南方科技大学

STA303: Artificial Intelligence

Introduction

Fang Kong

https://fangkongx.github.io/Teaching/STA303/Fall2025/index.html

Slide credits: ai.berkeley.edu

Self introduction

- Position
  - Assistant professor at the department of statistics and data science
- Education
  - Shanghai Jiao Tong University, PhD in computer science
  - Shandong University, bachelor's degree in software engineering
- Research experience
  - CUHK, Tencent, MSRA, Alibaba Damo Academy…
- Office hour
  - 13:00-15:00, every Wednesday @ Room 315, Business School Building

How am I related to AI?

- Research Interests
  - Interactive machine learning
    - Bandit algorithms
    - Reinforcement learning
- Have published 10+ papers on top AI conferences ICML/NeurIPS/ICLR/COLT…
- Also the reviewer for ICML/NeurIPS/ICLR…

- Was recipient of Baidu Scholarship 2023
  - 10 graduate students worldwide in the field of AI

Course staff

- Lab Instructor
  - Fang Kong (孔芳)
  - Anqi Song (宋安琪)
  - Email: songaq@sustech.edu.cn
  - Research on parallel computing
  - Office hour: Wed 10:00-12:00

Course staff

- Teaching assistants
  - Bochao Li (李伯超)
  - Email: 12531179@mail.sustech.edu.cn
  - 1 year PhD student
  - Office hour: Wednesday 10:20 - 12:00
  - Minghan Wang(汪名翰)
  - Email: 12532247@mail.sustech.edu.cn
  - 1st year MSc student
  - Office hour: Wednesday 10:00-12:00
  - Kongchang Zhou(周孔畅)
  - Email: 12548015@mail.sustech.edu.cn
  - 1st year MSc student
  - Office hour: Wednesday 10:00-12:00

Grading

- Attendance (5%)
- Assignments (40%)
  - About 5 written & 5 programming assignments
- Project (25%)
- Final Exam (30%)

- Discount for late submissions
  - Final score = original score * (1 – 0.1*number of days late)
  - Submissions more than 5 days late will not be accepted

References

- CS188 Introduction to Artificial Intelligence
  - by Berkeley
- Artificial Intelligence: A Modern Approach
  - by Stuart Russell and Peter Norvig
- Reinforcement Learning: An Introduction
  - by Richard S. Sutton and Andrew G. Barto
- CS229 Machine Learning
  - by Stanford

Resources

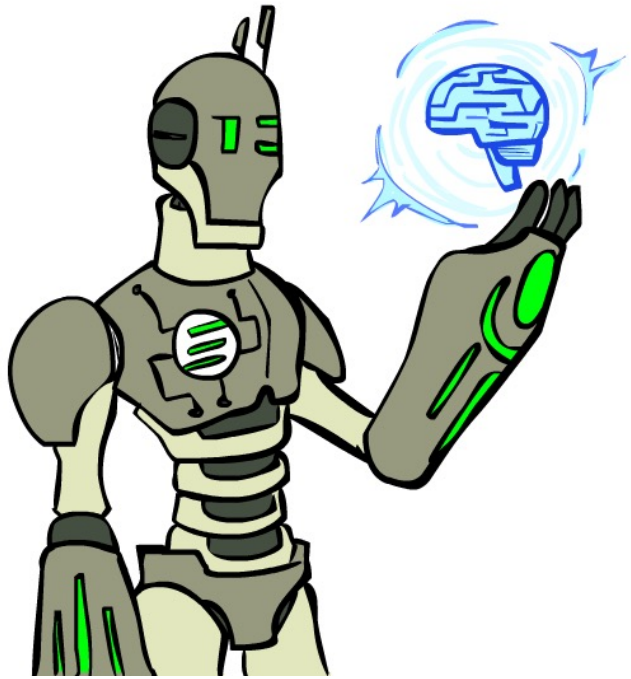
- Blackboard:
  - All resources (announcements, slides, assignments, grades, etc.) posted here
- QQ Group

Collaboration and academic dishonesty

- Discussions are encouraged
- Independently finish your assignment
- **You can consult LLMs, but not directly copy them!**

What is AI?

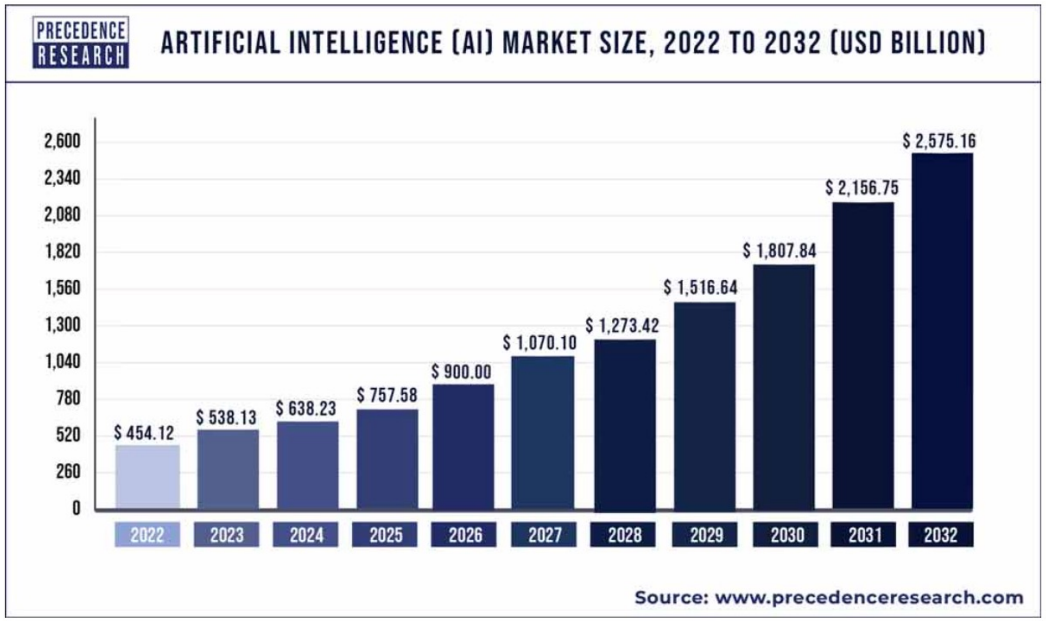
- What is artificial intelligence?
- What is this course?



AI is having real-world impact

- Economy
  - 454 billion USD globally

The global artificial intelligence (AI) market size was valued at USD 454.12 billion in 2022 and is expected to hit around USD 2,575.16 billion by 2032, progressing with a CAGR of 19% from 2023 to 2032. The North America artificial intelligence market was valued at USD 167.30 billion in 2022.



https://www.precedenceresearch.com/artificial-intelligence-market

AI is having real-world impact

- Economy
- Labor


Finance & economics | Free exchange

New research shows the robots are coming for jobs—but stealthily

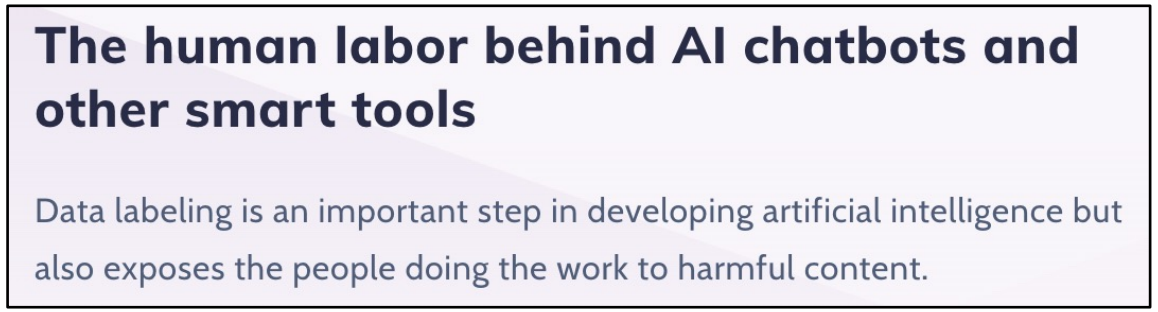
Look beneath the aggregate economic numbers, and change is afoot

The Economist, 2021


The Optimist's Guide to Artificial Intelligence and Work

The focus of much discussion is on how it will replace jobs, but nothing is inevitable.

New York Times, 2023

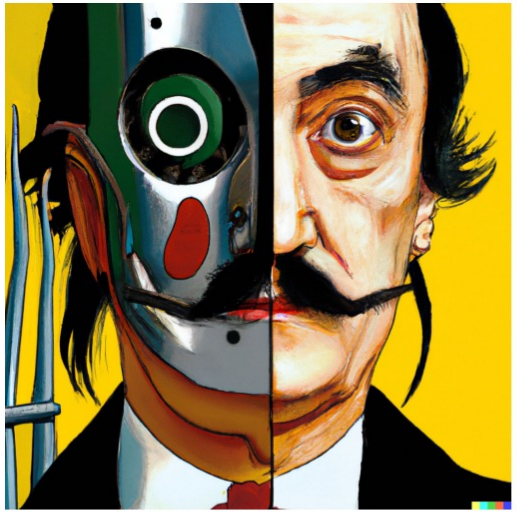

The human labor behind AI chatbots and other smart tools

Data labeling is an important step in developing artificial intelligence but also exposes the people doing the work to harmful content.

