

Artificial Intelligence

Algorithms and Applications with Python

Chapter 1



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python

Outline

1 Introduction into Artificial Intelligence

1.1 Motivation

1.2 Historical Foundations of Artificial Intelligence

1.3 Artificial Intelligence in Practice

1.4 Lecture Syllabus

► What we will learn:

- What artificial intelligence (AI) is and some illustrative use cases to show the potential of AI in context of information systems
- Why the industry needs AI experts like you, and how typical AI job profiles and their every day's work life looks like
- How we will organize the following lecture and what you can expect to learn

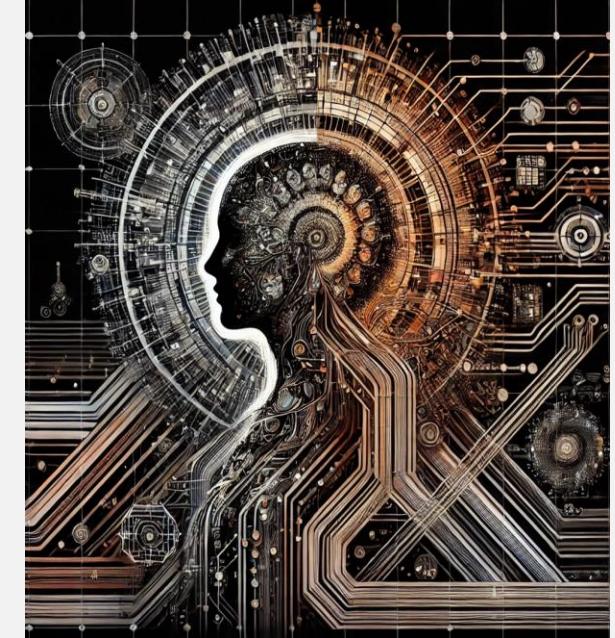


Image source: ↗ [Pixabay](#) (2019) / ↗ [CC0](#)

► Duration:

- 90 min + 45 min (Syllabus)

► Relevant for Exam:

- 1.1 - 1.3



NVIDIA GTC Trailer 2024

<https://www.youtube.com/watch?v=9tucY7Jhhs4>

1.1 The Age of AI 2024



**„Just as the industrial revolution freed
a lot of humanity from physical drudgery,
I think AI has the potential
to free up humanity from
a lot of the mental drudgery”**

Andrew Ng (Google Brain)



<https://www.forbes.com/sites/roberthof/2014/08/28/interview-inside-google-brain-founder-andrew-ngs-plans-to-transform-baidu/#ca7258a40a40>

1.1 (Intelligent) Automation @my Home



Image sources: Dominik Jung (2019)



1.1 Automation Means Automation of Human Work

Physical Robots

- Do simple work that humans do not want to or can not do
- E.g. automate moving heavy and dangerous loads or performing many repetitions, automate boring tasks
- Fast and safe execution, without or with less errors than humans
- **Domain:** cybernetics, control theory, engineering

Physical robots support physical work

Artificial Intelligence

- Modeling intelligent behavior to automate work that humans do not want to do
- E.g. Detect patterns in huge amount of data or automate the credit decision process in a bank
- Independent processing of different individual tasks
- **Domain:** computer science, statistics

Artificial Intelligence supports intellectual work

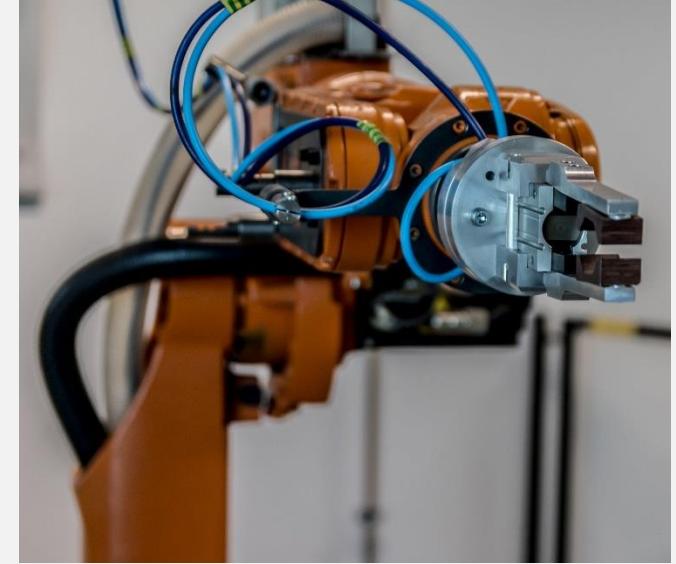


Image source: ↗ Pixabay (2019) / ↗ CCO



Image sources: Dominik Jung (2019)

1.1 Automation – AI the Job Killer?!

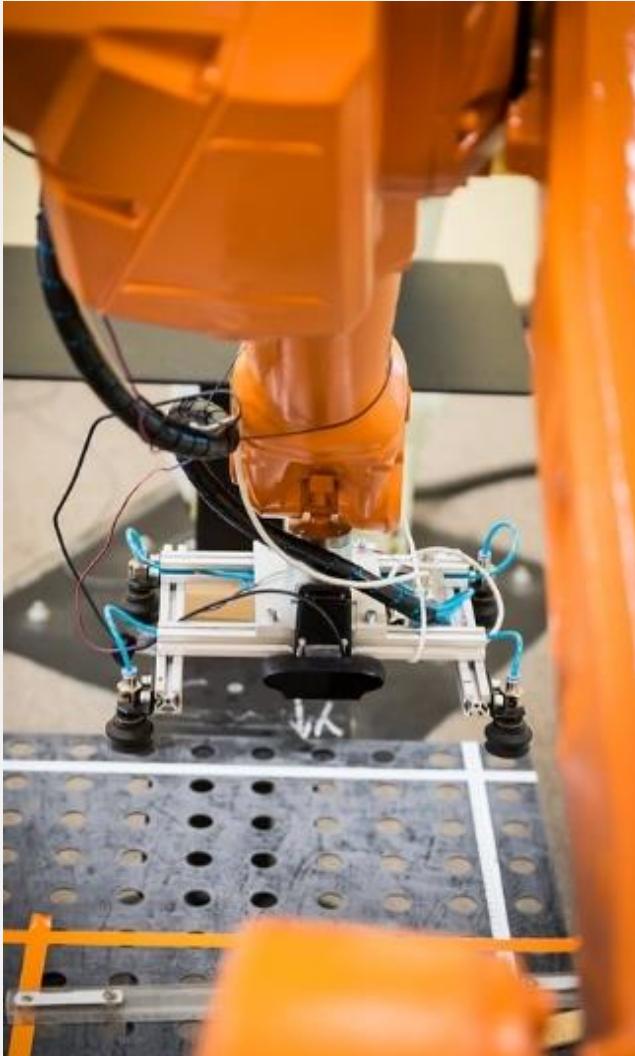


Image source: ↗ [Pixabay](#) (2019) / ↗ [CC0](#)

NY Times 1928

THE NEW YORK TIMES, SUNDAY, FEBRUARY 26, 1928.

XX 3

MARCH OF THE MACHINE MAKES IDLE HANDS

By EVANS CLARK.

A FEW days ago the General Motors Corporation reported the largest unemployment, amounting ever made by a single concern in the history of America. Three days later Governor Smith made public a report from the New York Industrial Commissioner which called public attention to serious un-

Prevalence of Unemployment With Greatly Increased Industrial Output Points to the Influence of Labor-Saving Devices as an Underlying Cause

have gone far to make construction a machine industry instead of a collection of hand trades. One tonne of concrete is now put up by two laborers. The hod-carrier has disappeared before the invasion of the material hoist. In concrete construction building materials are mixed, like dough, in a machine and literally poured into place without the

Zeit online, 2023

Künstliche Intelligenz

Wird mein Job bald überflüssig?

Bots können schreiben, malen, komponieren. Und das ist erst der Anfang. Künstliche Intelligenz könnte bald schon viele Jobs ersetzen. Vielleicht auch den unseres Autors?

1.1 Automation – Fact check: No Job Killer and Improves Livequality!

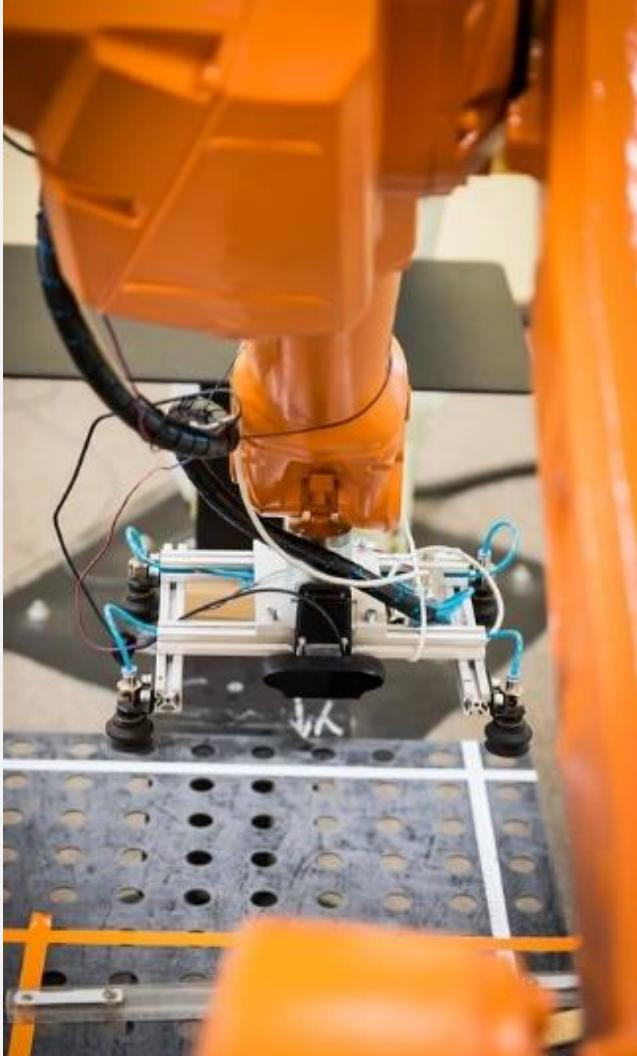


Image source: ↗ [Pixabay](#) (2019) / ↗ [CC0](#)

