolonged decrease in interest and funding

NOTABLE ADVANCES

Nascent AI (1956-1974)

- Creation of rules of formal logic and logical inference
- Implementation of search strategies
- Initial successes with AI in microworld approaches

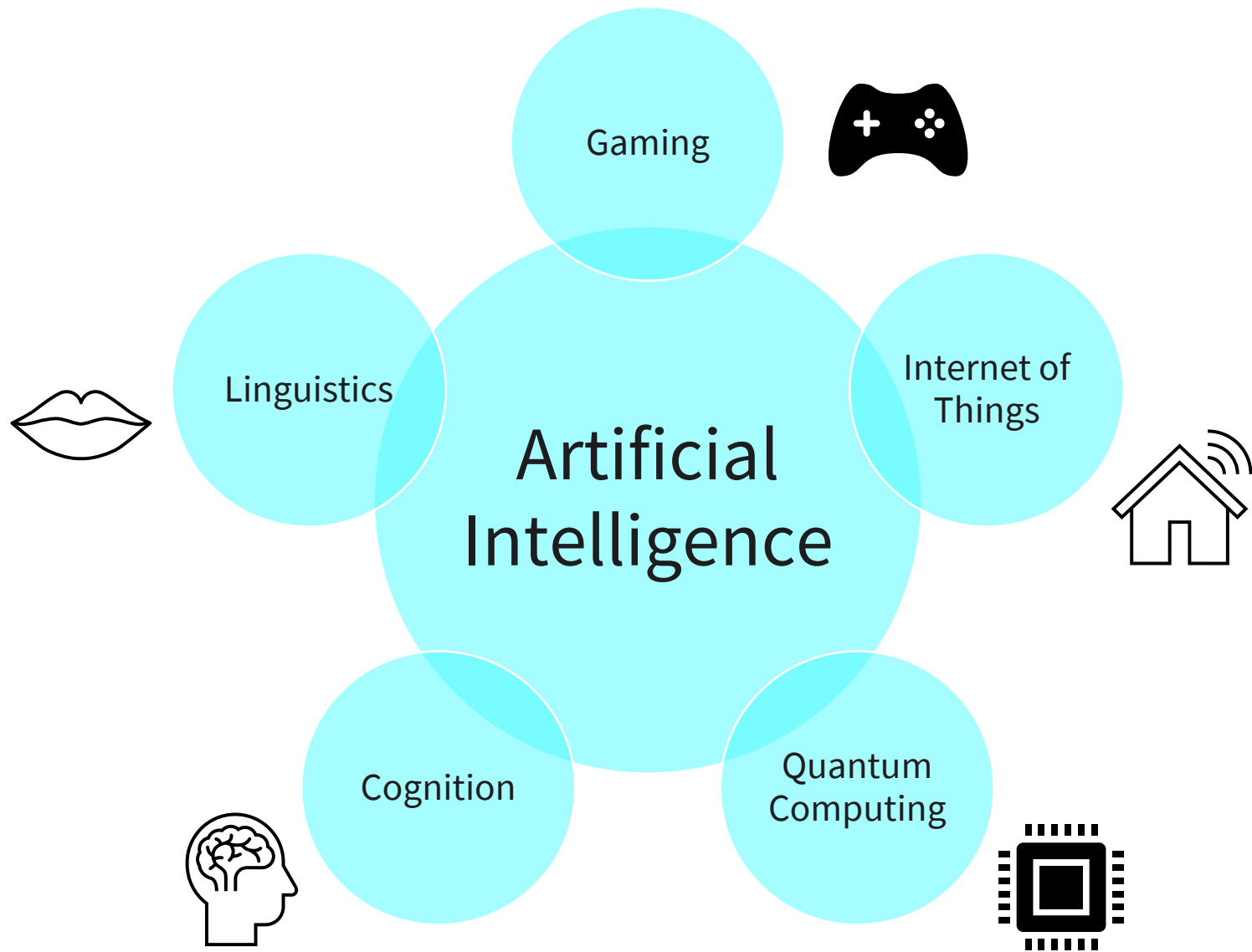
Knowledge Representation (1980-1987)

- Appearance of expert systems as intelligent behaviour in day-to-day situations rely on common sense knowledge
- Noticeable upturn in government funding
- Backpropagation as an effective training evolved

Learning from Data (1993 - Today)

- First computer system beat the world-champion in chess
- Intelligent agent paradigm results in AI being understood as study of intelligent agents, freeing it from human intelligence imitation
- Advances in computational and data storage capabilities result in further research possibilities