MarketWatch, 2023

AI is having real-world impact

- Economy
- Labor
- Art



vibrant portrait painting of Salvador Dalí with a robotic half face

a shiba inu wearing a beret and black turtleneck

a close up of a handpalm with leaves growing from it

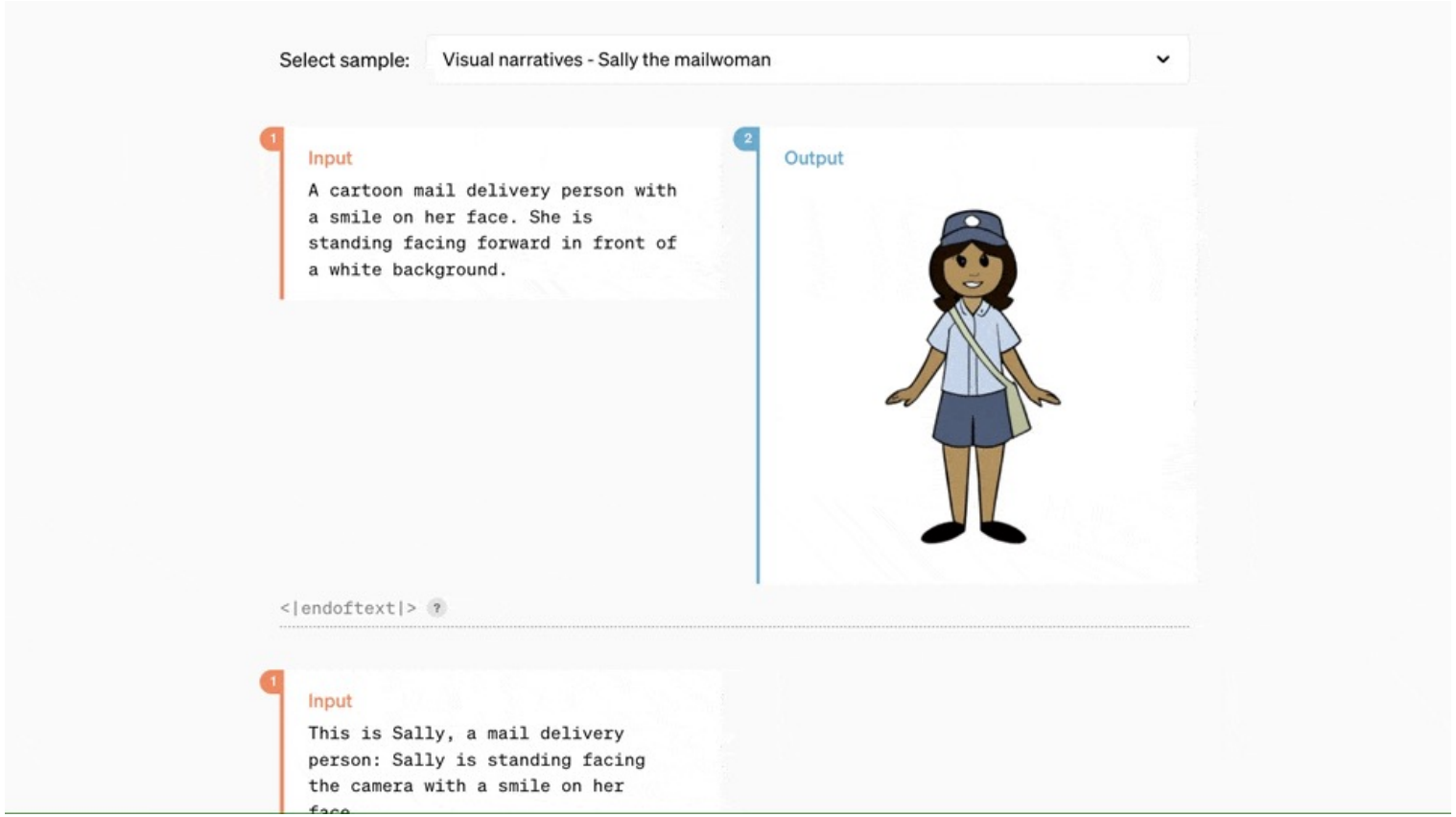
an espresso machine that makes coffee from human souls, artstation

panda mad scientist mixing sparkling chemicals, artstation

a corgi's head depicted as an explosion of a nebula

AI is having real-world impact

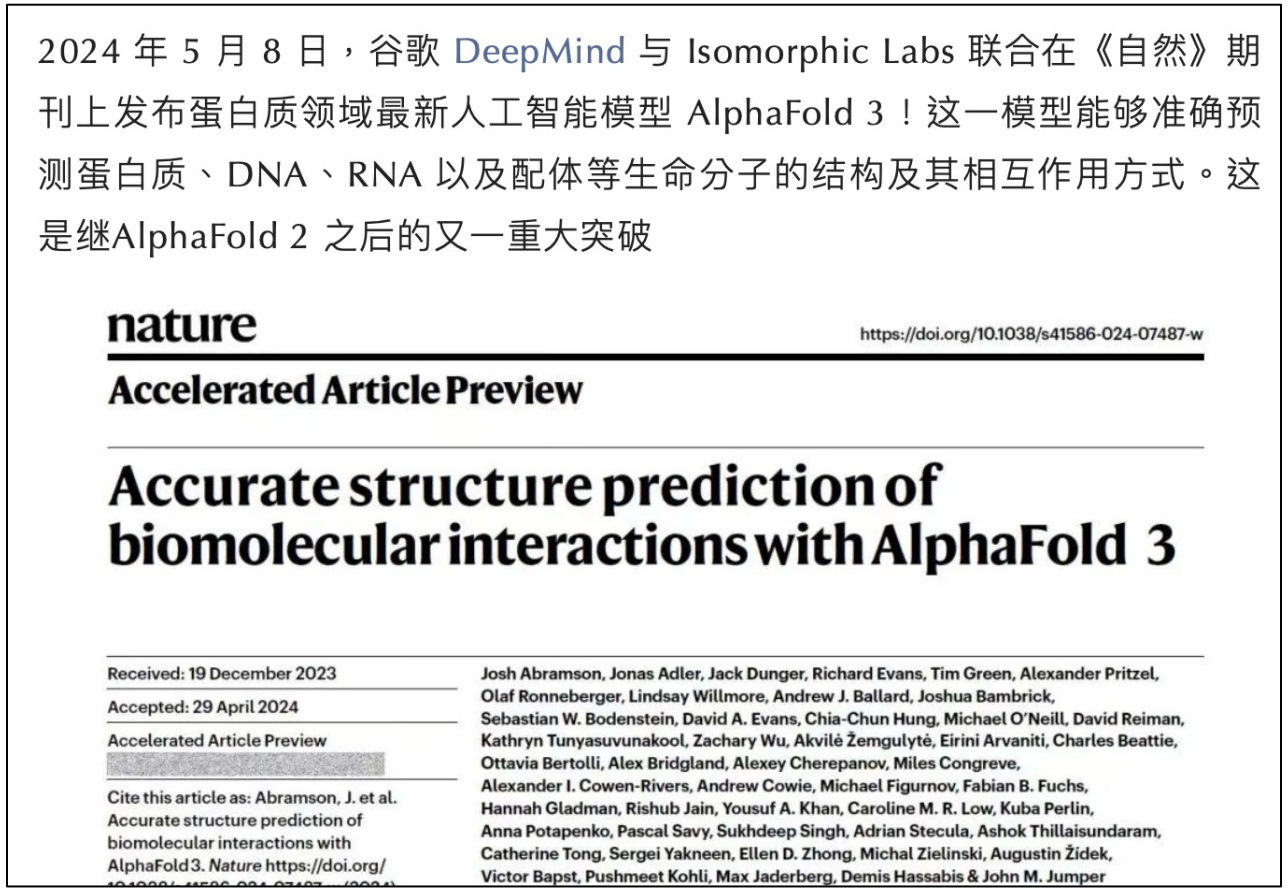
- Economy
- Labor
- Art



AI is having real-world impact

- Economy
- Labor
- Art
- Sciences

2024 年 5 月 8 日，谷歌 DeepMind 与 Isomorphic Labs 联合在《自然》期刊上发布蛋白质领域最新人工智能模型 AlphaFold 3！这一模型能够准确预测蛋白质、DNA、RNA 以及配体等生命分子的结构及其相互作用方式。这是继AlphaFold 2 之后的又一重大突破



nature

https://doi.org/10.1038/s41586-024-07487-w

Accelerated Article Preview

Accurate structure prediction of biomolecular interactions with AlphaFold 3

Received: 19 December 2023

Accepted: 29 April 2024

Accelerated Article Preview

Cite this article as: Abramson, J. et al. Accurate structure prediction of biomolecular interactions with AlphaFold 3. *Nature* https://doi.org/

Josh Abramson, Jonas Adler, Jack Dunger, Richard Evans, Tim Green, Alexander Pritzel, Olaf Ronneberger, Lindsay Willmore, Andrew J. Ballard, Joshua Bambrick, Sebastian W. Bodenstein, David A. Evans, Chia-Chun Hung, Michael O'Neill, David Reiman, Kathryn Tunyasuvunakool, Zachary Wu, Akvilė Žemgulytė, Eirini Arvaniti, Charles Beattie, Ottavia Bertolli, Alex Bridgland, Alexey Cherepanov, Miles Congreve, Alexander I. Cowen-Rivers, Andrew Cowie, Michael Figurnov, Fabian B. Fuchs, Hannah Gladman, Rishub Jain, Yousuf A. Khan, Caroline M. R. Low, Kuba Perlin, Anna Potapenko, Pascal Savy, Sukhdeep Singh, Adrian Stecula, Ashok Thillaisundaram, Catherine Tong, Sergei Yakneen, Ellen D. Zhong, Michal Zielinski, Augustin Žídek, Victor Bapst, Pushmeet Kohli, Max Jaderberg, Demis Hassabis & John M. Jumper

Nature, 2024

AI is having real-world impact

- Economy
- Labor
- Art
- Sciences

谷歌AI拿下IMO奥数银牌，数学推理模型AlphaProof面世，强化学习 is so back

机器之心 2024年07月26日 01:54 北京

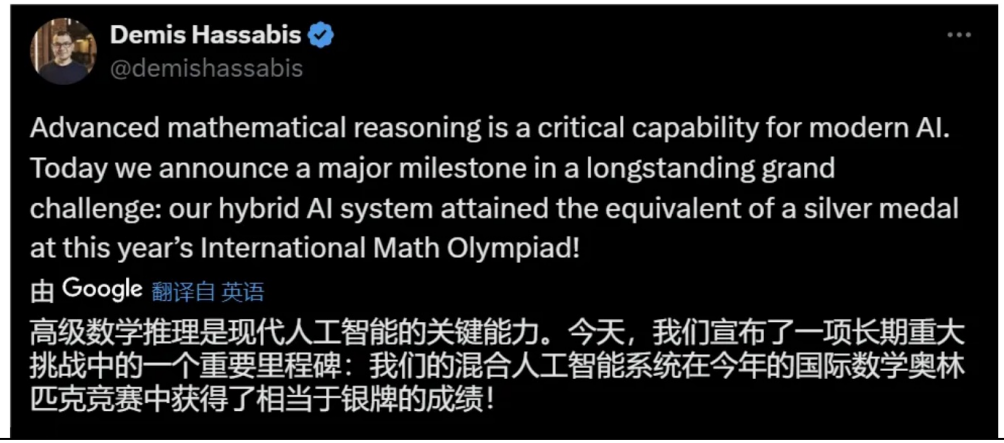
机器之心报道

机器之心编辑部

> 用上了 Gemini 大模型与 AlphaZero 强化学习算法，几何、代数、数论全都会。

对于 AI 来说，奥数不再是问题了。

本周四，谷歌 DeepMind 的人工智能完成了一项壮举：用 AI 做出了今年国际数学奥林匹克竞赛 IMO 的真题，并且距拿金牌仅一步之遥。



AI is having real-world impact

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- Labor
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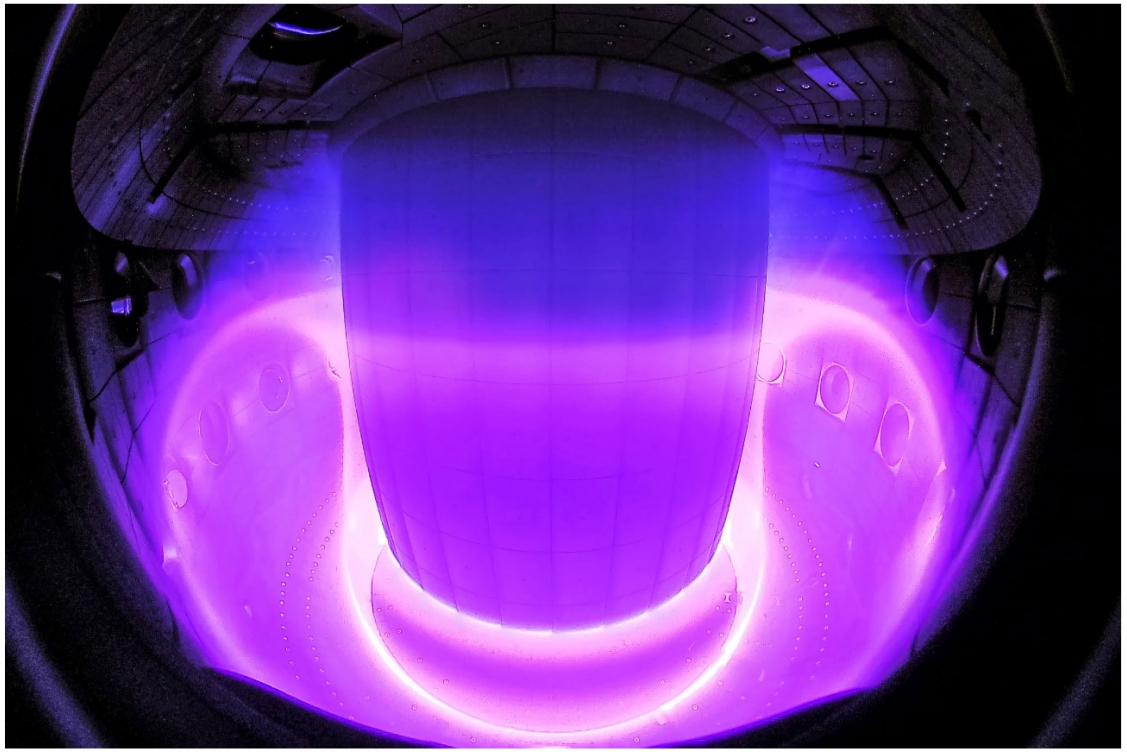
- Sciences

AMIT KATWALA SCIENCE FEB 16, 2022 11:00 AM

DeepMind Has Trained an AI to Control Nuclear Fusion

The Google-backed firm taught a reinforcement learning algorithm to control the fiery plasma inside a tokamak nuclear fusion reactor.