The Upside Of Automation: New Jobs, Increased Productivity And Changing Roles For Workers

Forbes, 2018

Künstliche Intelligenz

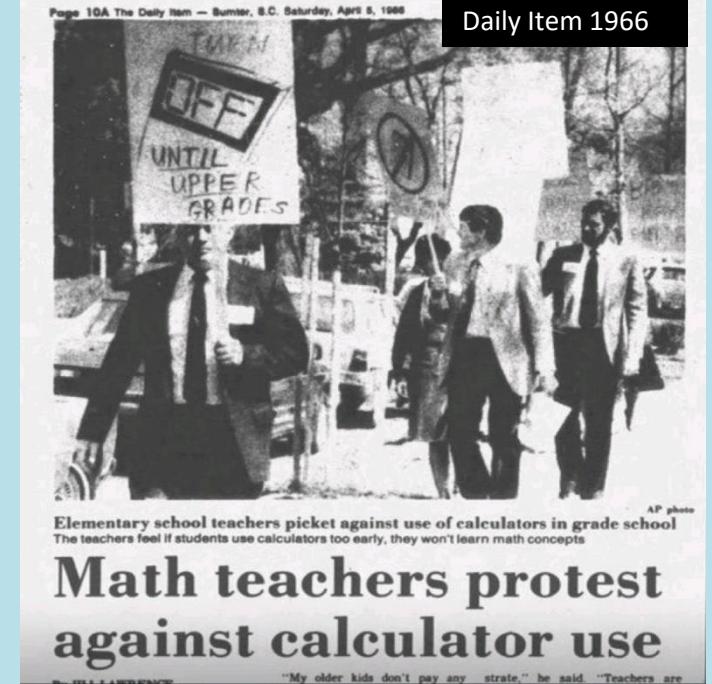
KI eher Jobmaschine als Jobkiller

von Frank Bethmann

ZDF, 2023

05.03.2023 08:59 Uhr

In bestimmten Bereichen wird Künstliche Intelligenz Jobs ersetzen, vor allem aber wird sie Jobs verändern. Gegenwärtig schafft KI in Deutschland jeden Monat Tausende neue Jobs.



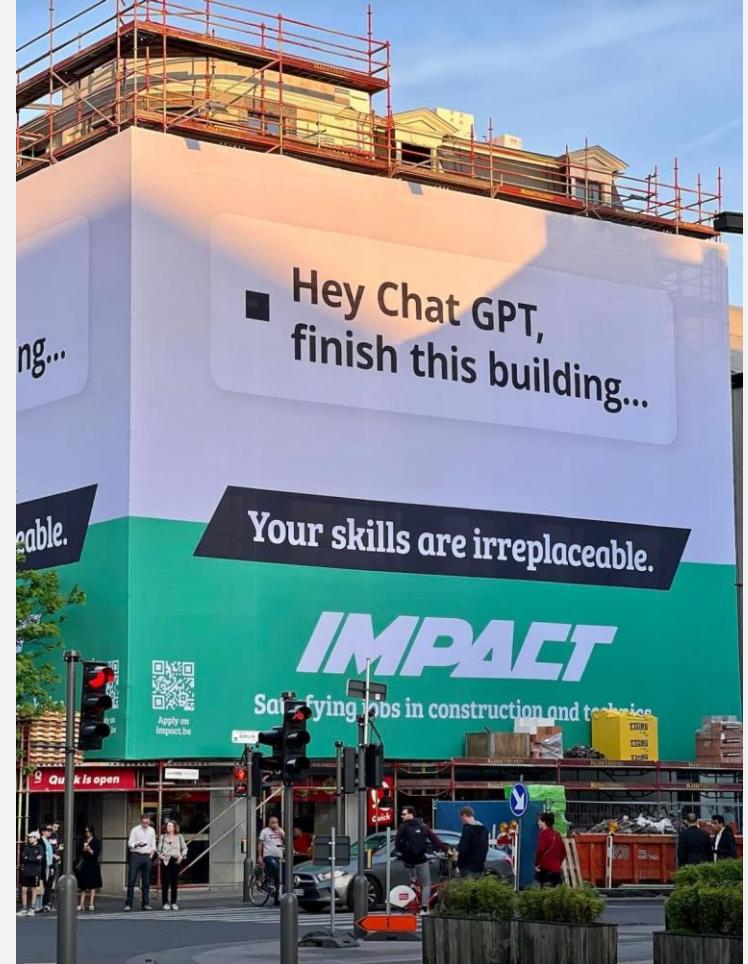
- Research on the impact of AI on the labor market suggests that monotonous jobs are replaced and new hybrid expert jobs are created. Current findings suggest that there is no relevant job loss due to AI (see e.g. Brynjolfsson & McAfee 2014).

Your turn!

Task

Please think for yourself:

- Where do you have contact with AI, and how does it make our everyday life easier?
- What is your personal opinion, how will AI influence the future work? What are potential risks and what are potential challenges?



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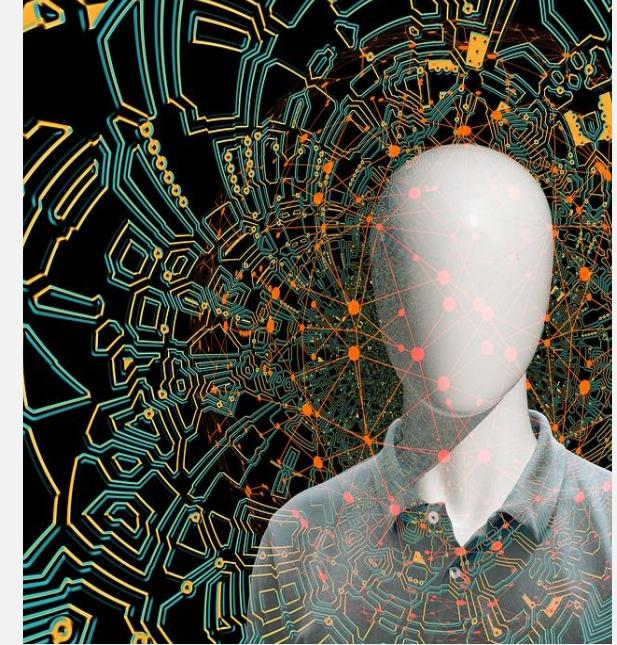


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1.2 Dartmouth Conference 1956



Image source: ↗ [Pixabay](#) (2019) / ↗ [CC0](#)



Image source ↗ [Hanover Main Street](#) (2015) by Ken Gallager / ↗ [CC BY-SA 3.0](#)



Image source: ↗ [Open Street Maps](#) (2019)

1.2 Dartmouth Conference (1956)



Image source: [↗ Pixabay](#) (2019) / [↗ CC0](#)

„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.“ – *Proposal Rockefeller Foundation*

Participants

Ray Solomonoff, Marvin Minsky, Claude Shannon, Trenchard More, Nat Rochester, Oliver Selfridge, Julian Bigelow, W. Ross Ashby, W.S. McCulloch, Abraham Robinson, Tom Etter, John Nash, David Sayre, Arthur Samuel, Kenneth R. Shoulders, Shoulders' friend, Alex Bernstein, Herbert Simon, Allen Newell

1.2 What is Artificial Intelligence (AI)?

D

Artificial Intelligence

The science and engineering of making intelligent machines, especially intelligent computer programs (McCarthy, 1956)

- Simulates human abilities such as the recognition of patterns, the solution of problems and the making of logical inferences
- Includes algorithms that learn from data and accurately predict future behavior
- Should in the future be able to make simple decisions for themselves and relieve, supplement and additionally enable people

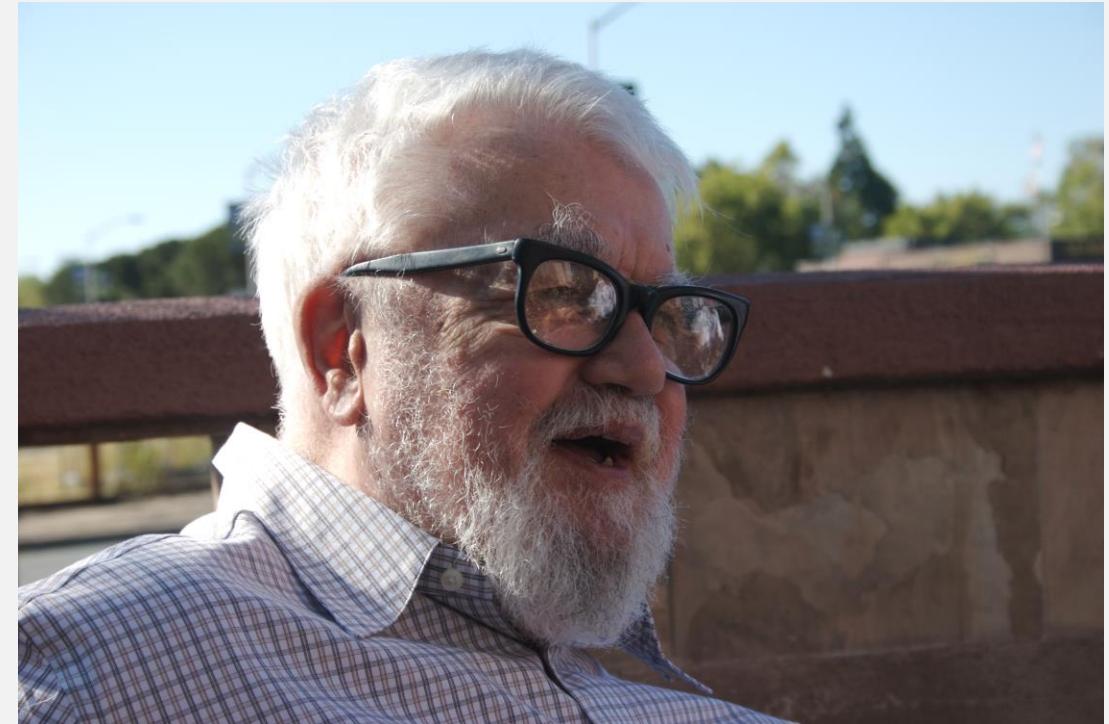


Image source: ↗ [John McCarthy](#) (2006) by null0 from ↗ [Flickr](#) / ↗ [CC-BY-SA-2.0](#)



What could be a potential problem of the definition of John McCarthy?