ADJACENT FIELDS





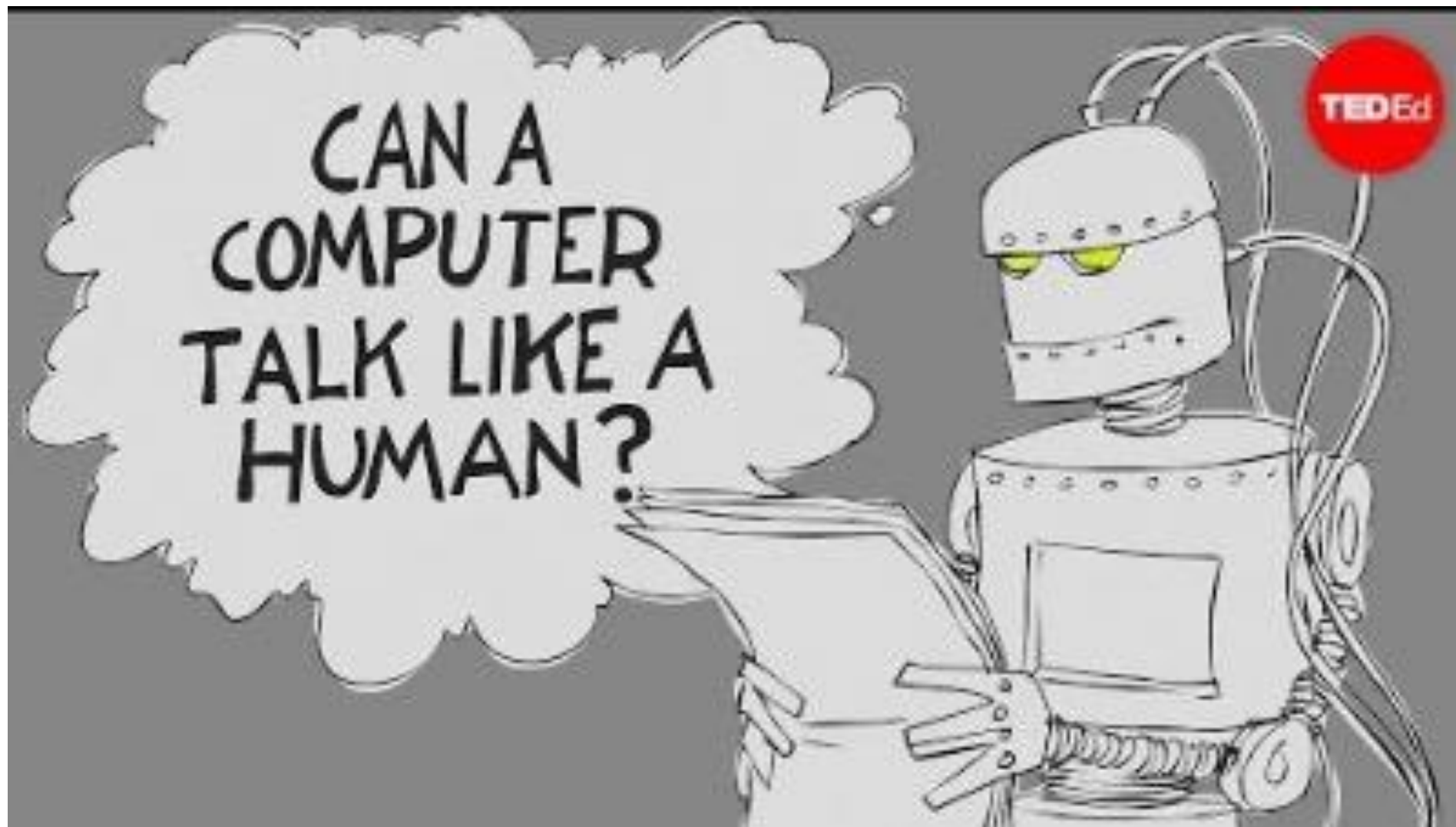
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SESSION 1

TRANSFER TASK

TRANSFER TASK



TRANSFER TASK

1. Discuss the concepts of the Turing Test with your peers.
2. Do you think an AI-powered chatbot is “intelligent”?
3. Try to challenge the intelligent machine by asking tough questions [here](#) and share your results!

TRANSFER TASK
PRESENTATION OF THE RESULTS

Please present your
results.

The results will be
discussed in plenary.





1. What does the term “AI Winter” mean?

- a) a period of declining research and funding for artificial intelligence.
- b) a period of increased funding for artificial intelligence
- c) the period of time before artificial intelligence became a concept or industry
- d) a period when artificial intelligence comes to dominate humanity.



2. The Gartner Hype Curve for Emerging Technologies tries to measure...

- a) hypothetical expectations.
- b) the degree to which technology can be trusted.
- c) the maturity of technological trends with respect to a schema of five successive phases.
- d) falsehoods in technological forecasting.



3. The mathematician and computer scientist Alan Turing is best known for...

- a) providing proof that the technological singularity has occurred.
- b) the invention of cognitive science with McCarthy.
- c) the notion that the rule of law applies to persons and the state.
- d) posing a test to determine whether a machine should be considered intelligent.

LIST OF SOURCES

Gartner. (2018). *Gartner Hype Cycle for Emerging Technologies, 2018*. Retrieved from <https://www.gartner.com/smarterwithgartner/5-trends-appear-on-the-gartner-hypecycle-for-emerging-technologies-2019/>

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