LECTURER: Nghia Duong-Trung

ARTIFICIAL INTELLIGENCE

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- Senior Researcher @ The German Research Center for Artificial Intelligence
  - BMBF Projects: https://milki-psy.de/, https://tech4comp.de/

- Freelance Lecturer @ IU

- PostDoc @ Technische Universität Berlin, Germany
  - Project: https://kiwi-biolab.de/

- PhD in Machine Learning at The Information Systems and Machine Learning Lab (ISMLL), University of Hildesheim, Germany

- Profile: https://sites.google.com/ismll.de/duongtrungnghia/

- Check attendance
- Attendance or partial attendance
- Excuse note (yes | no)
- Absence reason (yes | no)

- Course book: Artificial Intelligence_DLMAIAI01, provided by IU, myStudies

- Reading list DLMAIAI01, provided by IU, myStudies

- Additional teaching materials:

https://github.com/duongtrung/IU-AI-DLMAIAI01

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.

- The set of all tasks in which a computer can make decisions
- A computer makes these decisions by mimicking the ways a human makes decisions
  - by using logic and reasoning
  - by using our experience
- The set of all tasks in which a computer can make decisions based on **data**

- Remember-formulate-predict framework
  - We **remember** past situations that were similar
  - We **formulate** a general rule
  - We use this rule to **predict** what may happen in the future
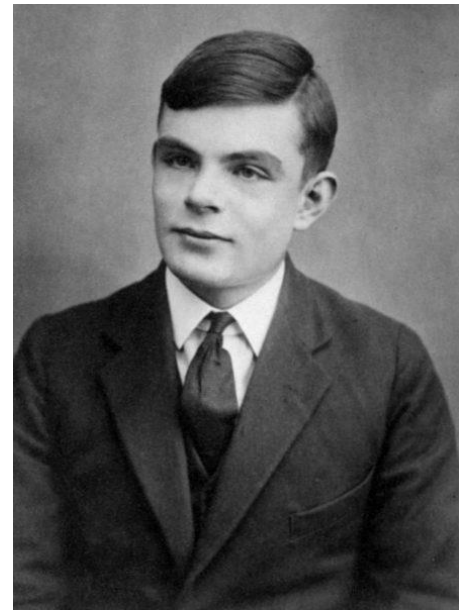
Ancient artificical intelligence history

— Aristotle (*syllogism*)

— David Hume (*learning curve*)

Alan Turing

Recent artificical intelligence history

— Alan Turing (*test*)

— John McCarthy (*Automata*)

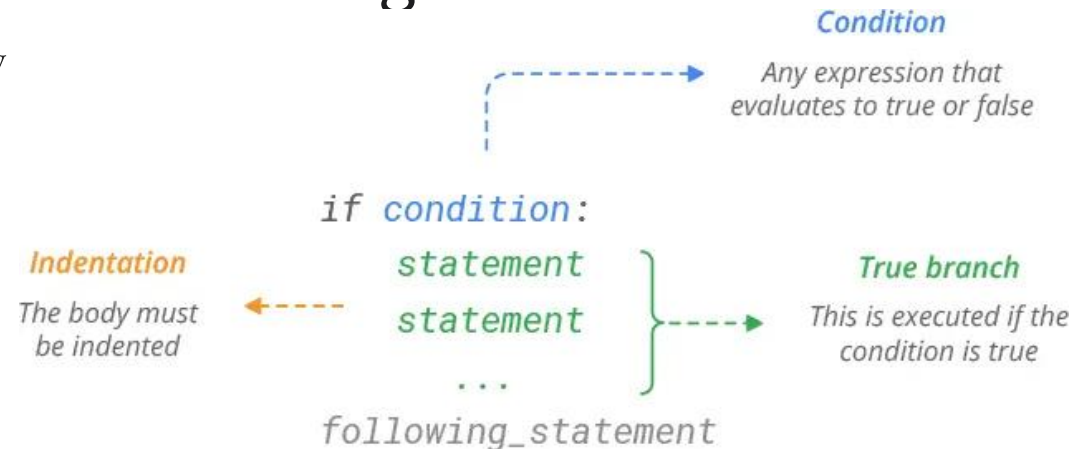— OpenAI - ChatGPT (conversational interaction)

John McCarthy

The two words *artificial* and *intelligence* were first put together on **August 31, 1955**, when professor John McCarthy from Dartmouth College, together with M.L Minsky from Harvard University, N. Rochester from IBM, and C. E. Shannon from Bell Telephone Laboratories, asked the Rockefeller Foundation to fund a summer of research on artificial intelligence

"*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. . . . 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.*
"

- Narrow AI:

- Solving a single, well defined task

- It can be broad (recognizing objects from pictures) or extremely specific (predicting which customers who bought product A are more likely to purchase product B as well

- General AI:

- Tackling every kind of task it's presented. This is similar to an extremely resourceful human, and you can think of it as the robot from The Terminator

- still far away, researchers don't know when we'll finally get it.