1.2 An Alternative Modern Approach...

**„Artificial Intelligence is
the study of how to make
computers do things
at which,
at the moment,
people are better“**

Elaine Rich (1991) – UT Austin



1.2 Different Research Perspectives on Intelligence in Artificial Intelligence

- Different research perspectives due to different understandings of intelligence (from Latin *intelligere* "understanding", literally "choosing between...")
 - What is intelligence in general?
 - How can we measure intelligence?
 - How does the brain “generate” intelligence?
- Two dimensions:
 - Thought processes/reasoning vs. behavior/action
 - Success according to human standards vs. success according to an ideal concept of intelligence rationality.

Systems that act like humans	Systems that act rationally
Systems that think like humans	Systems that think rationally

Adapted from Russell, S., & Norvig, P. (2016), p.2

1.2 Different Research Perspectives on Intelligence in Artificial Intelligence

Acting Humanly

- “The art of creating machines that perform functions that require intelligence when performed by people.” (Kurzweil, 1990)
- “The study of how to make computers do things at which, at the moment, people are better.” (Rich and Knight, 1991)

Acting Rationally

- “Computational Intelligence is the study of the design of intelligent agents.” (Poole et al., 1998)
- “AI . . . is concerned with intelligent behavior in artifacts.” (Nilsson, 1998)

Thinking Humanly

- “The exciting new effort to make computers think . . . *machines with minds*, in the full and literal sense.” (Haugeland, 1985)
- “[The automation of] activities that we associate with human thinking, activities such as decision-making, problem solving, learning . . .” (Bellman, 1978)

Thinking Rationally

- “The study of mental faculties through the use of computational models.” (Charniak and McDermott, 1985)
- “The study of the computations that make it possible to perceive, reason, and act.” (Winston, 1992)

Adapted from Russell, S., & Norvig, P. (2016), p.2

1.2 Possible Analogy to Intelligence Research

Acting Humanly ≈ Emotional Intelligence

- Feelings
- Empathie
- Harmony
- Motivation
- Synergie

Acting Rationally ≈ Methodical Intelligence

- Structure
- System
- Discipline
- Precision
- Safety

Thinking Humanly ≈ Creative Intelligence

- Imagination
- Innovation
- Visualization
- Intuition
- Creativity

Thinking Rationally ≈ Analytic Intelligence

- Critical analysis
- Strategic thinking
- Logic
- Objectivity

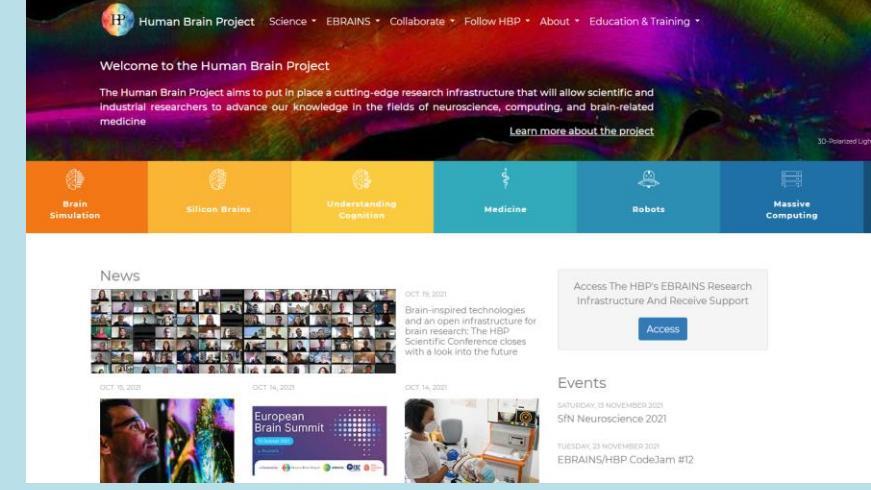
Adapted from Russell, S., & Norvig, P. (2016), p.2

1.2 AI Perspectives – Thinking Rationally

- Rationality is the idealized or “right” way of thinking
- Beginning with the Greek philosopher Aristotle, researchers have attempted to formalize the rules of rational thought by logic
- **Logicist perspective to AI:** describe problem in formal logical notation and apply general deduction procedures to solve it
- Problems with the logicist approach
 - Computational complexity of finding the solution
 - Describing real-world problems and knowledge in logical notation
 - A lot of intelligent or “rational” behavior has nothing to do with logic

1.2 AI Perspectives – Thinking Humanly

- Requires scientific theories of internal thinking (Mind-Body Problem!)
- **Cognitive** perspective: This type of research (cognitive science and neuroscience) are now distinct from artificial research due to complexity
- Problems with this approach
 - Computational complexity of finding the solution
 - Can a system understand itself?

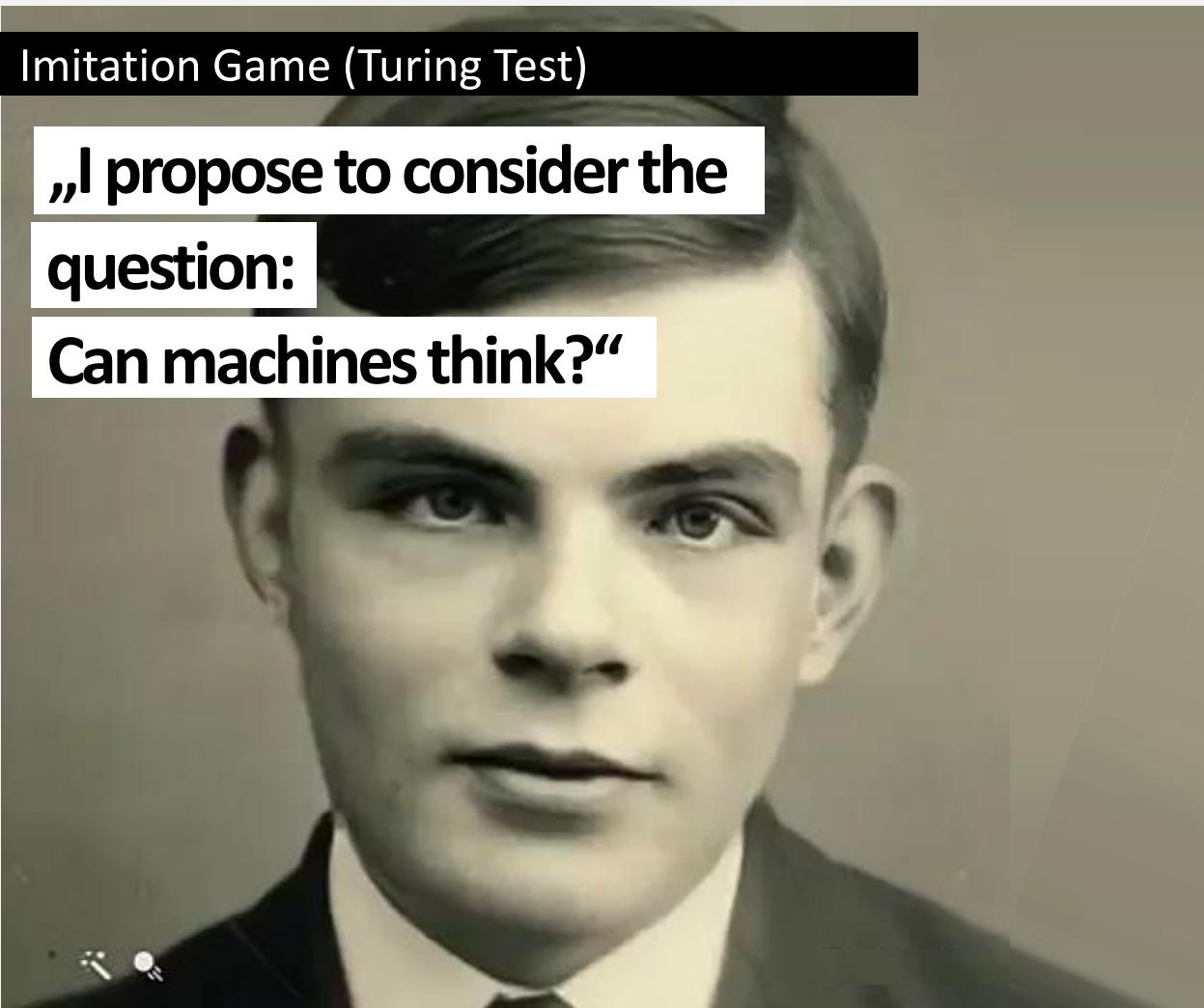


The screenshot shows the homepage of the Human Brain Project. At the top, there's a navigation bar with links for "Science", "EBRAINS", "Collaborate", "Follow HBP", "About", and "Education & Training". Below the navigation is a banner with the text "Welcome to the Human Brain Project" and a brief description of the project's goal: "The Human Brain Project aims to put in place a cutting-edge research infrastructure that will allow scientific and industrial researchers to advance our knowledge in the fields of neuroscience, computing, and brain-related medicine". There are six colored boxes below the banner representing different research areas: "Brain Simulation" (orange), "Silicon Brains" (yellow), "Understanding cognition" (light blue), "Medicine" (teal), "Robots" (purple), and "Massive Computing" (blue). Below these boxes, there are sections for "News" and "Events". The "News" section features a grid of thumbnail images from a conference, with dates like OCT 15, 2021, OCT 16, 2021, and OCT 14, 2021. The "Events" section lists "European Brain Summit" (SATURDAY, 13 NOVEMBER 2021) and "EBRAINS/HBP CodeJam #12" (TUESDAY, 23 NOVEMBER 2021). A call-to-action button "Access" is located on the right side of the news section. At the bottom left, there's a logo with an upward-pointing arrow inside a circle, followed by the text "Human Brain Project of the European Union" and the website URL "https://www.humanbrainproject.eu".

1.2 AI Perspectives – Acting Rationally

- A rational agent is one that acts to achieve the best expected outcome
 - Goals are application-dependent and are expressed in terms of the **utility of outcomes**
 - Being rational means **maximizing your expected utility**
 - In practice, utility optimization is subject to the agent's computational constraints (*bounded rationality* or *bounded optimality*)
- This definition of rationality only concerns the decisions/actions that are made, not the cognitive process behind them
- Rationality is only feasible in ideal environments
- Rationality is not a very good model of reality (see decision support literature)

1.2 AI Perspectives – Acting Humanly



- The Turing Test, proposed by Alan Turing (1950), was designed to provide a satisfactory operational definition of intelligence
 - A computer passes the test if a human interrogator, after posing some written questions, cannot tell whether the written responses come from a person or from a computer.
 - Turing predicted that by the year 2000, machines would be able to fool 30% of human judges for five minutes
- Turing Test meaningless due to Chinese room argument?