PHOTOGRAPH:CURDIN WÜTHRICH, SPC/EPFL

Wired, 2022

AI is having real-world impact

- Economy
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- Sciences

DeepSeek-R1: Incentivizing Reasoning Capability in LLMs via Reinforcement Learning

DeepSeek-AI, Daya Guo, Dejian Yang, Haowei Zhang, Junxiao Song, Ruoyu Zhang, Runxin Xu, Qihao Zhu, Shirong Ma, Peiyi Wang, Xiao Bi, Xiaokang Zhang, Xingkai Yu, Yu Wu, Z.F. Wu, Zhibin Gou, Zhihong Shao, Zhuoshu Li, Ziyi Gao, Aixin Liu, Bing Xue, Bingxuan Wang, Bochao Wu, Bei Feng, Chengda Lu, Chenggang Zhao, Chengqi Deng, Chenyu Zhang, Chong Ruan, Damai Dai, Deli Chen, Dongjie Ji, Erhang Li, Fangyun Lin, Fucong Dai, Fuli Luo, Guangbo Hao, Guanting Chen, Guowei Li, H. Zhang, Han Bao, Hanwei Xu, Haocheng Wang, Honghui Ding, Huajian Xin, Huazuo Gao, Hui Qu, Hui Li, Jianzhong Guo, Jiashi Li, Jiawei Wang, Jingchang Chen, Jingyang Yuan, Junjie Qiu, Junlong Li, J.L. Cai, Jiaqi Ni, Jian Liang, Jin Chen, Kai Dong, Kai Hu, Kaige Gao, Kang Guan, Kexin Huang, Kuai Yu, Lean Wang, Lecong Zhang, Liang Zhao, Litong Wang, Liyue Zhang, Lei Xu, Leyi Xia, Mingchuan Zhang, Minghua Zhang, Minghui Tang, Meng Li, Miaojun Wang, Mingming Li, Ning Tian, Panpan Huang, Peng Zhang, Qiancheng Wang, Qinyu Chen, Qiushi Du, Ruiqi Ge, Ruisong Zhang, Ruizhe Pan, Runji Wang, R.J. Chen, R.L. Jin, Ruyi Chen, Shanghao Lu, Shangyan Zhou, Shanhuang Chen, Shengfeng Ye, Shiyu Wang, Shuiping Yu, Shunfeng Zhou, Shuting Pan, S.S. Li et al. (100 additional authors not shown)

We introduce our first-generation reasoning models, DeepSeek-R1-Zero and DeepSeek-R1. DeepSeek-R1-Zero, a model trained via large-scale reinforcement learning (RL) without supervised fine-tuning (SFT) as a preliminary step, demonstrates remarkable reasoning capabilities. Through RL, DeepSeek-R1-Zero naturally emerges with numerous powerful and intriguing reasoning behaviors. However, it encounters challenges such as poor readability, and language mixing. To address these issues and further enhance reasoning performance, we introduce DeepSeek-R1, which incorporates multi-stage training and cold-start data before RL. DeepSeek-R1 achieves performance comparable to OpenAI-o1-1217 on reasoning tasks. To support the research community, we open-source DeepSeek-R1-Zero, DeepSeek-R1, and six dense models (1.5B, 7B, 8B, 14B, 32B, 70B) distilled from DeepSeek-R1 based on Qwen and Llama.

Subjects: **Computation and Language (cs.CL)**; Artificial Intelligence (cs.AI); Machine Learning (cs.LG)
Cite as: arXiv:2501.12948 **[cs.CL]**
(or arXiv:2501.12948v1 **[cs.CL]** for this version)
https://doi.org/10.48550/arXiv.2501.12948

AI is having real-world impact

- Economy
- Labor
- Art
- Sciences
- Law

COMMENTARY

How AI will revolutionize the practice of law

John Villasenor
March 20, 2023

AI is having real-world impact

- Economy
- Labor
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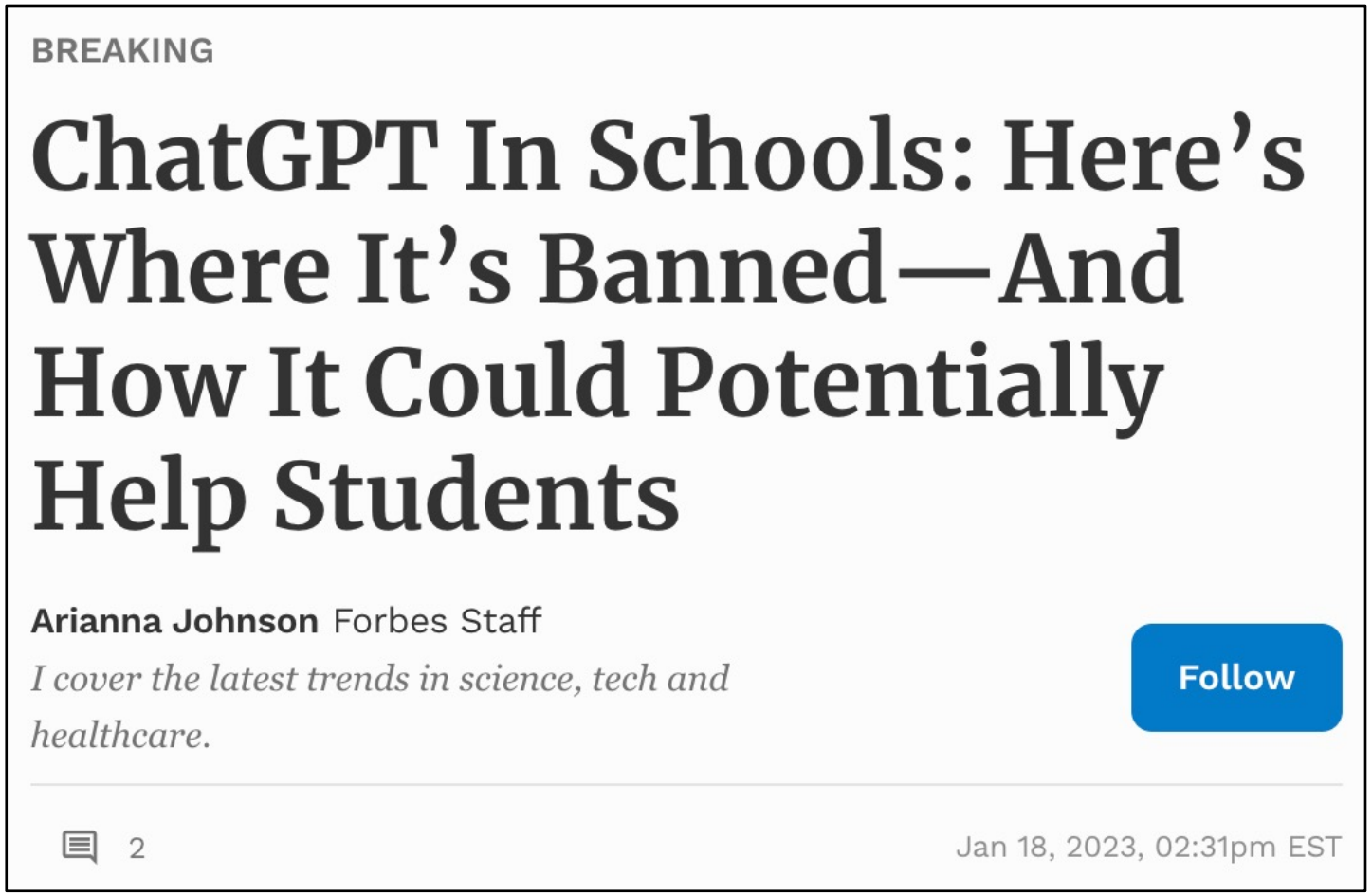
- Sciences
- Law
- Education



BREAKING

ChatGPT In Schools: Here's Where It's Banned—And How It Could Potentially Help Students

Arianna Johnson Forbes Staff

I cover the latest trends in science, tech and healthcare.

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Jan 18, 2023, 02:31pm EST

Forbes, 2023

AI is having real-world impact

- Economy
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- Law
- Education
- Ecology

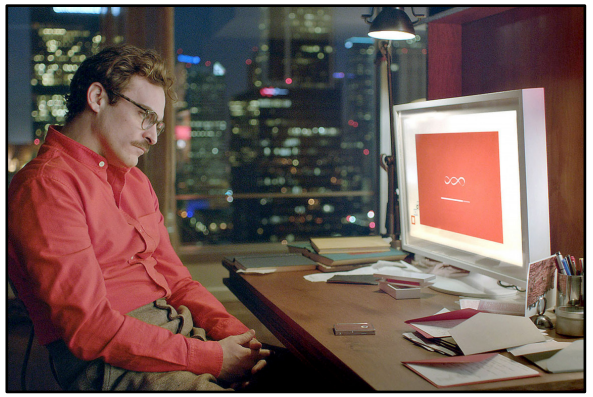
https://theceomagazine.cn/business/sustainability-the-cleanest-industrial-revolution/

What is AI?

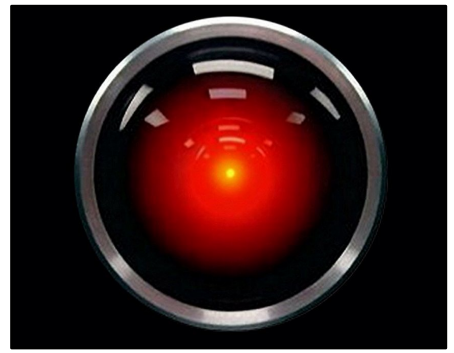
Science fiction AI?