- The engine of the AI revolution: machine learning

- ML is the field of study that gives computers the ability learn without being explicitly programmed

Condition

Any expression that evaluates to true or false

`if condition:`

Indentation

The body must be indented

`statement`
`statement`
`...`
`following_statement`

True branch

This is executed if the condition is true

- Explicitly programming a computer means defining the rules and instructions it must follow to perform a specific task
  - This is what software engineers do when they write software that handles your everyday tasks
- Unfortunately, things are not always explicit
  - Can you explain the process you make to recognize a cat vs a dog?
  - Can you list all the English grammar rules you apply as you talk?
  - If you can't precisely explain how you do something, there's no chance that you can instruct a computer to do it.

Source of the text: McCarthy, 2007, p. 2.

- From rules to data
- ML couldn't possibly have

Blossomed before the 2000s

- Learning from data doesn't

for free, and computers need

Fast processors to perform

This task

- Availability of data and cheap computing power created the

perfect environment for ML to bloom

Traditional Programming

+ −
X =

Rules   Computer

The computer can perform the task it has been *instructed* to do.

Machine Learning

Data   Computer

The computer can perform the task it has *learned* to do.
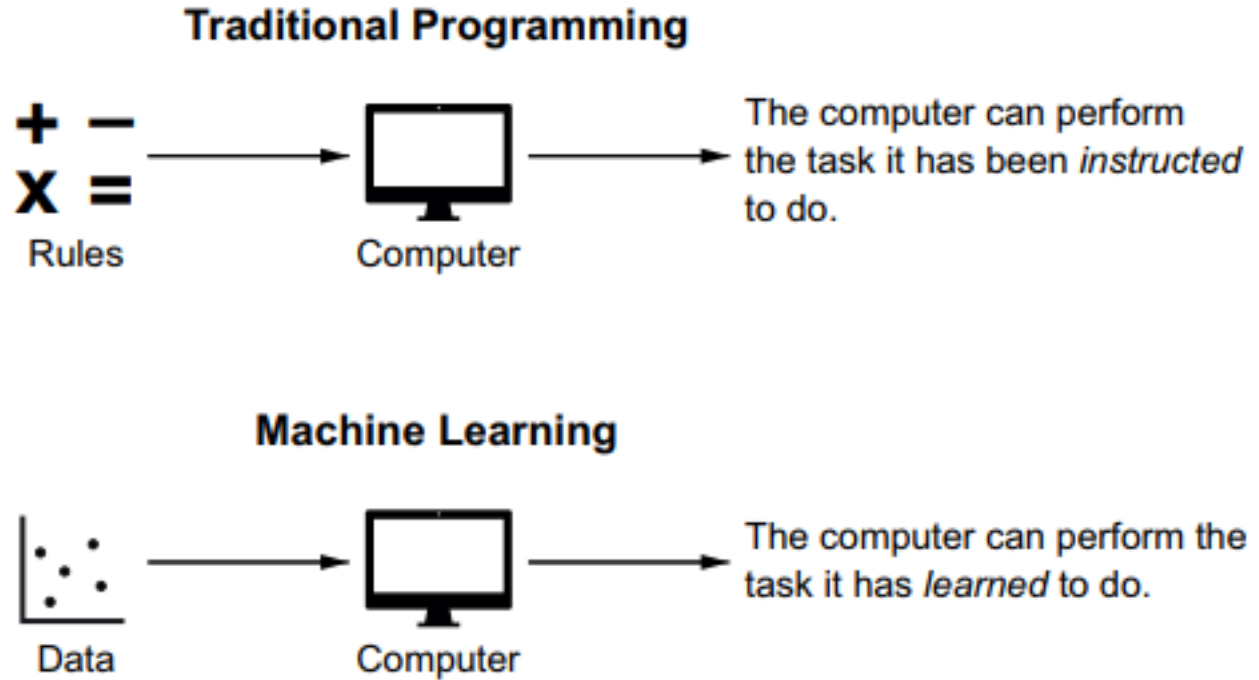
- Software that solves a problem without explicit human instruction
  - The definition focuses on the outcome of the technology rather than the specific techniques used to build it
  - It's almost equivalent to what we said about ML?
    - Learning is an intelligent trait, while ML is just a tool. It is the tool behind 99% of the successful applications we happen to call AI today.

THE MAIN DIFFERENCES BETWEEN AI AND DATA SCIENCE?