Jajal T (2018) | Image source: ↗ [Passport photo of Alan Turing at age 16](#) (1928?) / Public Domain

1.2 The Chinese Room Argument



Online available at Cogprints from University of Southampton: ↗ <http://cogprints.org>

Jajal T (2018); Searle J (1980) | Image source: ↗ [Pixabay](#) (2019) / ↗ [CC0](#)

Some potential problems with the Turing Test:

- Human behavior is not (always) intelligent (see decision support literature)
- Some intelligent behavior may not be human
- Human observers may be easy to fool

Chinese Room argument:

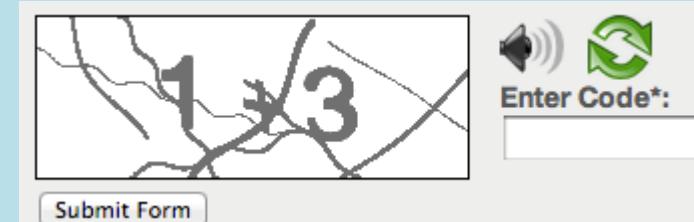
- one may simulate intelligence without having true intelligence

General Problem with these tests

- Results are not reproducible, constructive or amenable to mathematical analysis

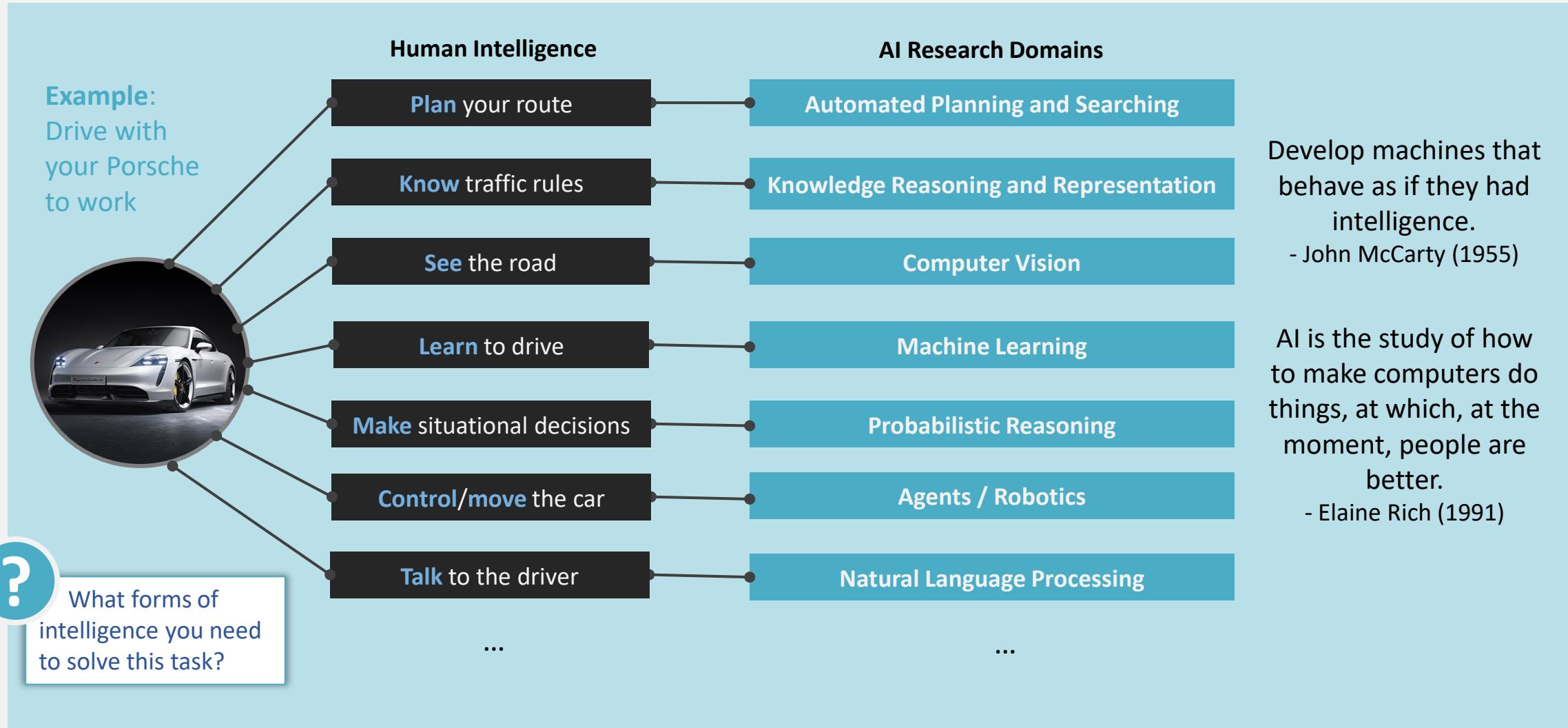
1.2 CAPTCHAs, or the Turing Test backwards

- Abbreviation of “Completely Automated Public Turing test to tell Computers and Humans Apart”
- We know that computers cannot pass a Turing test, hence we give them simple questions that can only be answered by humans
- Examples:



- Computers can't see and have to learn how to solve such tasks
- Computers can do the math, but don't understand the question

1.2 So What is Artificial Intelligence As Domain About?



1.2 AI Research Domains Map Directly to Our Lecture Chapters

Automated Planning and Searching



A machine gets the ability for an optimized automated planning or scheduling that leads to action sequences

Knowledge Reasoning and Representation



A machine gets the ability to represent knowledge and make inferences based on that knowledge.

Computer Vision



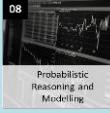
A machine gets the ability to interpret and understand visual information from the world.

Machine Learning



A machine gets the ability to learn from data and improve its performance over time without explicit programming.

Probabilistic Reasoning



A machine gets the ability to handle uncertainty and make decisions based on probabilities.

Agents / Robotics



A machine gets the ability to autonomously perform tasks in the physical world through interaction and movement.

Natural Language Processing



A machine gets the ability to understand, interpret, and generate human language.

1.2 Other Questions We Will Consider

- How can I replicate the algorithms and concepts (→ Crashcourse Programming with Python)
- Building real-life AI solutions (with Python)
- Preparing data for AI applications



- Should my AI kill the child or the old lady if my car loses control (ethics and AI, Chapter 11)
- General Intelligence: Achieving the full range of human cognitive abilities (= general AI or strong AI or full AI)
- Social Intelligence: A machine gets the ability to recognize, interpret, process, and simulate human affects



1.2 Different Conceptualizations of Real-Life Artificial Intelligence



1.2 Artificial Intelligence Today and Tomorrow

Today

„Artificial Narrow Intelligence“

- Operates within a pre-determined, pre-defined range, even if it appears to be much more sophisticated
- ChatGPT, Google assistant and translate, or Siri are examples of narrow AI

Jajal T (2018)



Image source: Dominik Jung (2019)

1.2 Artificial Intelligence Today and Tomorrow



Jajal T (2018) | Image source: ↗ [Pixabay](#) (2019) / ↗ [CC0](#)

Research

„General Artificial Intelligence“

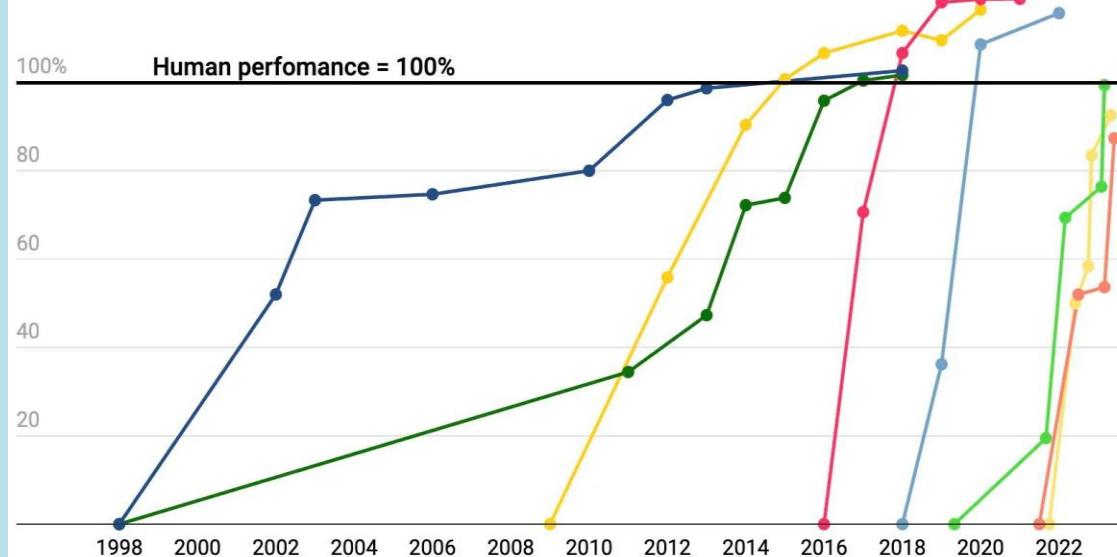
- Can successfully perform any intellectual task that a human being can (see research areas of artificial intelligence)
- Do Machines have the ability to think abstractly, creatively, strategize, and tap into our thoughts and memories to make informed decisions?