R2D2 and C3PO droids from Star Wars

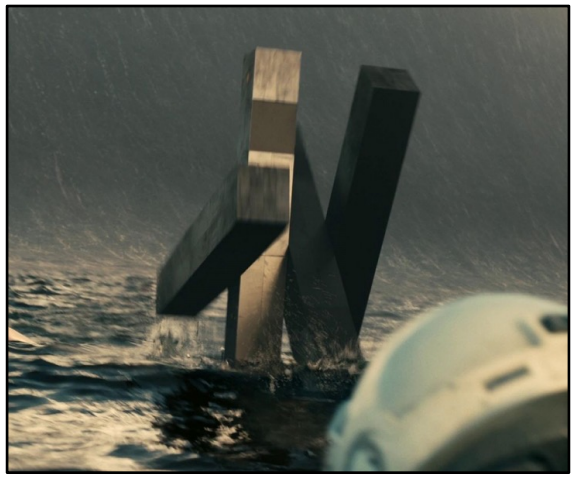
Wall-E



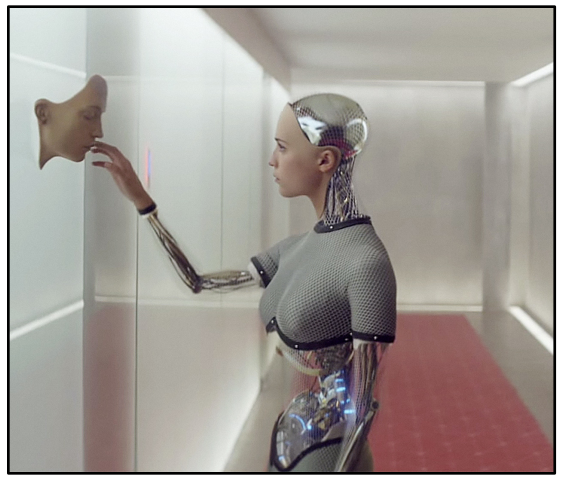
Samantha from Her



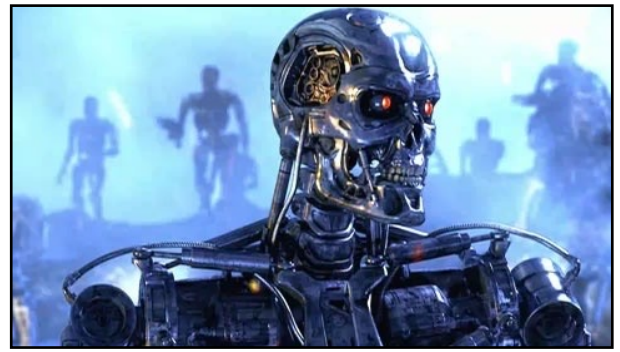
Hal 9000 from 2001



CASE from Interstellar



Ava from Ex Machina

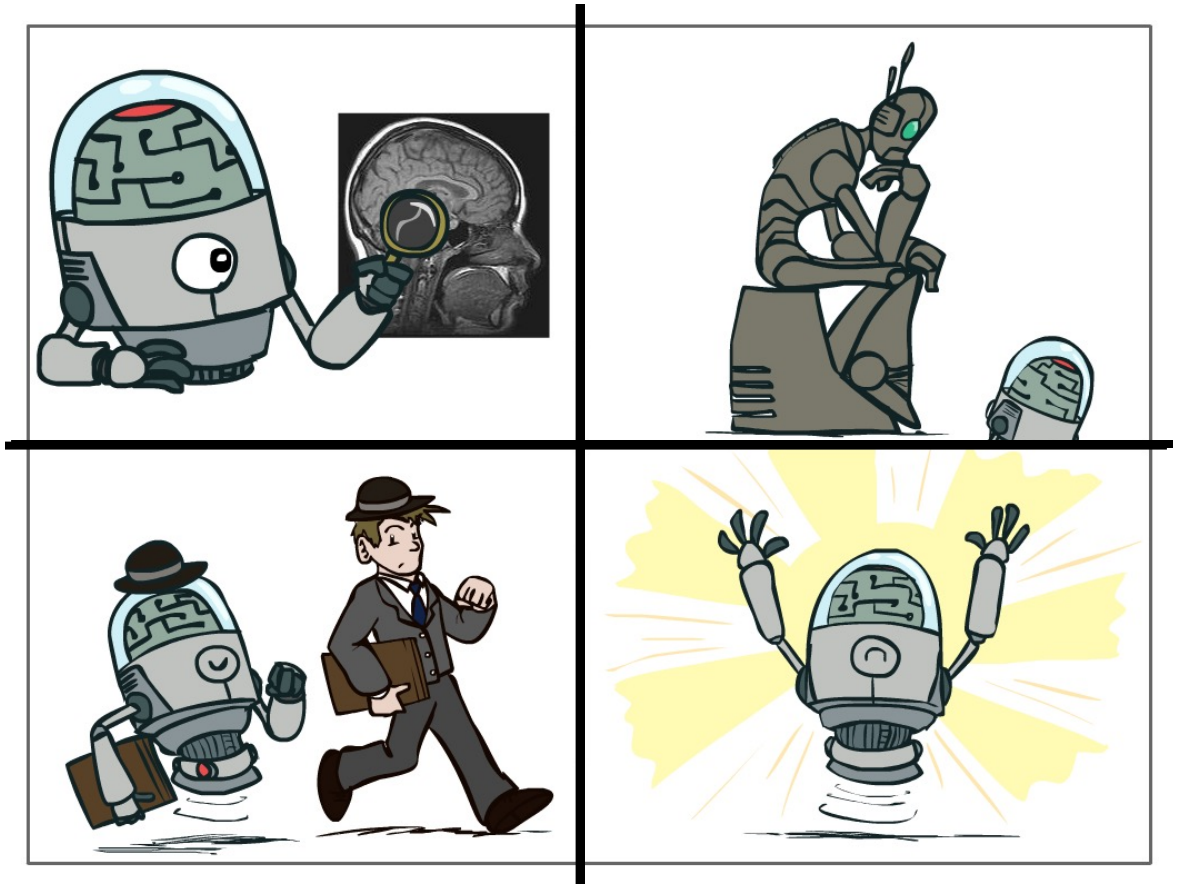


T-800 from Terminator

What should we build?

Should we make machines that…

Think like people?



Think rationally?

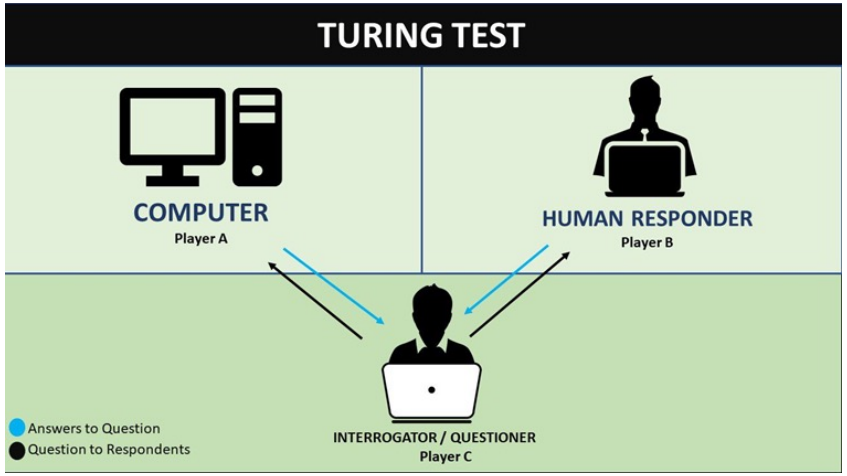
Act like people?

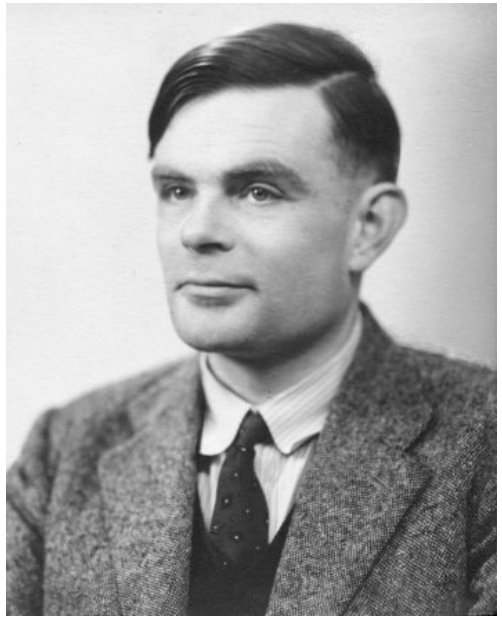
Act rationally?

Act like people

- Turing Test

- In 1950, Turing defined a test of whether a machine could perform
- Practically though, it is a test of whether a machine can ‘act’ like a person
- “A human judge engages in a natural language conversation with one human and one machine, each of which tries to appear human. If judge can’t tell, machine passes the Turing test.”



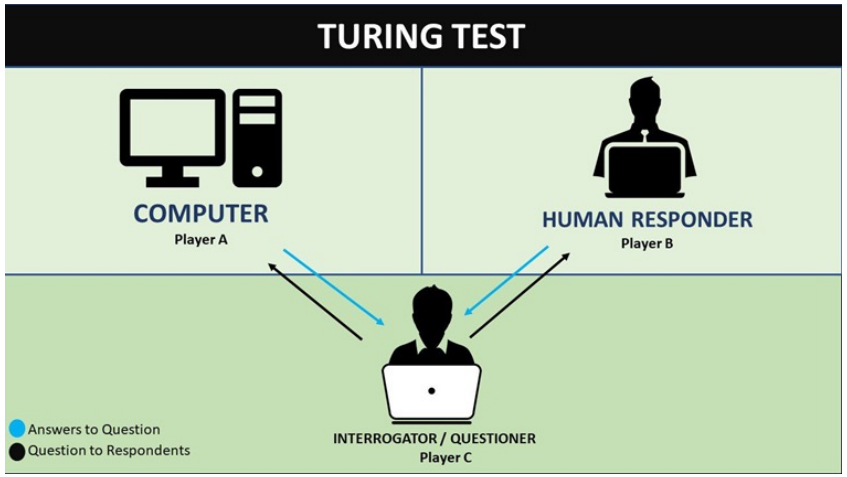


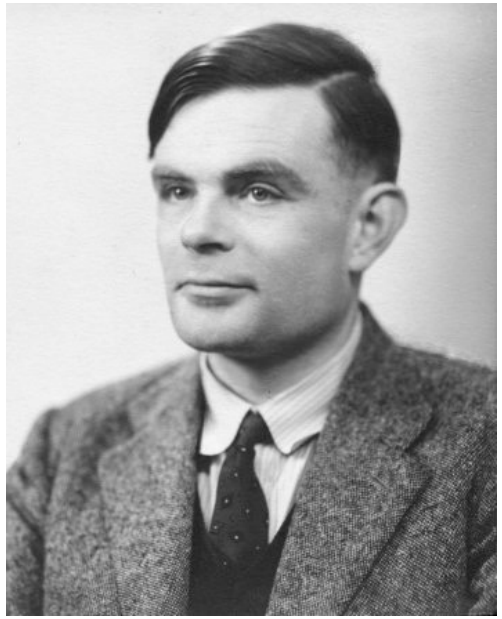
en.wikipedia.org/wiki/Turing_test
https://seattlewebsitedesign.medium.com/what-is-a-turing-testt-d379477fed9b

Act like people

- Turing Test

- The machine should have the capability:
  - Natural language processing
  - Knowledge representation
  - Automated reasoning
  - Machine learning
  - (Computer vision, robotics…)