- Automates tasks or predicts future events based on data
- Is commonly used "live": it continuously elaborates news data and produces answers
- It commonly has the form of software

- Produces insights based on data
- Is commonly "one-off": it produces some insights that inform decisions

- It commonly has the form of a presentation or report

THE HISTORY OF AI

Advancements in AI: A Timeline

greatlearning
Learning for Life

1943
Evolution of Artificial Neurons

1950
Invention of Turing Machine

1956
Coinage of the word 'Artificial Intelligence'

1975 – 1980
First AI Winter

1972
First Intelligent Robot - WABOT 1

1966
First Chatbot - ELIZA

1987 – 1993
Second AI Winter

1997
First computer to beat a World chess champion

2002
AI enters Household - Roomba Vaccum

2019
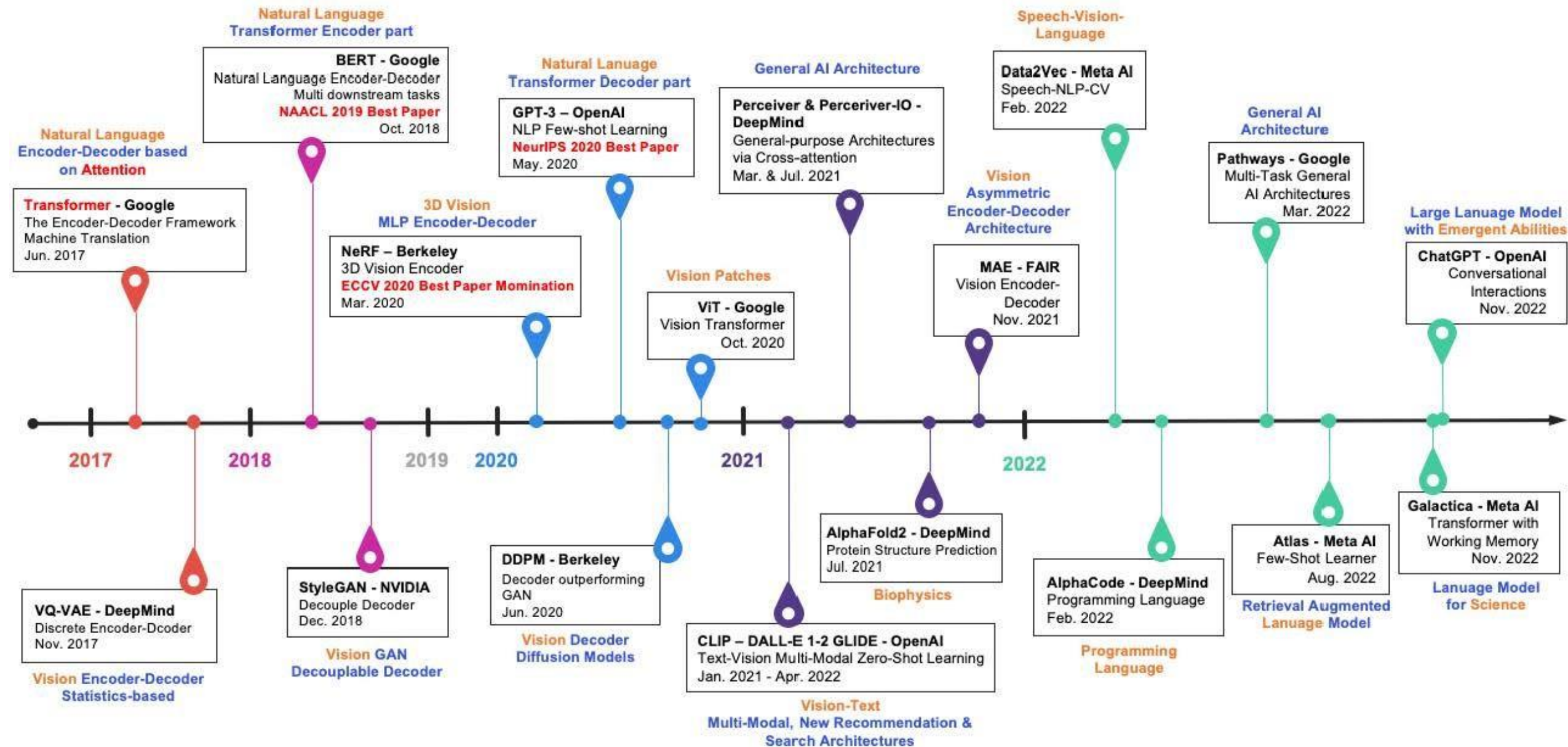Open AI - 'Dactyl' trains itself to solve a Rubik's Cube