1.2 Artificial Intelligence vs. Humans Today

AI has surpassed humans at a number of tasks and the rate at which humans are being surpassed at new tasks is increasing

State-of-the-art AI performance on benchmarks, relative to human performance

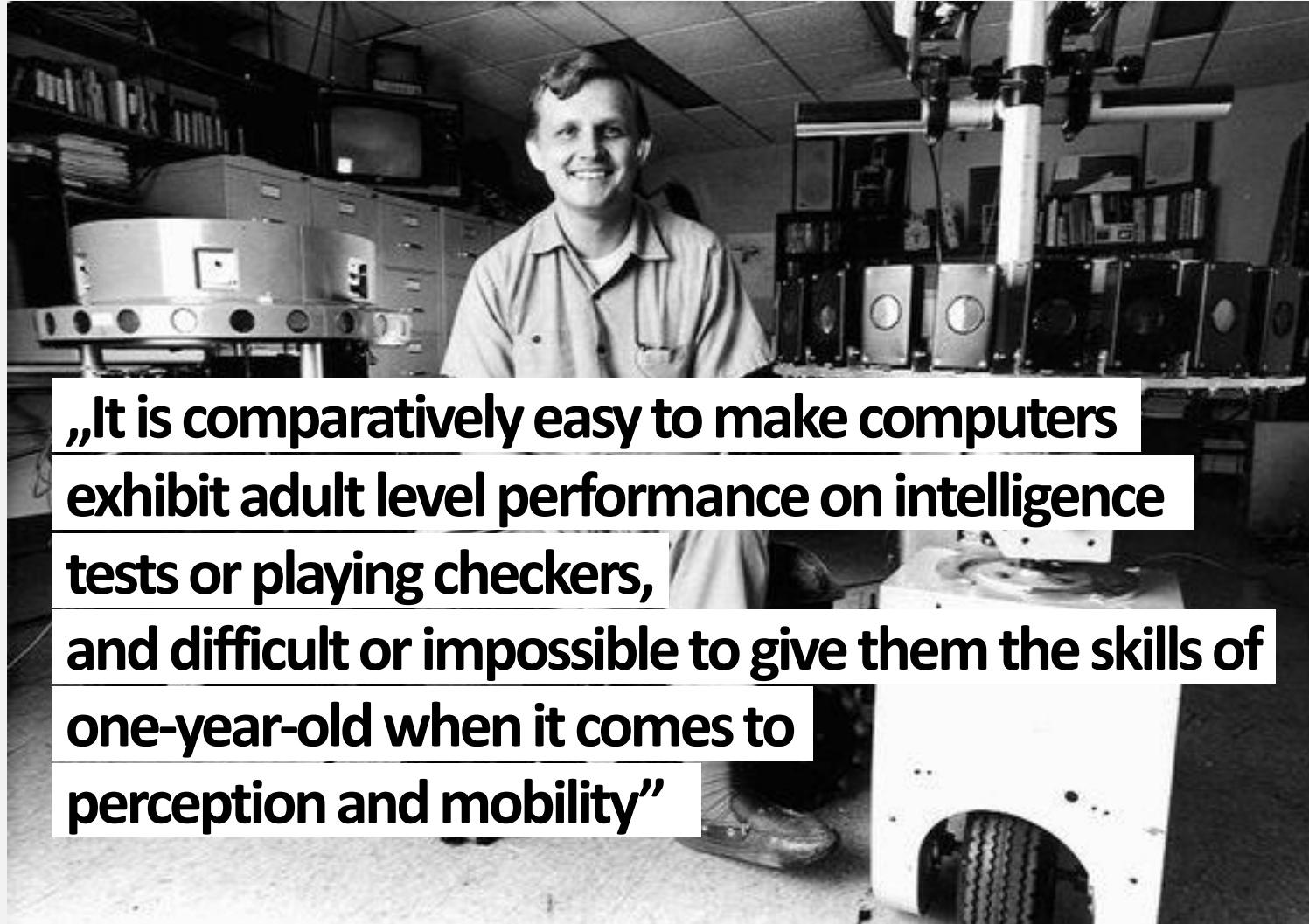
● Handwriting recognition ● Speech recognition ● Image recognition ● Reading comprehension
● Language understanding ● Common sense completion ● Grade school math ● Code generation



For each benchmark, the maximally performing baseline reported in the benchmark paper is taken as the "starting point", which is set at 0%. Human performance number is set at 100%. Handwriting recognition = MNIST, Language understanding = GLUE, Image recognition = ImageNet, Reading comprehension = SQuAD 1.1, Reading comprehension = SQuAD 2.0, Speech recognition = Switchboard, Grade school math = GSK8k, Common sense completion = HellaSwag, Code generation = HumanEval.

- Artificial Intelligence outperforms humans today in many specific tasks and there are first agents that combine these abilities (e.g. chatgpt)
- The work of Wei et al. (2022) raises the question if these agents have "emergent abilities".
- However, these findings have been disproved, see e.g. Schaeffer et al. (2023)

1.2 Moravec's Paradox



„It is comparatively easy to make computers exhibit adult level performance on intelligence tests or playing checkers, and difficult or impossible to give them the skills of one-year-old when it comes to perception and mobility“

Image source: ↗ [Museum of Computer History](#) (1990)

- Early AI researchers concentrated on the tasks that (male) scientists found the most challenging, abilities of animals and two-year-olds were overlooked
- We are least conscious of what our brain does the best
- Sensorimotor skills took millions of years to evolve
- Our brains were not designed for abstract thinking

Science Fiction

„Super Artificial Intelligence“

- Oxford philosopher Nick Bostrom: “any intellect that greatly exceeds the cognitive performance of humans in virtually all domains of interest”
- Surpass human intelligence in all aspects

Wake up Neo
The Matrix has you...
Follow the white rabbit
Knock knock Neo.

1.2 Artificial Intelligence Today and Tomorrow

Today

„Artificial Narrow Intelligence“

- Operates within a pre-determined, pre-defined range, even if it appears to be much more sophisticated
- Google assistant, google translate, Siri are examples of narrow AI

Research

„General Artificial Intelligence“

- Can successfully perform any intellectual task that a human being can
- So far: Machines have not the ability to think abstractly, creatively, strategize, and tap into our thoughts and memories to make informed decisions

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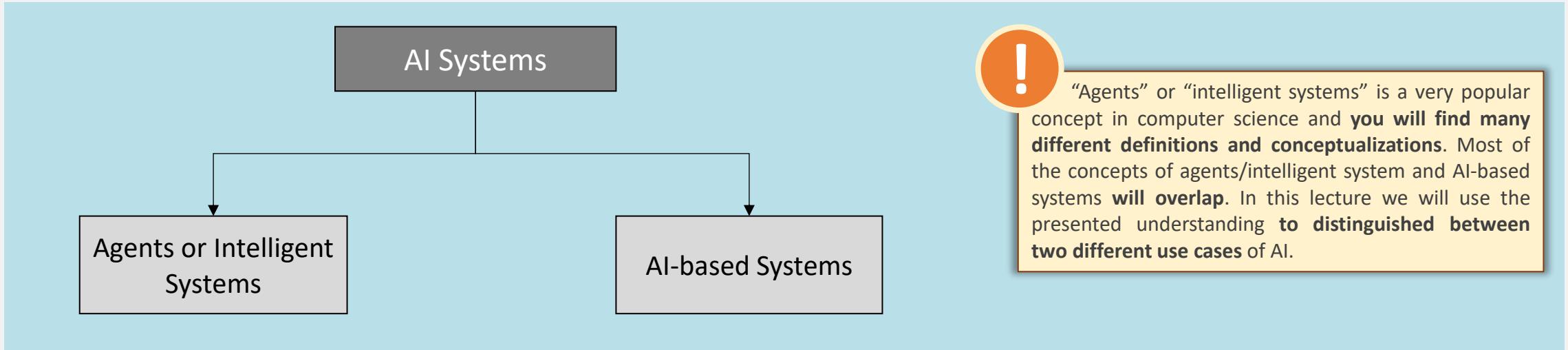
AI will be used as a supporter and partly as a decision maker, but will not make people obsolete.

1.1 Foundations of AI Research

- **Different fields have contributed to AI in the form of ideas, viewpoints and techniques:**
 - Philosophy: Logic, reasoning, mind as a physical system, foundations of learning, language and rationality
 - Mathematics: Formal representation and proof algorithms, computation, (un)decidability, (in)tractability, probability
 - Psychology: adaptation, phenomena of perception and motor control
 - Economics: formal theory of rational decisions, game theory
 - Linguistics: knowledge representation, grammar
 - Neuroscience: physical substrate for mental activities
 - Cybernetics and control theory: homeostatic systems, stability, optimal agent design

Adapted from Russell, S., & Norvig, P. (2016), p.2

1.2 Two Different Use Cases for AI in Computer Science



Agents (or „intelligent“ systems)

- Use AI as autonomous entity acting intelligent (achieving specific goals) embedded in an environment
- **Examples:** factory robot, chatbot, trading bot, fraud detection agent etc.

AI-based System

- Use AI in a computer system integrating AI-based components or methods for a specific purpose
- **Examples:** expert systems, decision support systems, planning systems, diagnosis system etc.

1.2 Special Use Case: Business Informatics

The screenshot shows the homepage of the BISE Journal. At the top, there are logos for BISE, Gesellschaft für Informatik (GI), and INFORMS. Below the header, a navigation bar includes links for BISE Journal, Call For Papers, For Authors, For Editors and Reviewers, Community, and WUM. The main content area features a heading '01/2021 – AI-Based Information Systems' and a sub-headline 'Published : 08.07.2019 | Categories: Call For Papers'. A section titled 'Special Issue' discusses the impact of Artificial Intelligence (AI) on business and society, mentioning US economist Erik Brynjolfsson and the Massachusetts Institute of Technology.

The screenshot shows the AIS eLibrary website. The header includes the AIS logo and the text 'Serving society in the advancement of excellence in the study and practice of informatics'. Below the header is a navigation menu with links for Login, Home, Join AIS, JAIS, CAIS, TRR, THCI, and MISQE. The main content area shows the URL 'Home > Other Conferences > Wirtschaftsinformatik > Wi 2021 > Track 10'. To the right, there is a graphic of a stylized 'WI' and the text 'TRACK 10: DESIGN, MANAGEMENT AND IMPACT OF AI-BASED SYSTEMS'.

AI-based Information Systems in Business and Organizational Context

- How do individuals and societies react to intelligent machines which outperform their human counterparts? For instance, what is the impact on HR management and educational institutions?
- How do emerging technologies affect labor markets and jurisdictions? Should new regulations be introduced?
- What are AI's possible effects on organizational governance and hierarchy, structure, and processes? Are current managerial models, strategy development, and quality management techniques still applicable?
- Which behavioral, ethical, and societal issues are bound to arise from increased AI use and how can these be countered?

1.2 Classroom Task

Your turn!