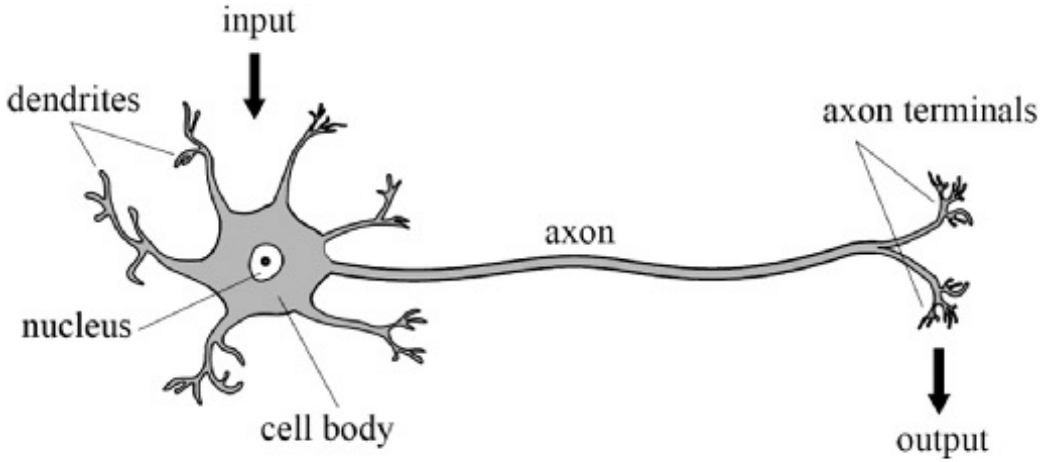




en.wikipedia.org/wiki/Turing_test
https://seattlewebsitedesign.medium.com/what-is-a-turing-testt-d379477fed9b

Think like people

- The cognitive modeling approach
- The interdisciplinary field of cognitive science hopes to construct precise and testable theories of the human mind
- Real cognitive science is necessarily based on experimental investigation of actual humans or animals

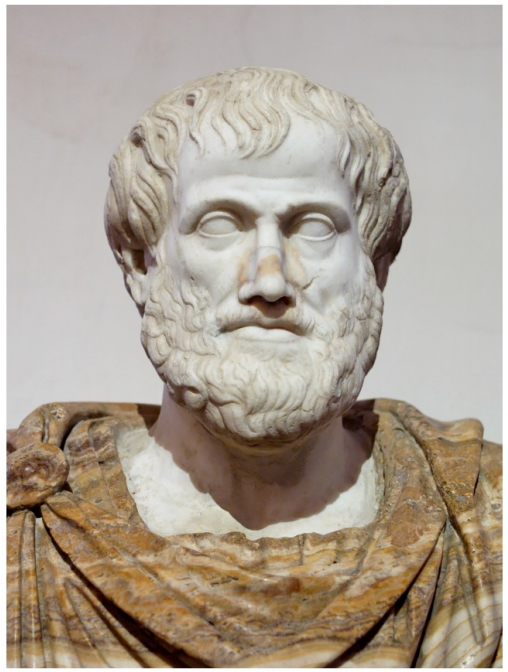


https://www.researchgate.net/figure/The-biological-neuron_fig2_320384373

Think rationally

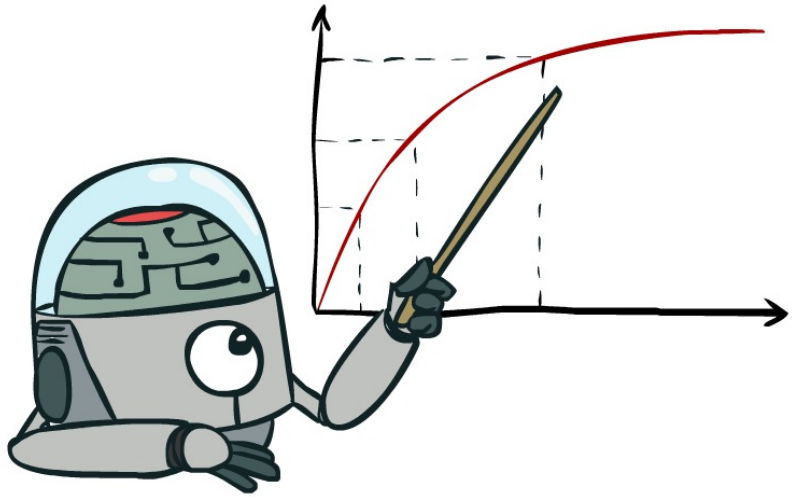
- The Greek philosopher Aristotle, syllogisms (三段论)
- The emphasis was on correct inferences

- The logicists hope to build on logic systems to create intelligent systems



Act rationally: Rational decisions

- We'll use the term **rational** in a very specific, technical way:
  - Rational: *maximally achieving pre-defined goals*
  - Goals are expressed in terms of the **utility** of outcomes
  - World is uncertain, so we'll use **expected** utility
  - Being rational means acting to **maximize your expected utility**



What should we build?

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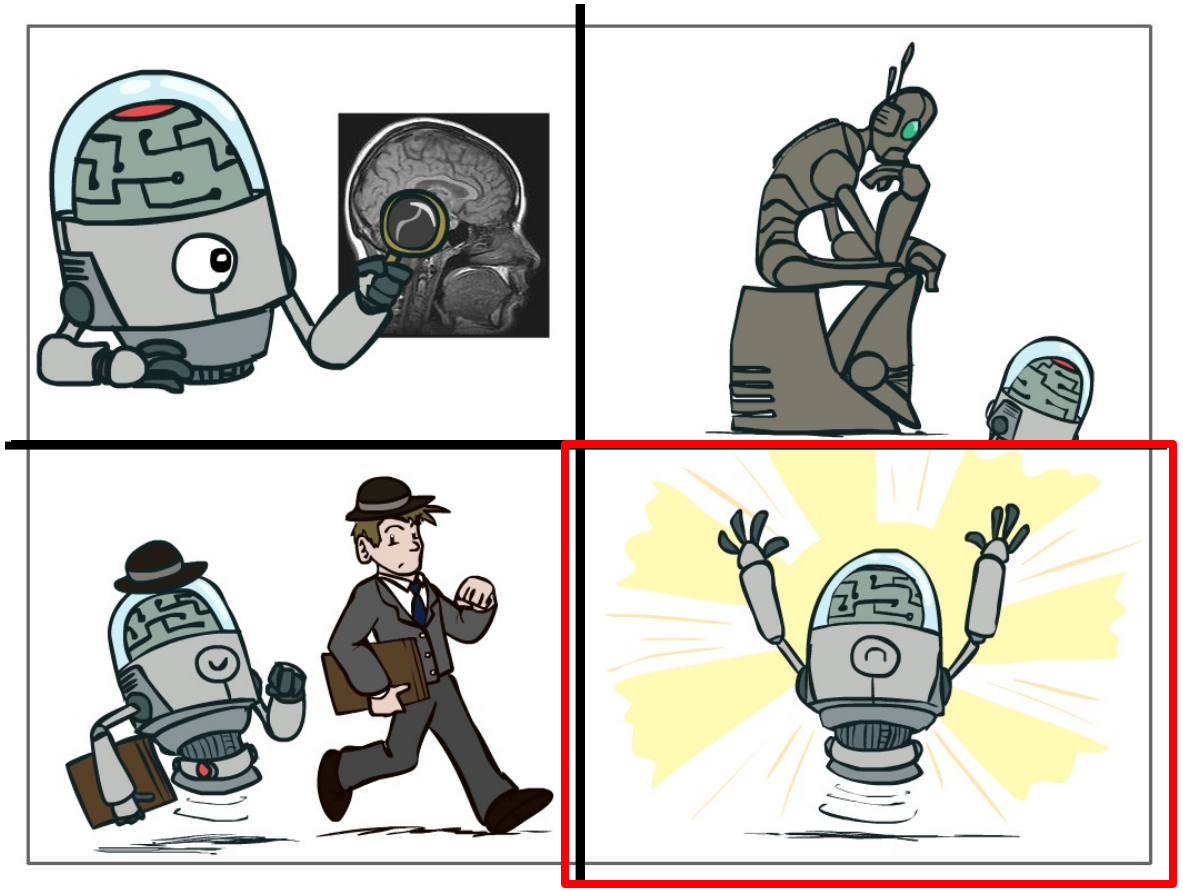


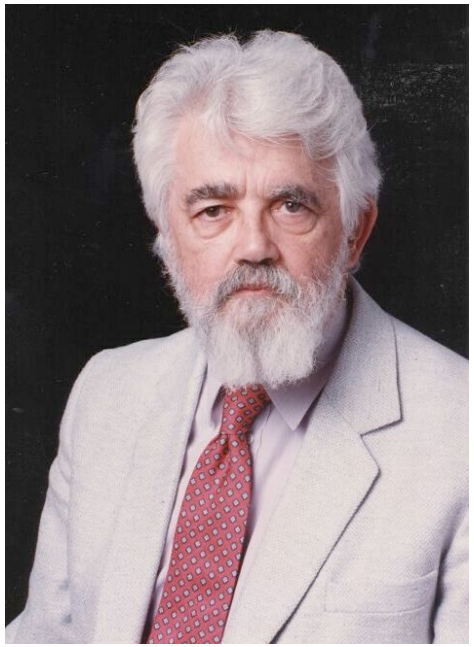
Think rationally?

Act like people?

Act rationally?

AI definition by John McCarthy

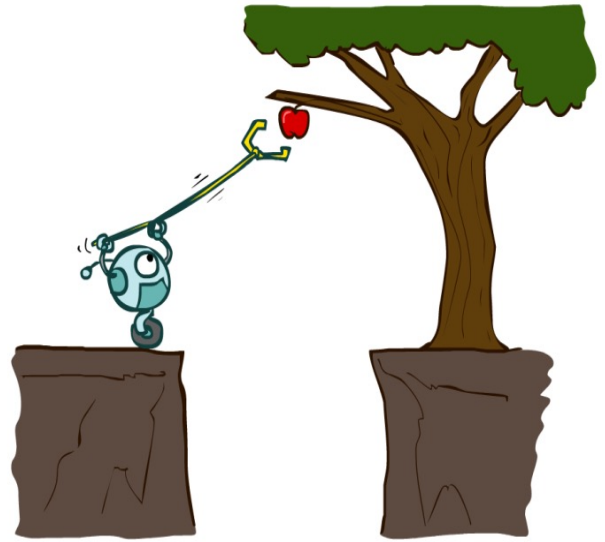
- What is artificial intelligence
  - It is the science and engineering of making intelligent machines, especially intelligent computer programs
- What is intelligence
  - Intelligence is the computational part of the ability to achieve goals in the world