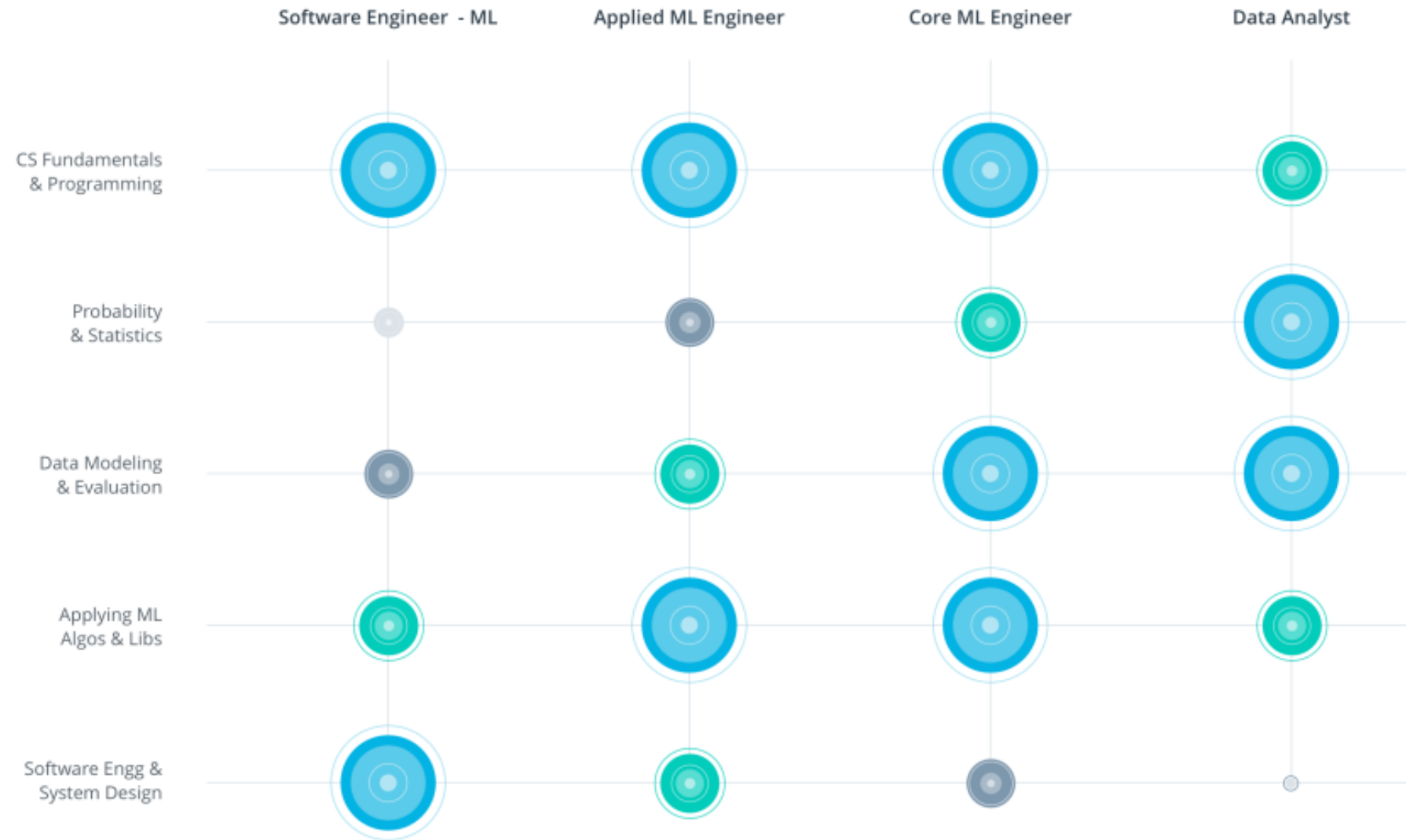**2018**
Google Duplex - Formation of Virtual Assistants

2012
Launch of 'Google Now'

BLOG TALK

The Continuing Trend of AI:
Developing General-purpose Architectures

Natural Language Encoder-Decoder based on Attention

Transformer - Google
The Encoder-Decoder Framework
Machine Translation
Jun. 2017

Natural Language Transformer Encoder part

BERT - Google
Natural Language Encoder-Decoder
Multi downstream tasks
NAACL 2019 Best Paper
Oct. 2018

3D Vision MLP Encoder-Decoder

NeRF – Berkeley
3D Vision Encoder
ECCV 2020 Best Paper Momination
Mar. 2020

Natural Lanuage Transformer Decoder part

GPT-3 – OpenAI
NLP Few-shot Learning
NeurIPS 2020 Best Paper
May. 2020

Vision Patches

ViT - Google
Vision Transformer
Oct. 2020

General AI Architecture

Perceiver & Perceriver-IO - DeepMind
General-purpose Architectures
via Cross-attention
Mar. & Jul. 2021