Task

Please discuss with your neighbors:

- What is AI? What are characteristics and abilities that can emerge in “intelligence”?
- Which of these abilities needs an artificial intelligence to pass the imitation game?

Task

Consider the case of the French Scrabble champion Nigel Richards, who memorized every French word in the French dictionary and won the French Scrabble championship without speaking any French. Would be an AI doing the same be intelligent?

The screenshot shows a news article from The Guardian. The header includes navigation links for News, Opinion, Sport, Culture, Lifestyle, and a menu icon. Below the header, there are links for World, Europe, US, Americas, Asia, Australia, Middle East, Africa, Inequality, and Global development. The main headline is "The French Scrabble champion who doesn't speak French". A sub-headline states: "New Zealander Nigel Richards racks up remarkable victory after reportedly memorising francophone Scrabble dictionary in nine weeks". A photo of a man with a long beard and glasses is displayed. The article is attributed to "Kim Willsher in Paris" and published on "Tue 21 Jul 2015 19.39 CEST". It has 395 shares. A yellow banner at the top right indicates the article is "more than 9 years old". On the right side of the page, there is an advertisement for "FeWo-direkt" showing a terrace with a table and chairs.

<https://www.theguardian.com/lifeandstyle/2015/jul/21/new-french-scrabble-champion-nigel-richards-doesnt-speak-french>

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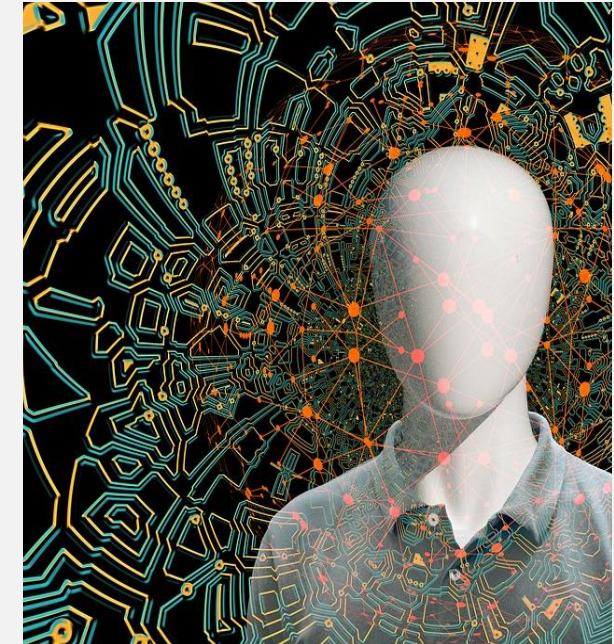


Image source: [↗ Pixabay](#) (2019) / [↗ CC0](#)

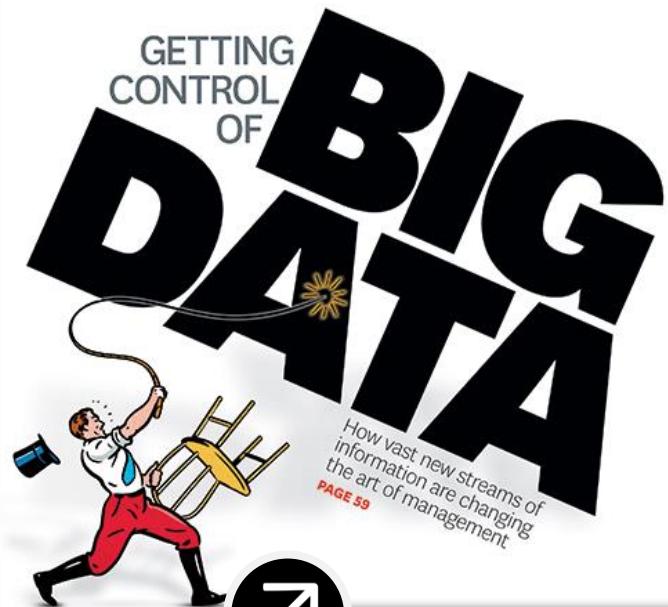
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Harvard Business Review



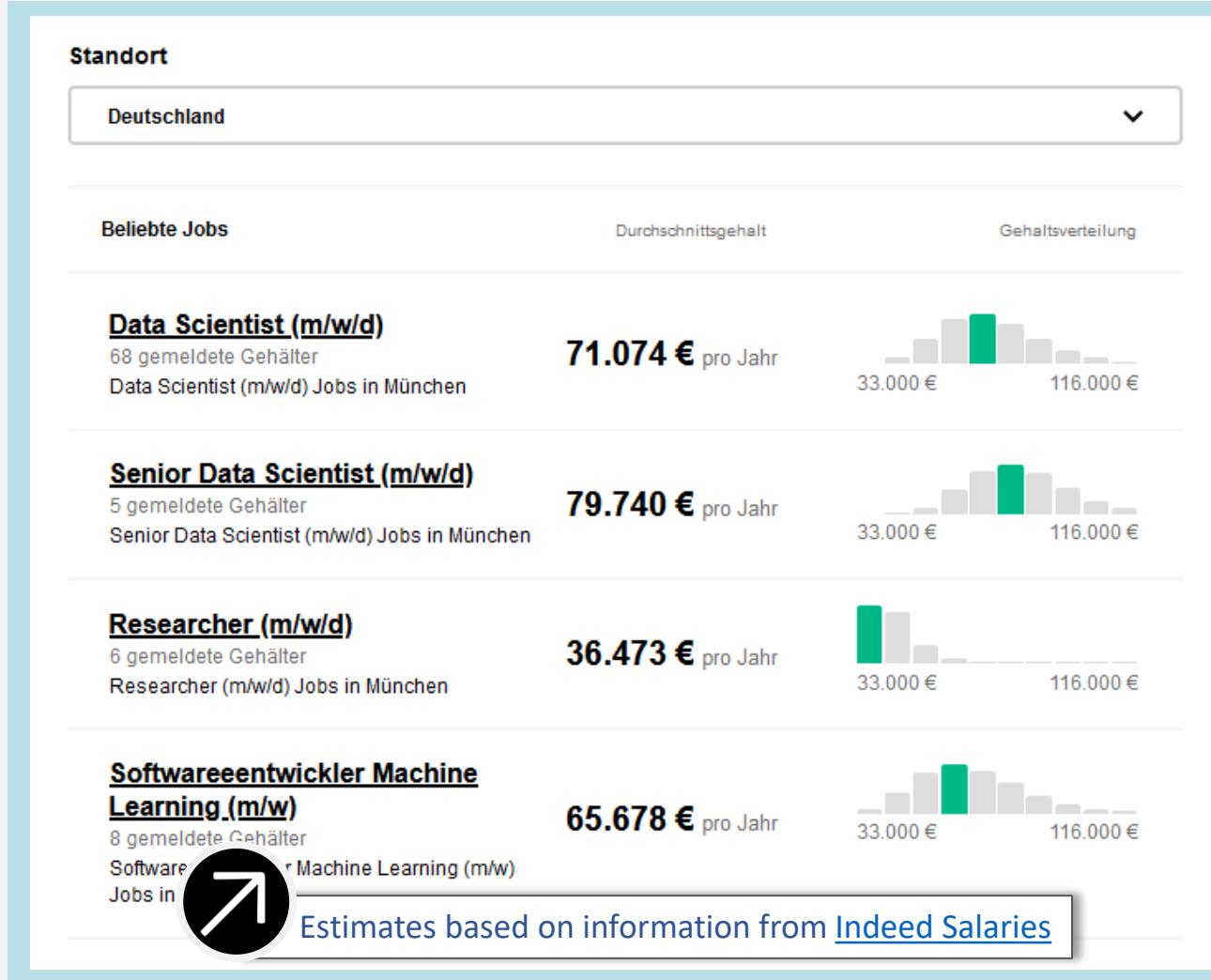
<https://hbr.org/2012/10/data-scientist-the-sexiest-job-of-the-21st-century>

Data Scientist: The Sexiest Job of the 21st Century

Thomas H. Davenport and D.J. Patil

“The shortage of data scientists is becoming a serious constraint in some sectors.”

1.3 How is the Job Situation? What Can You Expect to Earn? (2020!)



- **Various factors influence the starting salary:** size of the company, location, industry, degree and professional experience all play a role.
- **Internships or experience** gained through a working student job are good prerequisites for a higher starting salary

1.3 Industry in Germany is Looking for AI and Data Science Skills

COMPUTERWOCHE

IT-Gehälter 2024: Der Gehaltsvergleich in der Informatik

KI ersetzt keine Berufserfahrung

Wie in anderen Berufsgruppen auch, wirkten sich die Entwicklungen im Bereich der Künstlichen Intelligenz auf die Art der Arbeit im IT-Umfeld aus. Verschiedene Studien legen nahe, dass große Teile der Arbeit im IT-Bereich automatisiert werden könnte. Allerdings gelte das vor allem für repetitive Tätigkeiten und Einstiegskompetenzen. "Berufserfahrung und Führungskompetenzen bleibt nach wie vor wichtig und sind so gut wie nicht automatisierbar – was sich wiederum in höheren Gehältern niederschlägt", weiß Stahl.

Im Beruferanking unter erfahrenen Fachkräften mit drei bis sechs Jahren Berufserfahrung beziehen Softwarearchitekten mit rund 73.000 Euro das höchste Gehalt. Auf Platz zwei folgen die Data Scientists mit rund 71.500 Euro im Jahr, dann die IT-Security-Experten mit 69.000 Euro und dahinter die SAP-Berater mit ca. 64.000 Euro Jahresgehalt.

Source: Computer Woche (2024), <https://www.computerwoche.de/article/2728533/der-grosse-gehaltsvergleich-in-der-informatik.html>

1.3 Research Jobs for AI Specialists



- PhD in AI topics (e.g. computer science) has a positive influence on the starting salary
- However, in the course of a career, **practical knowledge** and **project experience** are more important, so that the salaries of doctoral candidates and employees **without a doctorate are at a similar level later in the job**
- However, an AI research career will be impossible without a **PhD**.