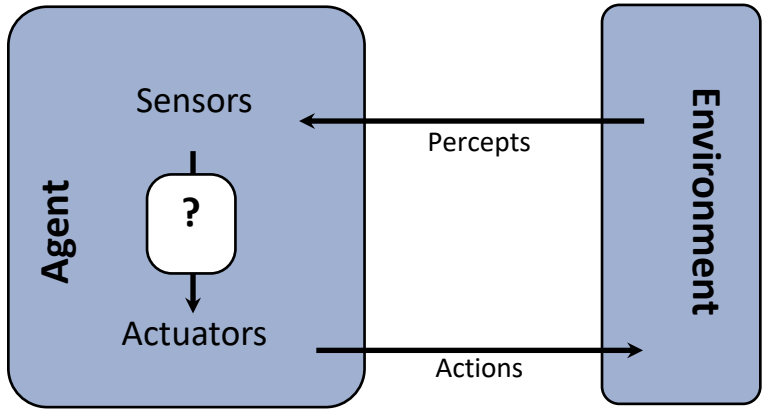


http://www-formal.stanford.edu/jmc/whatisai/whatisai.html

This course: Designing rational agents

- An **agent** is an entity that perceives and acts.
- A **rational agent** selects actions that maximize its (expected) **utility**.
- Characteristics of the **percepts**, **environment**, and **action space** dictate techniques for selecting rational actions
- This course is about:
  - General AI techniques for a variety of problem types
  - Learning to recognize when and how a new problem can be solved with an existing technique



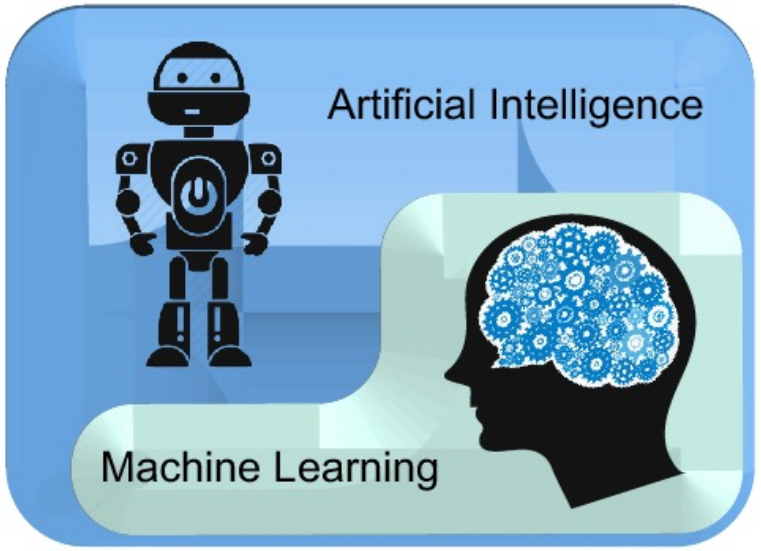


What is Machine Learning?

- Term “Machine Learning” coined by Arthur Samuel in 1959
  - Samuel Checkers-playing Program
- Common definition (by Tom Mitchell):
  - Machine Learning is the study of computer algorithms that improve automatically through experience
- Subfield of Artificial Intelligence (AI)
  - The hottest subfield - reinvigorated interest in AI due to deep learning!

Difference between AI and ML

- AI is a **bigger** concept to create intelligent machines that can simulate human thinking capability and behavior
- Machine learning is an application or **subset** of AI that allows machines to learn from data without being programmed explicitly

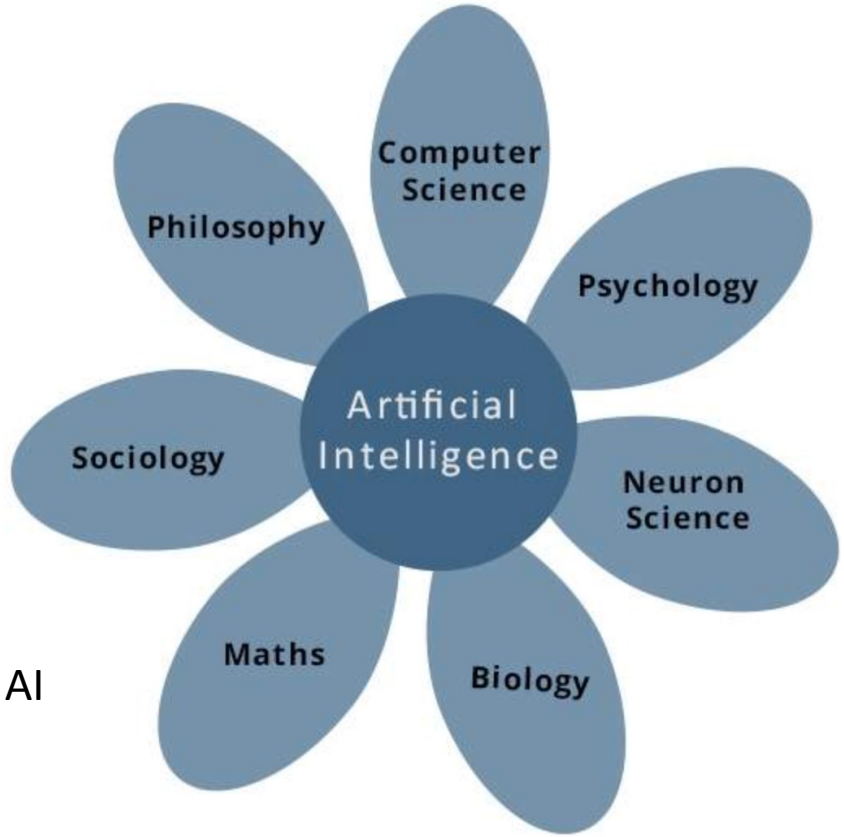


- Example of AI but is not ML
  - A* search algorithm

https://www.javatpoint.com/difference-between-artificial-intelligence-and-machine-learning

What contributes to AI?

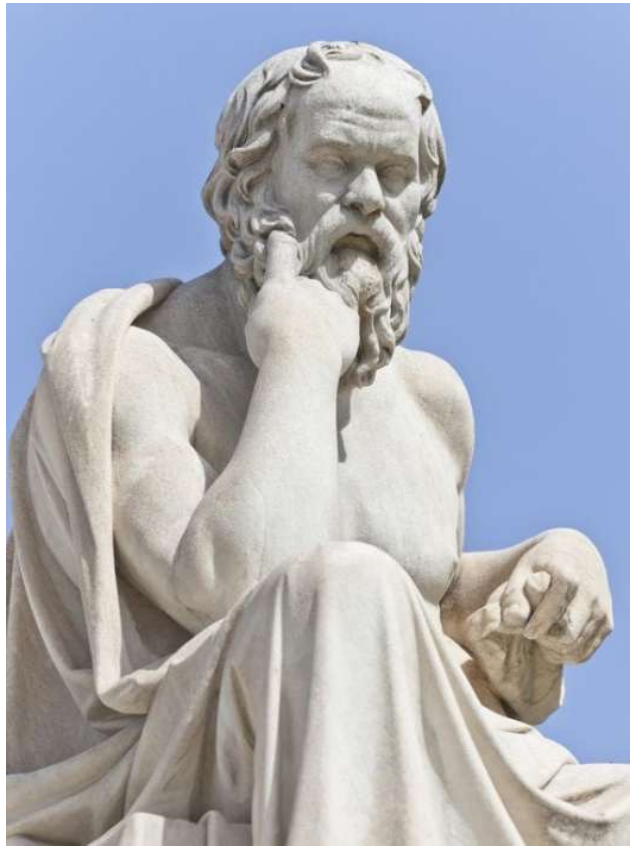
The disciplines that contributed ideas, viewpoints, and techniques to AI



https://www.tutorialspoint.com/artificial_intelligence/artificial_intelligence_overview.htm

Philosophy

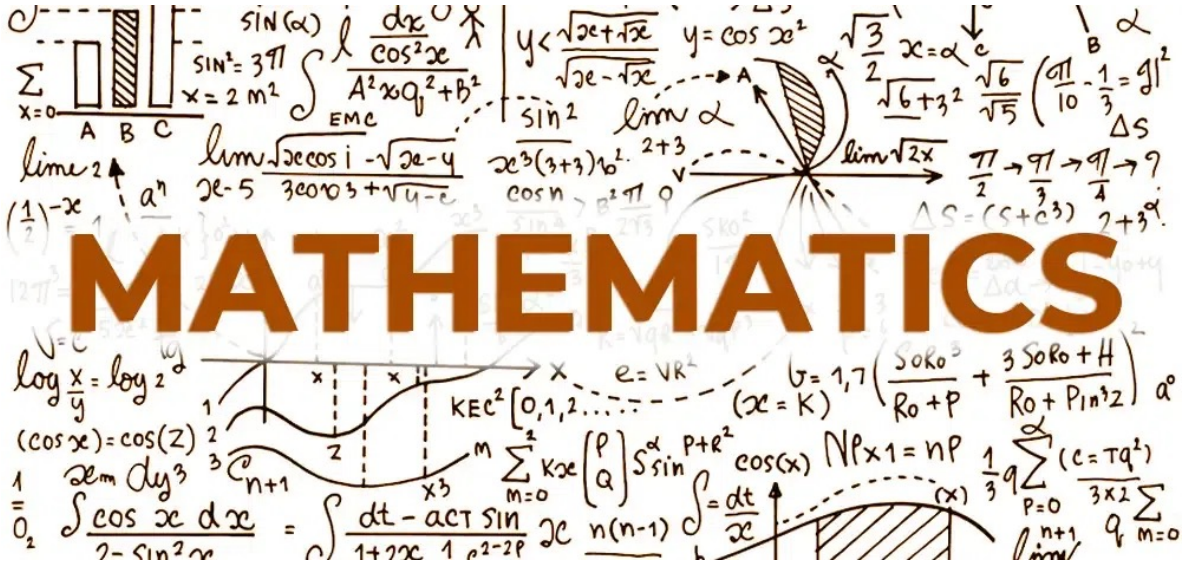
- Can formal rules be used to draw valid conclusions?
- How does the mind arise from a physical brain?
- Where does knowledge come from?
- How does knowledge lead to action?



"The only thing I know is that I know nothing". --Socrates

Mathematics

- What are the formal rules to draw valid conclusions?
- What can be computed?
- How do we reason with uncertain information?



- The first nontrivial algorithm is thought to be Euclid's algorithm for computing greatest common divisors (最大公约数)
- NP-completeness/probability/entropy

https://www.geeksforgeeks.org/maths/

Economics

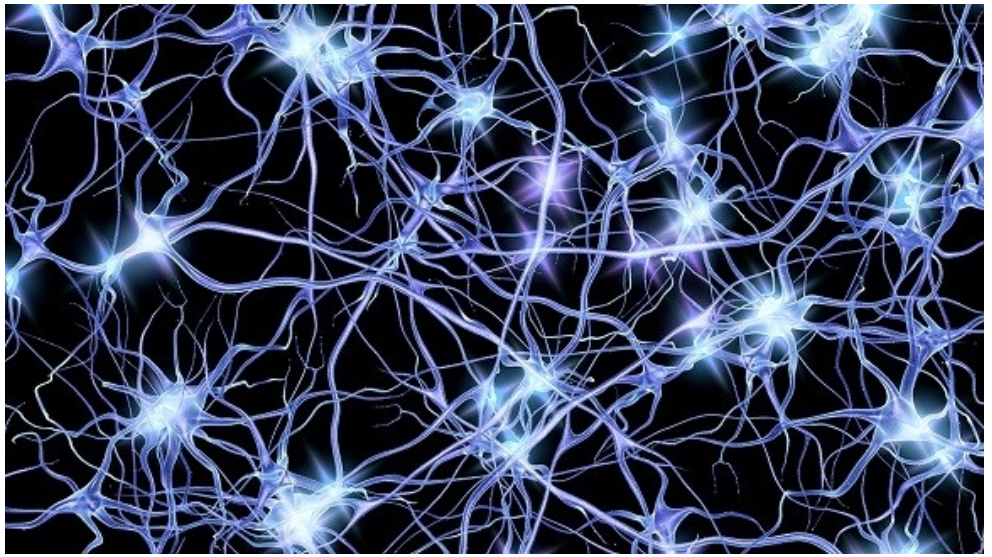
- How should we make decisions so as to maximize payoff?
- How should we do this when others may not go along?
- How should we do this when the payoff may be far in the future?