Speech-Vision-Language

Data2Vec - Meta AI
Speech-NLP-CV
Feb. 2022

Vision Asymmetric Encoder-Decoder Architecture

MAE - FAIR
Vision Encoder-Decoder
Nov. 2021

General AI Architecture

Pathways - Google
Multi-Task General
AI Architectures
Mar. 2022

Large Lanuage Model with Emergent Abilities

ChatGPT - OpenAI
Conversational
Interactions
Nov. 2022

2017   2018   2019   2020   2021   2022

VQ-VAE - DeepMind
Discrete Encoder-Dcoder
Nov. 2017

Vision Encoder-Decoder Statistics-based

StyleGAN - NVIDIA
Decouple Decoder
Dec. 2018

Vision GAN Decouplable Decoder

DDPM - Berkeley
Decoder outperforming
GAN
Jun. 2020

Vision Decoder Diffusion Models

CLIP – DALL-E 1-2 GLIDE - OpenAI
Text-Vision Multi-Modal Zero-Shot Learning
Jan. 2021 - Apr. 2022

Vision-Text Multi-Modal, New Recommendation & Search Architectures

AlphaFold2 - DeepMind
Protein Structure Prediction
Jul. 2021

Biophysics

AlphaCode - DeepMind
Programming Language
Feb. 2022

Programming Language

Atlas - Meta AI
Few-Shot Learner
Aug. 2022

Retrieval Augmented Lanuage Model

Galactica - Meta AI
Transformer with
Working Memory
Nov. 2022

Lanuage Model for Science

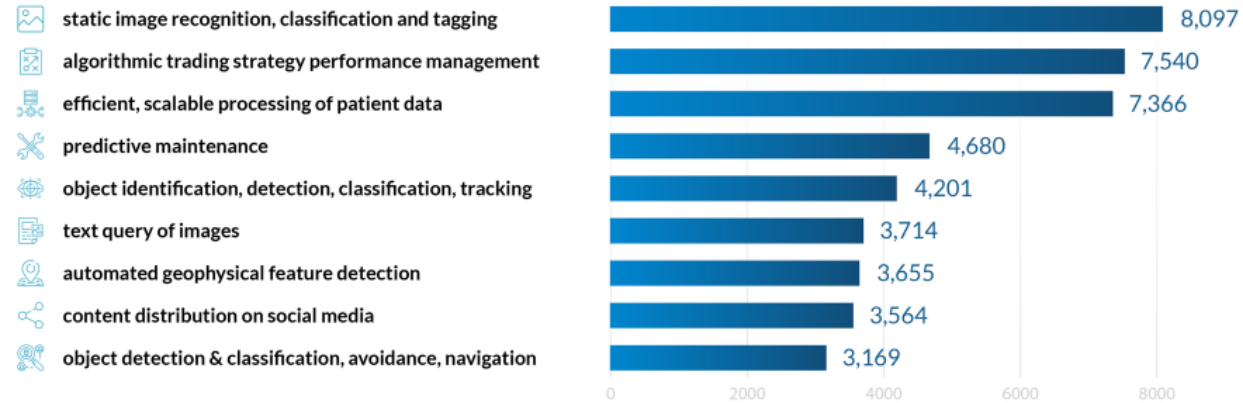|	Software Engineer - ML	Applied ML Engineer	Core ML Engineer	Data Analyst
CS Fundamentals & Programming				
Probability & Statistics				
Data Modeling & Evaluation				
Applying ML Algos & Libs				
Software Engg & System Design				

3 Key AI Trends You Should Know

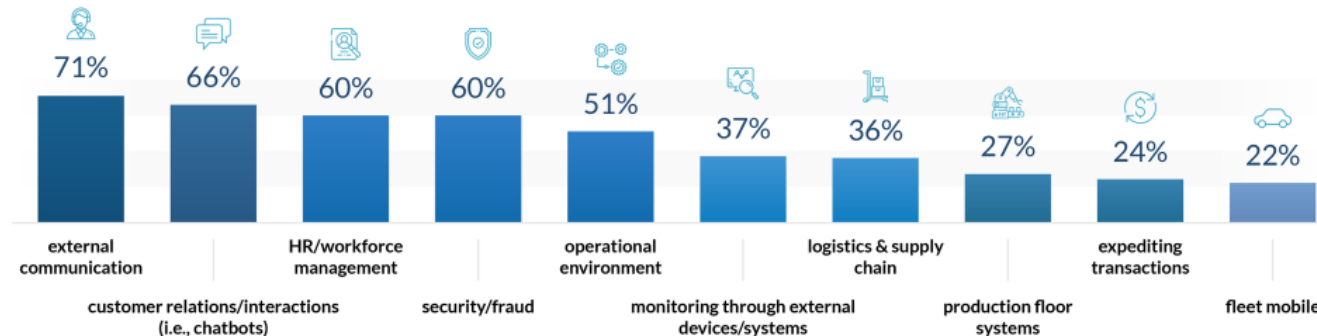## 1 Global AI revenue forecast by 2025, ranked by use case in millions US dollar