THE EXPANDING UNIVERSE OF MODERN AI

"THE BIG BANG"

Big Data
Algorithms
GPU

Berkeley
Carnegie Mellon University
DEEPMIND
MIT
NYU
OpenAI
Université de Montréal
UNIVERSITY OF OXFORD
UNIVERSITY OF TORONTO

RESEARCH

Preferred Networks
facebook
Google
Microsoft
NVIDIA
PyTorch
TensorFlow
Theano
Berkeley
Caffe
CNTK
University of Oxford
University of Montreal
University of Toronto
Chainer
theano

FRAMEWORKS

AI-as-a-PLATFORM

Amazon web services
Azure
Google
IBM Watson

START-UPS

api.ai
Personal Assistants
conversational interface
drive.ai
Automotive
computer vision
nervana
Tech
AI-as-a-service
SADAKO
Waste Management
sorting robots
MetaMind
eCommerce & Medical
recommendation engines
BLUE RIVER TECHNOLOGY
Agriculture
crop-yield optimization
clarifai
Tech
visual recognition platform
Morpho
Tech
computer vision
SocialEyes*
Medical
diabetic retinopathy
Orbital Insight
Geospatial
predictions from images
deep genomics
Genomics
genetic interpretation
Orbital Insight
Education
teaching robots

4,000+ AI START-UPS

\$33B IN FUNDING

Source: Crunchbase & Pitchbook

INDUSTRY LEADERS

SIEMENS
Ford
TARGET
TESLA
gsk
Audi
Alibaba.com
AstraZeneca
BAIDU
Bloomberg
MASSACHUSETTS GENERAL HOSPITAL
Mercedes-Benz
charles SCHWAB
VOLVO
MERCK
Walmart
Pinterest
YAHOO
Schlumberger
Yandex
yelp

Source: NVIDIA Accelerated Computing Workshop @LRZ

1.3 Job Profiles in AI (Examples)

AI Specialist

- Professional responsible for AI related topics at companies
- Designing, developing and maintaining simple AI related solutions
- Product owner in AI-related projects

Data Engineer

- Models scalable database and data flow architectures
- Develops and improves the IT infrastructure on the hardware and software side
- Deals with topics such as IT Security , Data Security and Data Protection

Data Scientist

- AI-Expert responsible for collecting, analyzing and interpreting extremely large amounts of data
- The role is an offshoot of several traditional technical roles, including mathematician, scientist, statistician and computer professional

Robotics Scientist

- Engineer responsible for implementing intelligent robots
- Bridge between mechanical engineering, electrical engineering, computer science

Business Data Analyst / BI Developer

- Designing, developing and maintaining business intelligence solutions
- Crafting and executing queries upon request for data
- Presenting information through reports and visualization

Machine Learning Engineer

- Engineer responsible for implementing intelligent robots
- Bridge between mechanical engineering, electrical engineering, computer science

AI Research Scientist

- Works mostly for universities or big companies
- Passionately drive and further advance innovations in the field of computer vision

AI Product Owner

- Defining the vision and strategy of AI-driven products
- Ensuring that the development team creates solutions that meet business goals and user needs.

...

1.3 Example CV - Yann LeCun



LinkedIn profile icon

Facebook profile icon

Pierre and Marie Curie University logo

Yann LeCun · 3rd

VP & Chief AI Scientist at Meta

Top Voice

New York, New York, United States · [Contact info](#)

LinkedIn icon

Facebook icon

Pierre and Marie Curie University logo

Bell icon

1.3 Example CV - Andrew Ng



Andrew Ng · 3rd

Founder of DeepLearning.AI; Managing General Partner of AI Fund;
Exec Chairman of Landing AI

Top Voice



DeepLearning.AI



University of California,
Berkeley



Your turn!

Task

As part of your focus on the field of AI in your studies, I would like you to research the current job market for AI-related roles. Identify the key skills, qualifications, and experience that employers are looking for in AI professionals. Then, compare these requirements with your current curriculum and skillset.

Consider the following questions:

- Which areas of your curriculum align with the job market demands?
- What gaps do you see in your knowledge or skills?
- Are there specific skills you need to focus on to enhance your employability in AI?

Feel free to come to me after the lecture for personalized advice on how to deepen your expertise or address any gaps. You are also welcome to share any questions or suggestions for future lectures, and I will do my best to incorporate them.

Workbook Exercises

- Please read the chapter 1.1-1.2, 26 and 27 from the course book of Russel S. & Norvig P. to understand the origins and historical backgrounds of AI. Then work through the exercises 1.1, 1.3 – 1.15. You can skip the parts about „agents“, we will handle this topic in the next chapter.
- Take a look at the different AI job profiles in this lecture and search for related current job positions in the internet. Compare the job requirements with the content of the syllabus. Make yourself a list with things you want to learn for AI jobs you are interested in. At the end of the lecture check if you learnt all the stuff you want to learn – if something is missing write me an email with the content you would like to see in the future in this lecture.
- Please solve the last task of chapter 1.3 until next time.

Coding Exercises

- *Coding exercises start after lecture 3*

Further reading

- I strongly recommend the article from François Chollet about how AI works ↗ <https://www.heise.de/news/KI-Experten-Investitionen-in-KI-um-ein-Tausendfaches-zu-hoch-9674984.html>.

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3. LinkedIn (2020): The jobs of tomorrow. Online available at <https://blog.linkedin.com/2019/december/10/the-jobs-of-tomorrow-linkedin-s-2020-emerging-jobs-report>

Images

All images that were not marked other ways are made by myself, or licensed ↗[CC0](#) from ↗[Pixabay](#).

Conferences

- Biennial International Joint Conference on AI (IJCAI)
- Annual National Conference on AI (AAAI)
- Biennial European Conference on AI (ECAI)

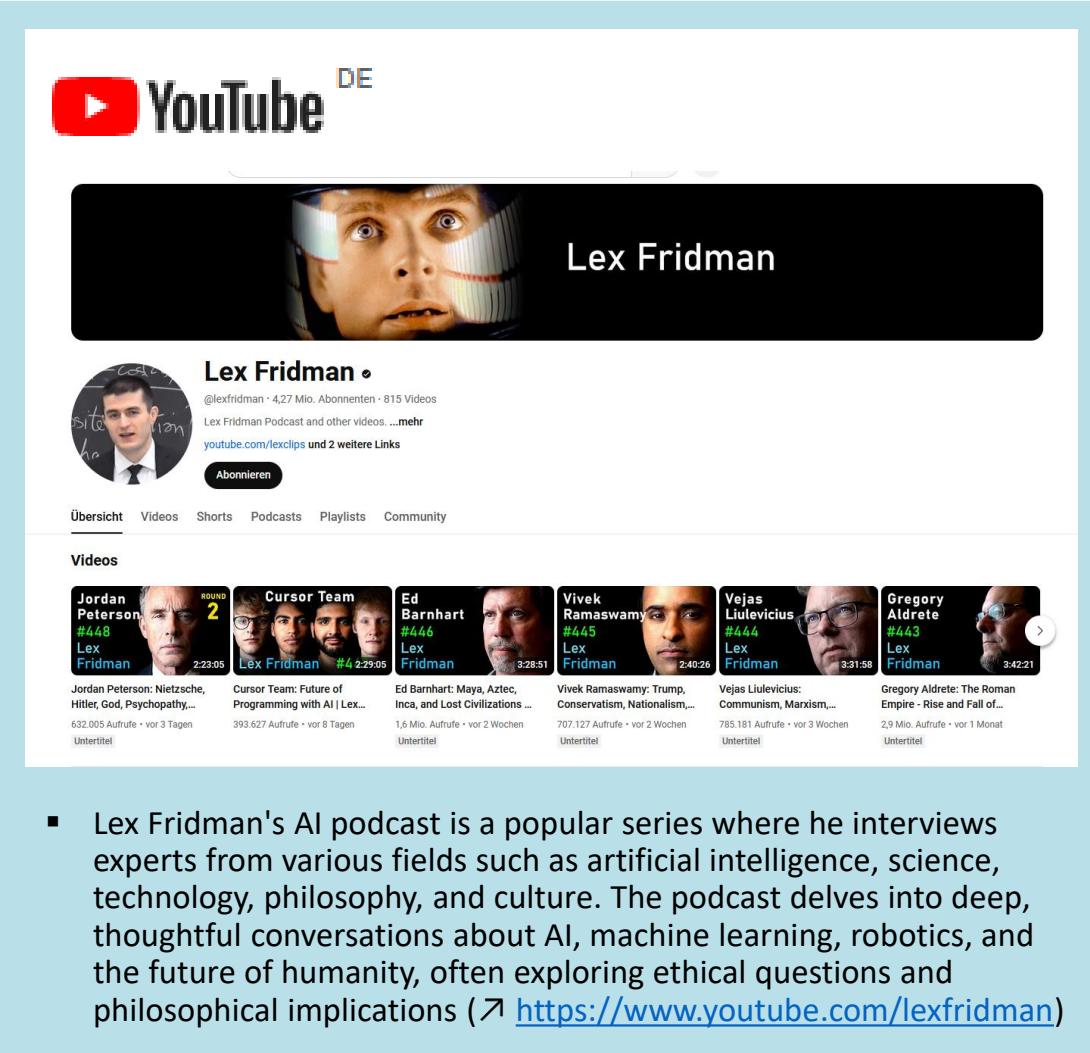
Journals

- Artificial Intelligence (Elsevier)
- Computational Intelligence
- Journal of Artificial Intelligence Research, pioneered free on-line publication (<http://www.jair.org>)
- IEEE Transactions on Pattern Analysis and Machine Intelligence

Since the 1980s various subfields emerged, joined forces with related fields. Many journals and annual conferences in subareas like e.g.