- The pioneering AI researcher Herbert Simon (1916–2001) won the Nobel Prize in economics in 1978 for his early work showing that models based on satisficing—making decisions that are "good enough," rather than laboriously calculating an optimal decision— gave a better description of actual human behavior (Simon, 1947)

https://www.maltaseminary.org/?p=2865

Neuroscience

- How do brains process information?



	Supercomputer	Personal Computer	Human Brain
Computational units	10^4 CPUs, 10^{12} transistors	4 CPUs, 10^9 transistors	10^{11} neurons
Storage units	10^{14} bits RAM	10^{11} bits RAM	10^{11} neurons
	10^{15} bits disk	10^{13} bits disk	10^{14} synapses
Cycle time	10^{-9} sec	10^{-9} sec	10^{-3} sec
Operations/sec	10^{15}	10^{10}	10^{17}
Memory updates/sec	10^{14}	10^{10}	10^{14}

https://www.nature.com/collections/fcajfbdbbd

Psychology

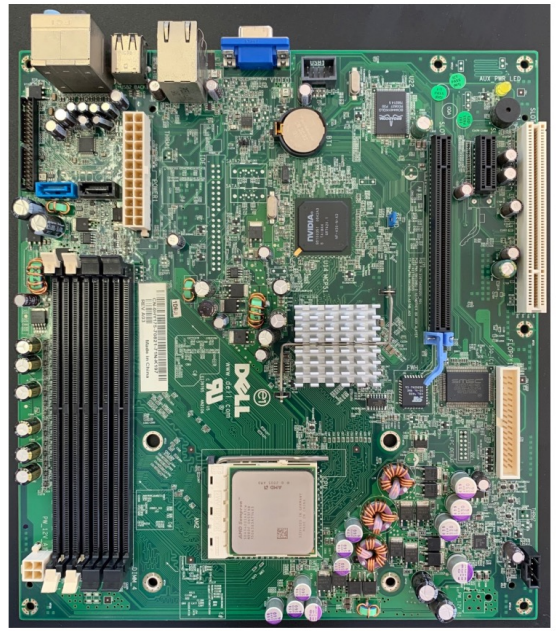
- How do humans and animals think and act?

- Cognitive psychology views the brain as an information-processing device
- Developmental psychology is the scientific study of how and why human beings change over the course of their life, especially concerned with infants and children

https://www.medicalnewstoday.com/articles/154874

Computer engineering

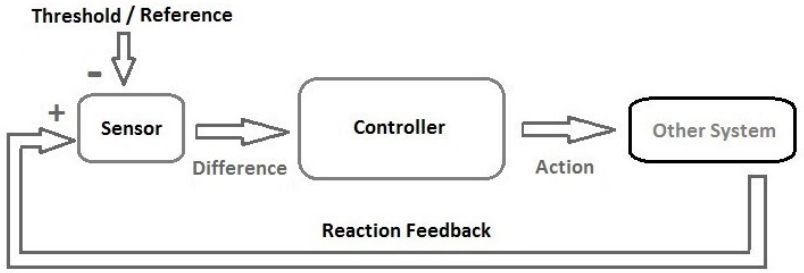
- How can we build an efficient computer?



- Designing algorithms is not enough
- Hardware
  - Modern digital electronic computer
- Software
  - Operating systems, programming languages, and tools needed to write modern programs (and papers about them)
- Work in AI has also pioneered many ideas to mainstream computer science
  - Time sharing, interactive interpreters, personal computers with windows and mice

Control theory and cybernetics

- How can artifacts operate under their own control?

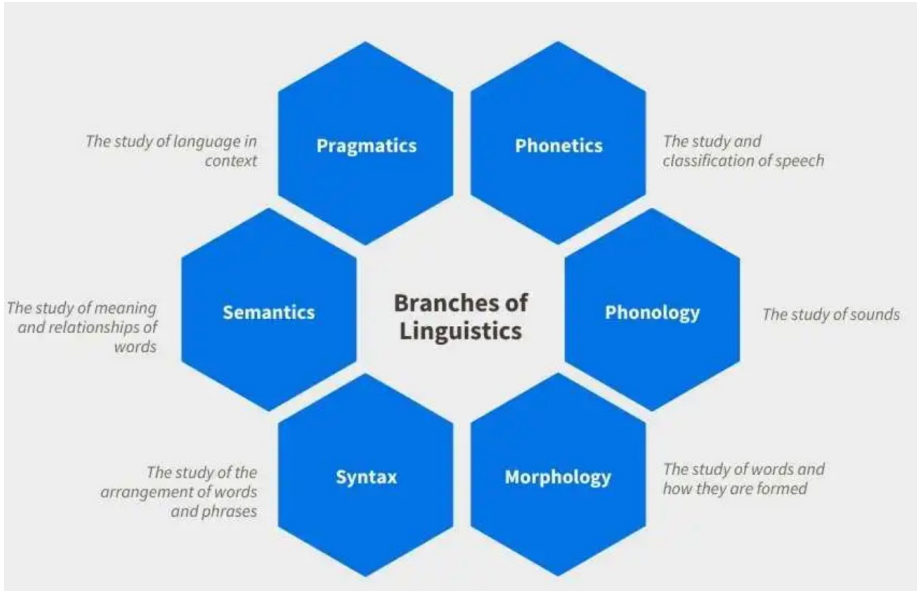


A Cybernetic Loop

- Control theory
  - To design systems that maximize an objective function over time
- Differences of control theory and AI:
  - Control theory more care about continuous variables with calculus and matrix algebra as tools
  - AI uses logical inference and computation to deal more discrete problems such as language, vision, and planning

Linguistics

- How does language relate to thought?



- Understanding language requires an understanding of the subject matter and context
  - Not just an understanding of the structure of sentences
- Knowledge representation
  - Decades of work on the philosophical analysis of language

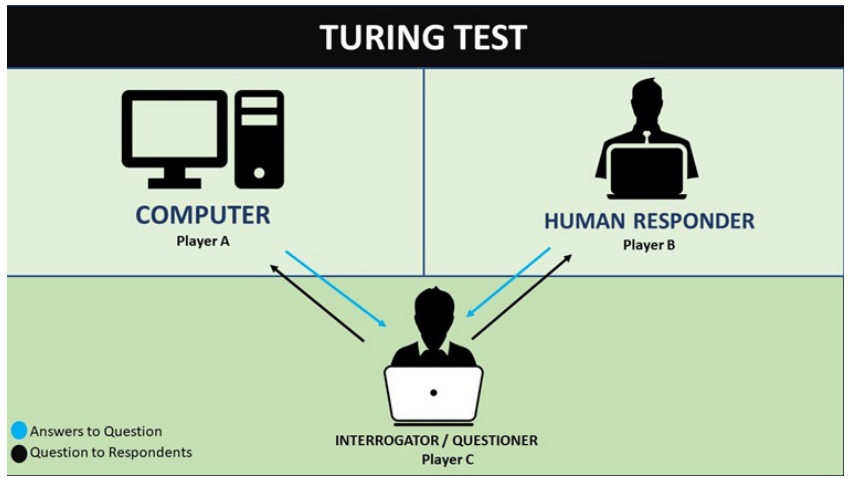
https://alethes.net/blog/linguistics/what-are-the-main-branches-of-linguistics/

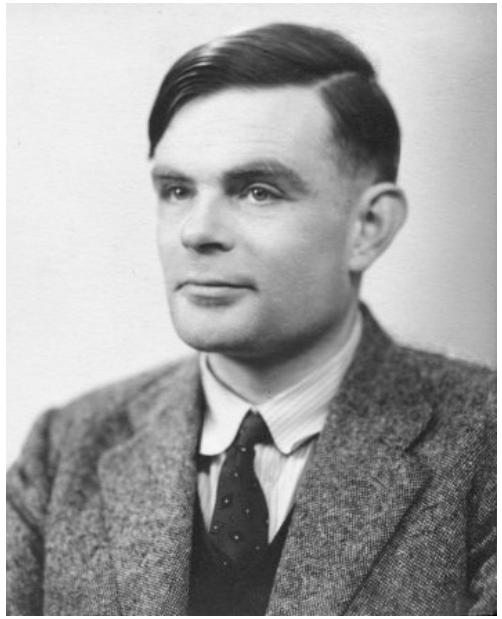
The History of AI

1940-1950 (Early days): Neural and computer science meet

- 1943: McCulloch & Pitts: Perceptron–boolean circuit model of brain

- 1950: Turing's “Computing Machinery and Intelligence”