Source: Statista

Use case	Revenue
static image recognition, classification and tagging	8,097
algorithmic trading strategy performance management	7,540
efficient, scalable processing of patient data	7,366
predictive maintenance	4,680
object identification, detection, classification, tracking	4,201
text query of images	3,714
automated geophysical feature detection	3,655
content distribution on social media	3,564
object detection & classification, avoidance, navigation	3,169

(axis: 0 — 2000 — 4000 — 6000 — 8000)

2 Penetration of artificial intelligence skills, by country

Source: Dun & Bradstreet

USA	China	India	Israel	Germany
100%	92%	84%	54%	45%

3 Organizations deploying AI, by functional areas

Source: Medium

Functional area	Percentage
external communication	71%
customer relations/interactions (i.e., chatbots)	66%
HR/workforce management	60%
security/fraud	60%
operational environment	51%
monitoring through external devices/systems	37%
logistics & supply chain	36%
production floor systems	27%
expediting transactions	24%
fleet mobile	22%

THE GARTNER HYPE CYCLE CURVE

https://www.gartner.com/en/research/methodologies/gartner-hype-cycle

Hype Cycle for Artificial Intelligence, 2022

Expectations (y-axis)

Time (x-axis)

Labels on curve:
- Synthetic Data
- Smart Robots
- Foundation Models
- Responsible AI
- Generative AI
- Neuromorphic Computing ModelOps
- Operational AI Systems
- AI TRiSM
- Composite AI
- Decision Intelligence
- AI Engineering
- Data-Centric AI
- Causal AI
- Physics-Informed AI
- Artificial General Intelligence
- Edge AI
- Knowledge Graphs
- Natural Language Processing
- Digital Ethics
- AI Maker and Teaching Kits
- AI Cloud Services
- Deep Learning
- Autonomous Vehicles
- Computer Vision
- Data Labeling and Annotation
- Intelligent Applications

Phases:
Innovation Trigger | **Peak of Inflated Expectations** | **Trough of Disillusionment** | **Slope of Enlightenment** | **Plateau of Productivity**

Plateau will be reached:
○ less than 2 years
● 2 to 5 years
● 5 to 10 years
▲ more than 10 years
⊗ obsolete before plateau

As of July 2022

gartner.com

Gartner®

— AI is the science of making intelligent machines.

— Early considerations about AI date back to the ancient Greek history.

— Nowadays, AI is an important component of computer science.

— Expert systems emulate decision making by using domain-specific knowledge of an expert.

— The Gartner hype cycle curve evaluates the potential of new technologies.

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
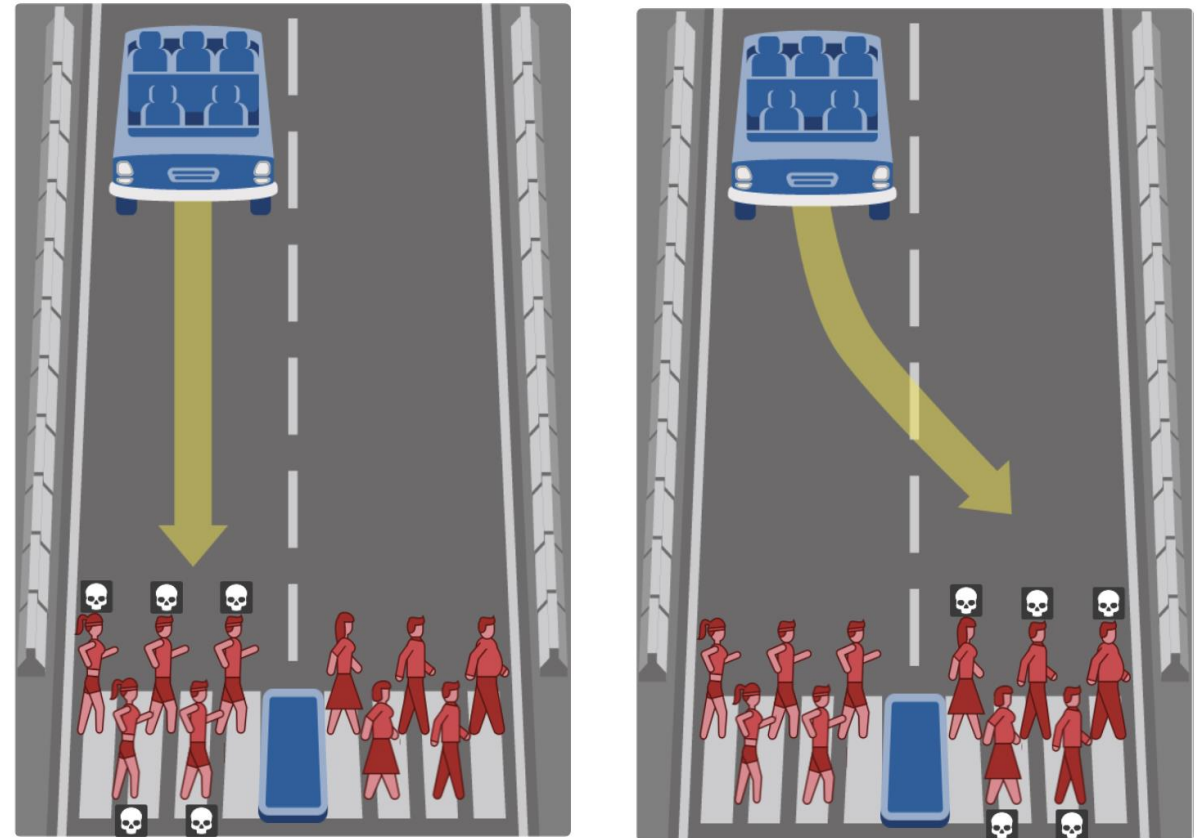
non-delivery of promised outcomes + hype + lack of funding + imbalance of data & computing capacity = **AI winter**