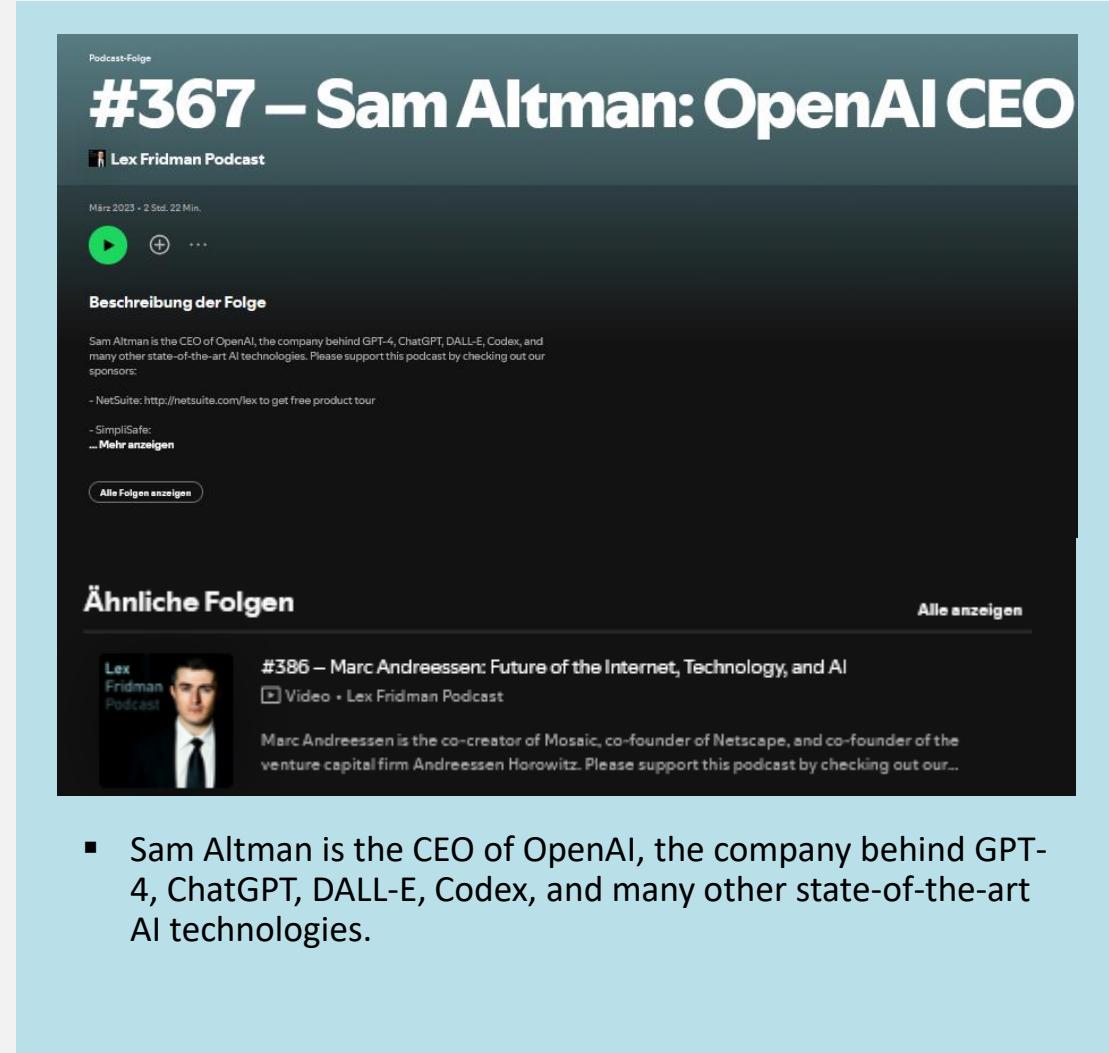
- Conference on Neural Information Processing Systems (NIPS or NeurIPS)

Lex Fridman Podcast Series About IT and AI



The screenshot shows Lex Fridman's YouTube channel page. At the top is a video thumbnail for "Lex Fridman" featuring him with a shocked expression. Below it is his channel profile picture, a banner with his name, and a "Subscribed" button. The main content area shows a grid of video thumbnails for various episodes, each with the episode number, title, and duration. Below the grid are links to his channel stats and a navigation bar with "Übersicht", "Videos", "Shorts", "Podcasts", "Playlists", and "Community".

- Lex Fridman's AI podcast is a popular series where he interviews experts from various fields such as artificial intelligence, science, technology, philosophy, and culture. The podcast delves into deep, thoughtful conversations about AI, machine learning, robotics, and the future of humanity, often exploring ethical questions and philosophical implications (↗ <https://www.youtube.com/lexfridman>)



The screenshot shows a specific podcast episode page for Lex Fridman. The title is "#367 – Sam Altman: OpenAI CEO". It includes a play button, episode details (March 2023, 2 Std. 22 Min.), and a description: "Sam Altman is the CEO of OpenAI, the company behind GPT-4, ChatGPT, DALL-E, Codex, and many other state-of-the-art AI technologies. Please support this podcast by checking out our sponsors: NetSuite, SimpliSafe, ...". Below the description are links to "Alle Folgen anzeigen" and "Ähnliche Folgen". A sidebar on the right shows a preview of another episode: "#386 – Marc Andreessen: Future of the Internet, Technology, and AI".

- Sam Altman is the CEO of OpenAI, the company behind GPT-4, ChatGPT, DALL-E, Codex, and many other state-of-the-art AI technologies.



Frankfurter Allgemeine
ZEITUNG FAZ.NET

Podcast für Deutschland Frühdenker Machtprobe Einspruch Wissen D:ECONOMY Beruf Finanzen Gesundheit Abo



F.A.Z. Podcast Künstliche Intelligenz

TE 1 / 2



PODCAST KÜNSTLICHE INTELLIGENZ
Wie Cyberkriminelle KI-Modelle für ihre Angriffe nutzen
André Loske, Chief Information Security Officer der Knauf Gruppe, erklärt.

1 2 → NÄCHSTE SEITE →

- In the podcast "Artificial Intelligence" Peter Buxmann and Holger Schmidt talk with guests about fields of application of artificial intelligence in companies and the development of new data-driven business models (↗ www.faz.net)



FRANKFURTER ALLGEMEINE
PODCAST KÜNSTLICHE INTELLIGENZ

KI im Aftersales

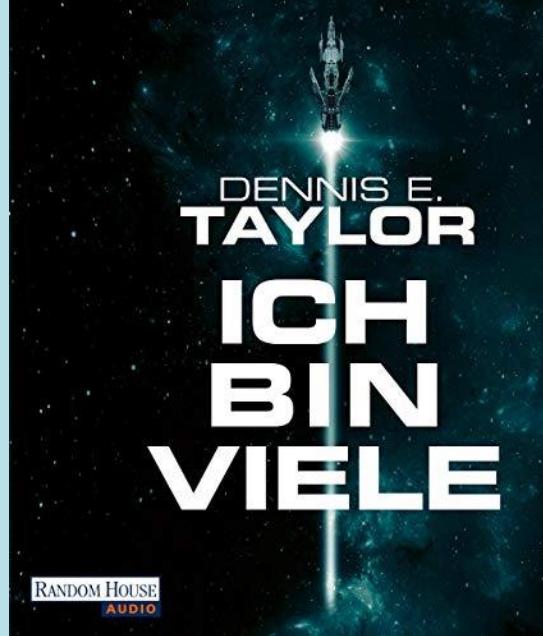
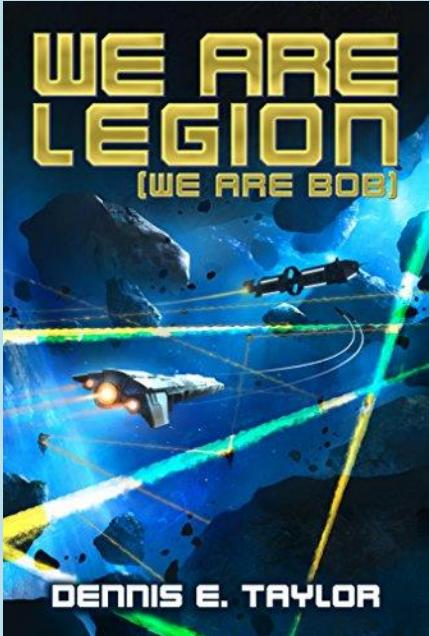
Fehler besser finden, Werkstattbesuche besser planen und mehr: Was die Computer im Auto schon können – und was noch möglich ist.



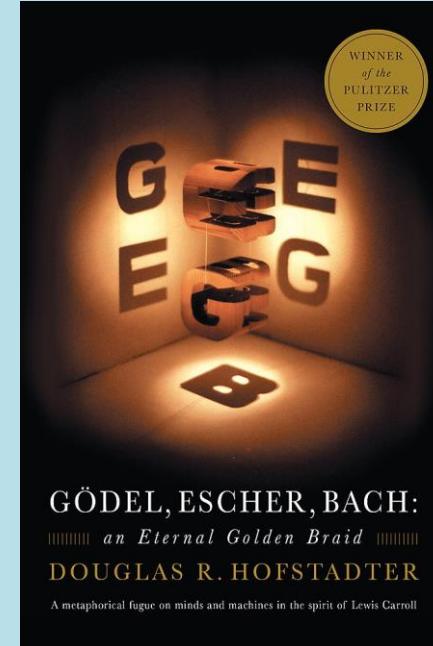
Prof. Dr. Peter Buxmann Dr. Holger Schmidt Prof. Dr. Stefan Lutz Dr. Dominik Jung

- Finding faults better, planning workshop visits better and more: what the computers in the car can already do - and what is still possible. (↗ www.faz.net/ki-wettbewerbsvorteil-fuer-auto-konzerne)

Non-Scientific Book/Movie Recommendations



- We are Legion, we are Bob - Dennis F Taylor ([↗ Amazon](#))
- Ich bin viele - Dennis F Taylor ([↗ Amazon](#))



GÖDEL, ESCHER, BACH:
an Eternal Golden Braid
DOUGLAS R. HOFSTADTER

A metaphorical fugue on minds and machines in the spirit of Lewis Carroll



- Gödel, Escher, Bach: An Eternal Golden Braid - Douglas R Hofstadter ([↗ Amazon](#))
- Gödel, Escher, Bach: Ein Endloses Geflochtes Band - Douglas R Hofstadter ([↗ Amazon](#))

Artificial Intelligence	<i>The science and engineering of making intelligent machines, especially intelligent computer programs (McCarthy, 1956/2007)</i>
CRISP-DM	<i>Cross-industry standard process for data-mining. The defacto standard framework for analytics and AI in industry.</i>
Dartmouth Conference	<i>Popular conference which gave rise of artificial intelligence as a research field</i>
Knowledge Reasoning	<i>Automation of simple, repetitive activities in information systems on the basis of known, defined rules</i>
Knowledge-based System	<i>An expert system or knowledge-based system is one that solves problems by applying knowledge that has been garnered from one or more experts in a field (Norvig, 1992)</i>
Machine Learning	<i>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’. (Mitchel, 2011); Automation and support of individual human tasks based on data</i>