Period characterized by a prolonged decrease in interest and funding

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
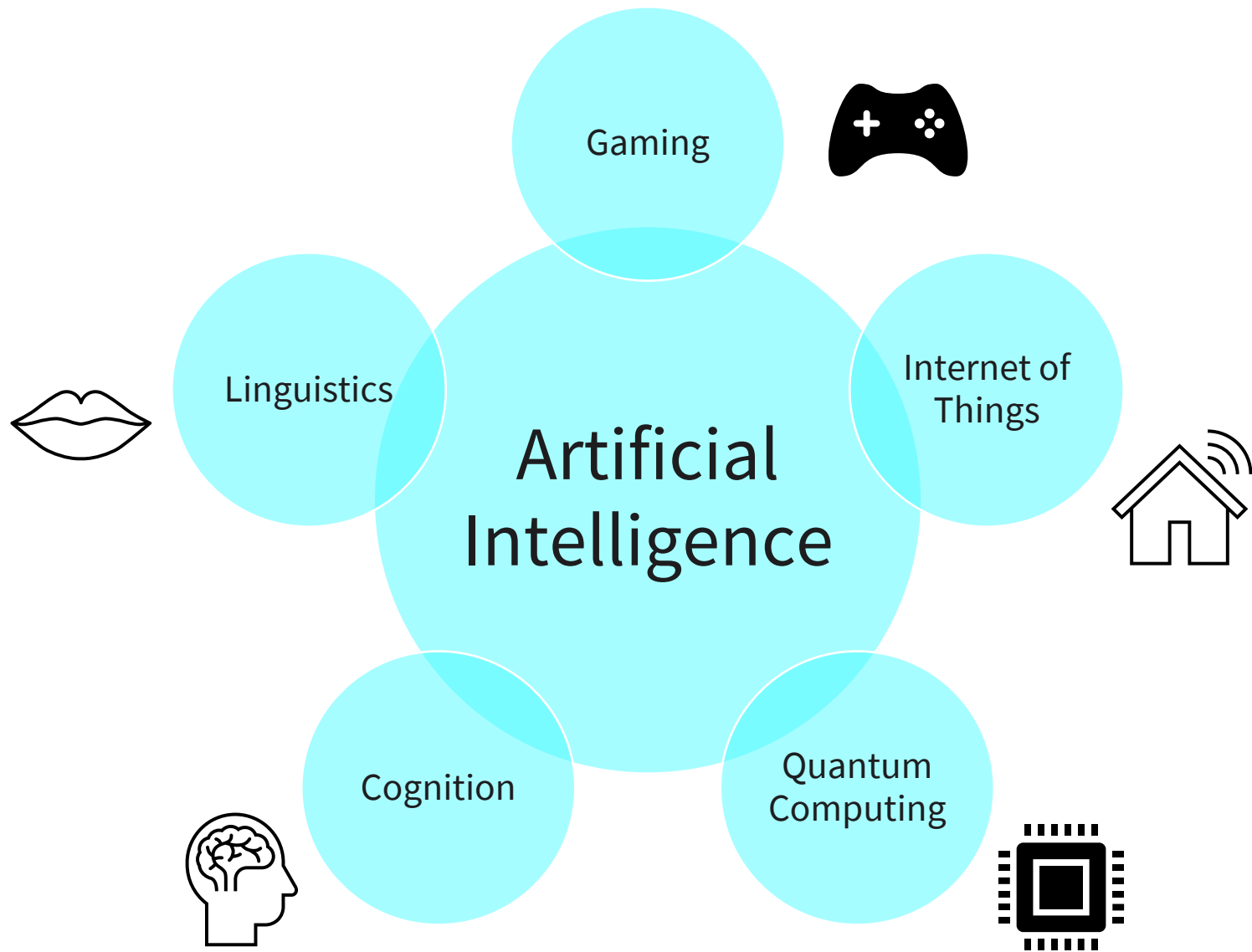
You have learned …

- … 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.

TRANSFER TASK
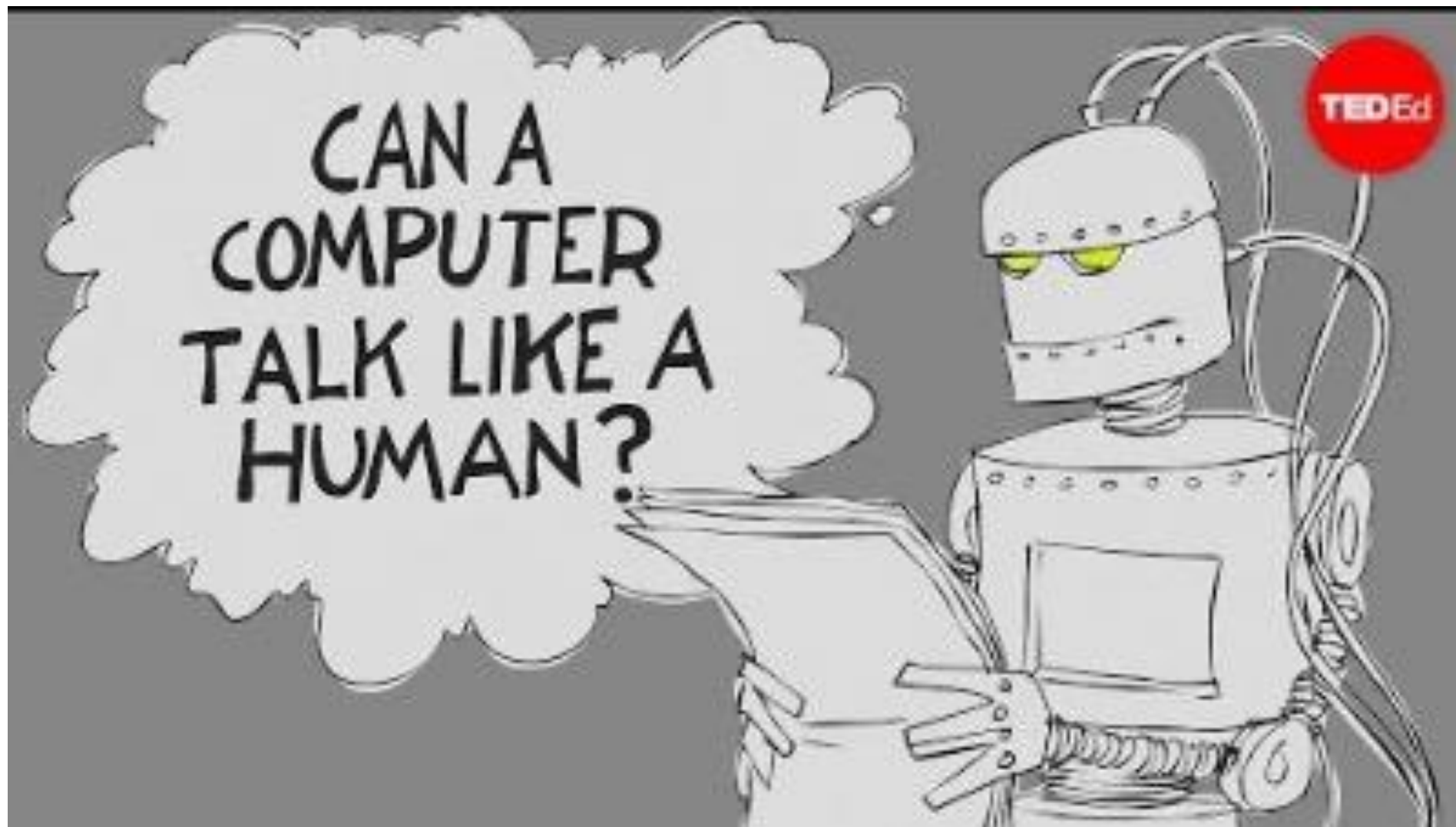
TRANSFER TASK

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!
4. Try using ChatGPT: https://openai.com/blog/chatgpt/

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

- https://end-to-end-machine-learning.teachable.com/courses
- https://www.udacity.com/course/intro-to-machine-learning-with-tensorflow-nanodegree--nd230
- https://www.coursera.org/specializations/machine-learning-introduction