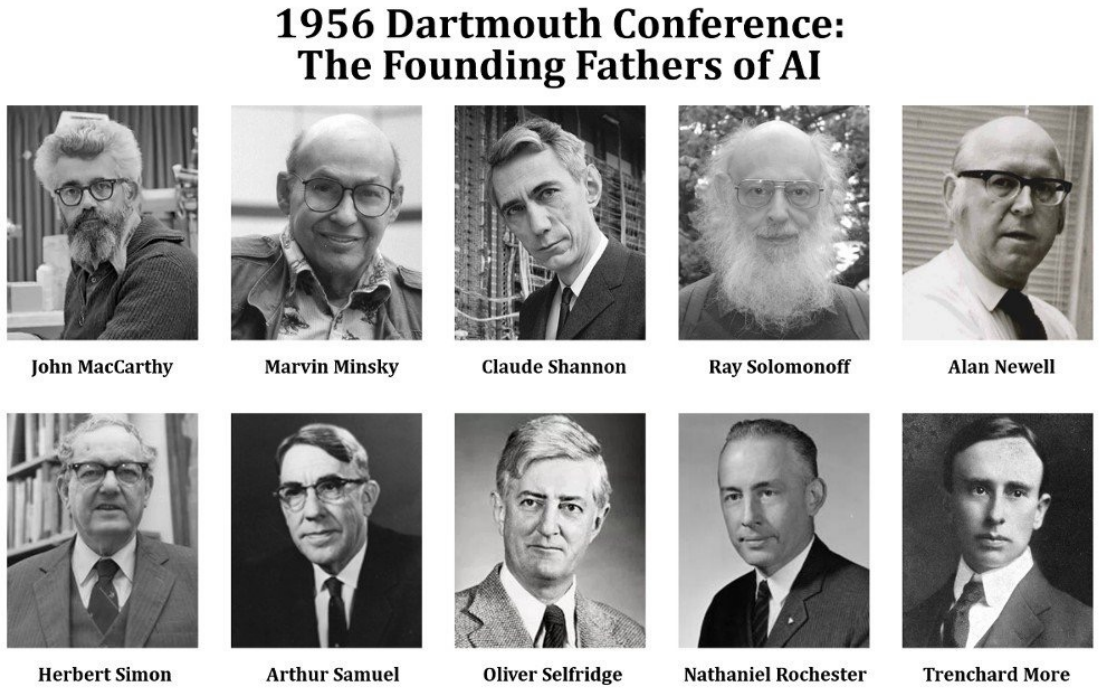




1950-70: Excitement! Logic-driven

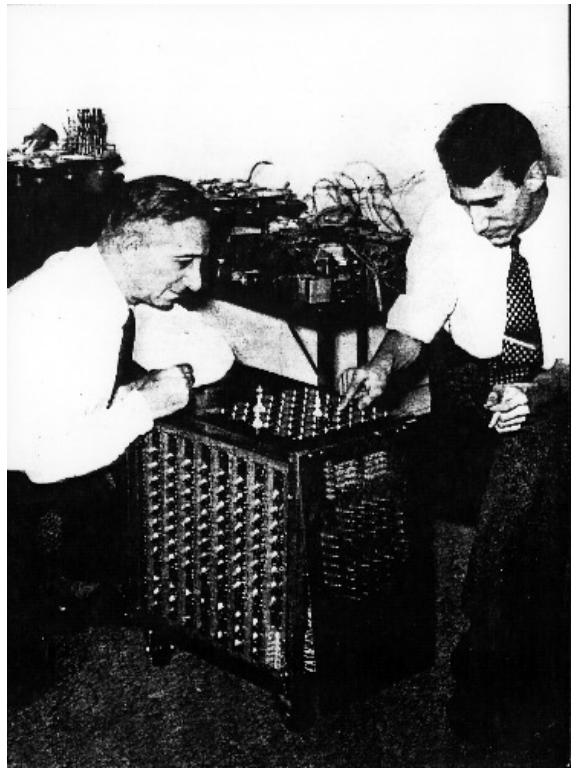
- 1950s: Early AI programs, including Samuel's checkers program, Newell & Simon's Logic Theorist, Gelernter's Geometry Engine

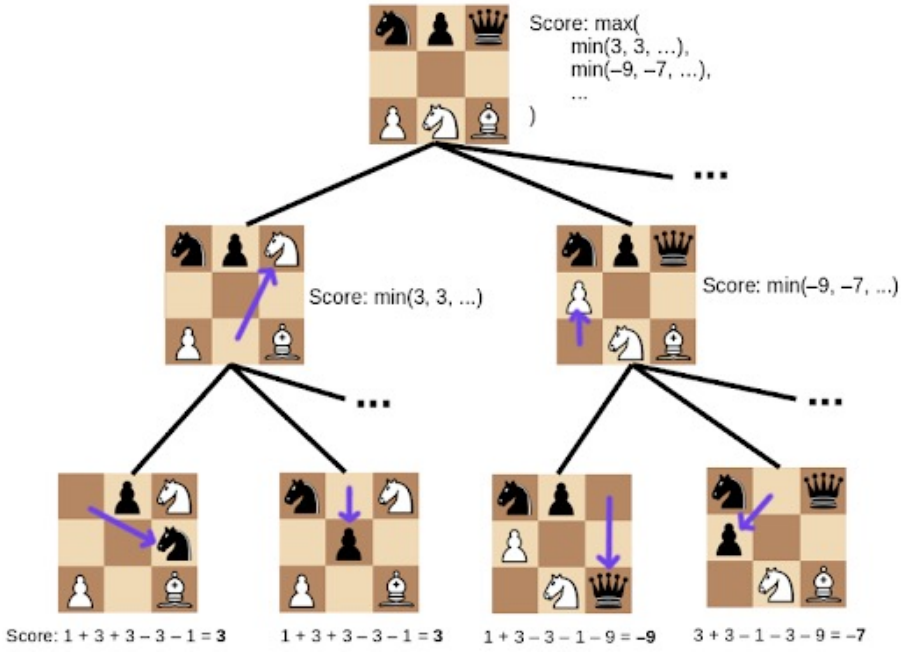
- 1956: Dartmouth meeting, “Artificial Intelligence” adopted



Chess as the first killer app for AI

- Claude Shannon proposed the first chess playing program in 1950
  - It included adversarial search and minimax (later lecture)
  - It also included many heuristics for faster searching





https://www.chessprogramming.org/Claude_Shannon
http://zackmdavis.net/blog/2019/05/minimax-search-and-the-structure-of-cognition/

1950-70: Early success

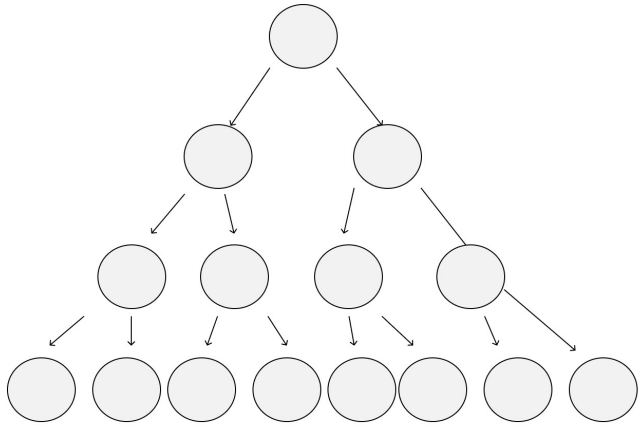
- Reasoning as search
  - Using heuristics to reduce search space (later lecture)
  - Herbert Gelernter's Geometry Theorem Prover (1958) and Symbolic Automatic Integrator written by Minsky's student James Slagle in 1961
- Neural networks
  - Frank Rosenblatt builds Perceptron machines (1957-1962) of up to four layers
- Natural language
  - Daniel Bobrow's program STUDENT, which could solve high school algebra word problems
- Automata
- ……

The promise of AI

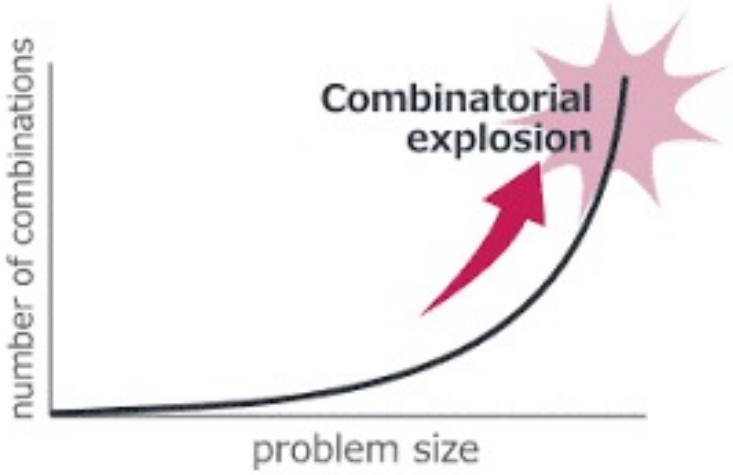
- 1965, H. A. Simon: "machines will be capable, within twenty years, of doing any work a man can do.”
- In 1967, John McCarthy told the U.S. government that it would be possible to build “a fully intelligent machine” in the space of a decade
- 1970, Marvin Minsky (in Life Magazine): “In from 3-8 years we will have a machine with the general intelligence of an average human being."

1974–1980: First AI Winter

- Limited computer power
- Intractability and the combinatorial explosion
- Commonsense knowledge and reasoning
  - Hard to encode so many concepts and rules
  - Didn’t know how to teach computers to learn these
- Moravec's paradox
  - Proving theorems and solving geometry problems is comparatively easy
  - Recognizing a face or crossing a room without bumping into anything is extremely difficult



Credit: Byrne Hobart



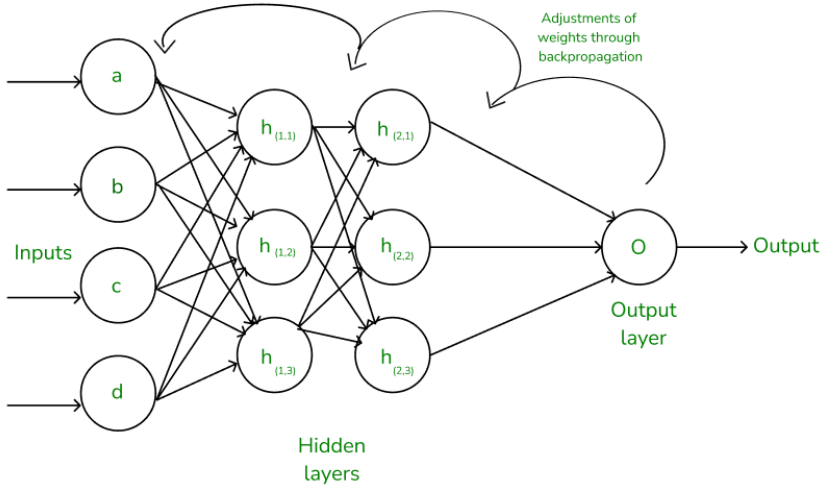
Credit: Jonathan Levin

Boom: 1980-1987

- Expert systems
  - Become the focus of mainstream AI research
  - An expert system is a program that answers questions or solves problems about a specific domain of knowledge, using logical rules that are derived from the knowledge of experts
  - XCON was completed at CMU for the Digital Equipment Corporation. It was saving the company 40 million dollars annually

The return of Neural Networks

- Physicist John Hopfield prove that a "Hopfield net" model could learn and process information, and provably converges after enough time
- Geoffrey Hinton and David Rumelhart popularized "backpropagation" for training neural networks



https://www.geeksforgeeks.org/backpropagation-in-neural-network/

Bust: second AI winter

- The sudden collapse of the market for specialized AI hardware in 1987
  - Desktop computers from Apple and IBM had been steadily gaining speed and power
- The earliest successful expert systems proved too expensive to maintain
  - difficult to update, could not learn

IBM PS/2

1990—2010: Statistical approaches, agents

- Resurgence of probability, focus on uncertainty
- Agents and learning systems… “AI Spring”?
- 1992: TD-Gammon achieves human-level play at backgammon
- 1997: Deep Blue defeats Gary Kasparov at chess
- 2002: Embodied AI; Roomba vacuum invented

TD Gammon Program

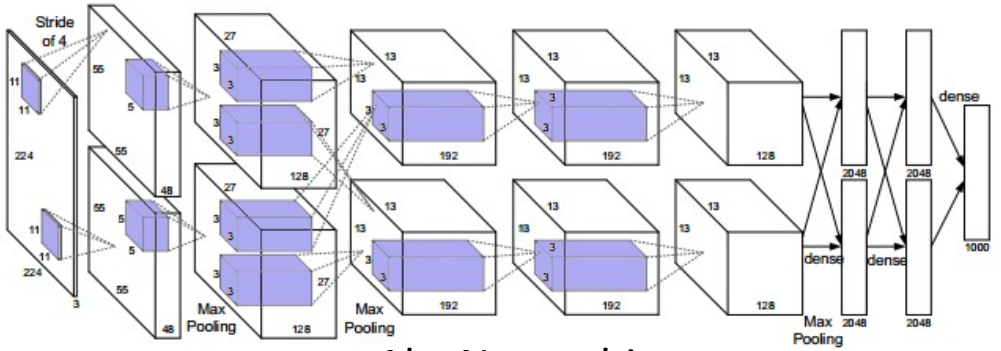
Original Roomba from 2002

Win Garry Kasparov by 3.5:2.5 on Chess
Search over 12 following steps

2010—2017: Big Data, GPUs, Deep Learning

- 2011: Apple releases Siri
- 2012: AlexNet wins ImageNet competition

Siri

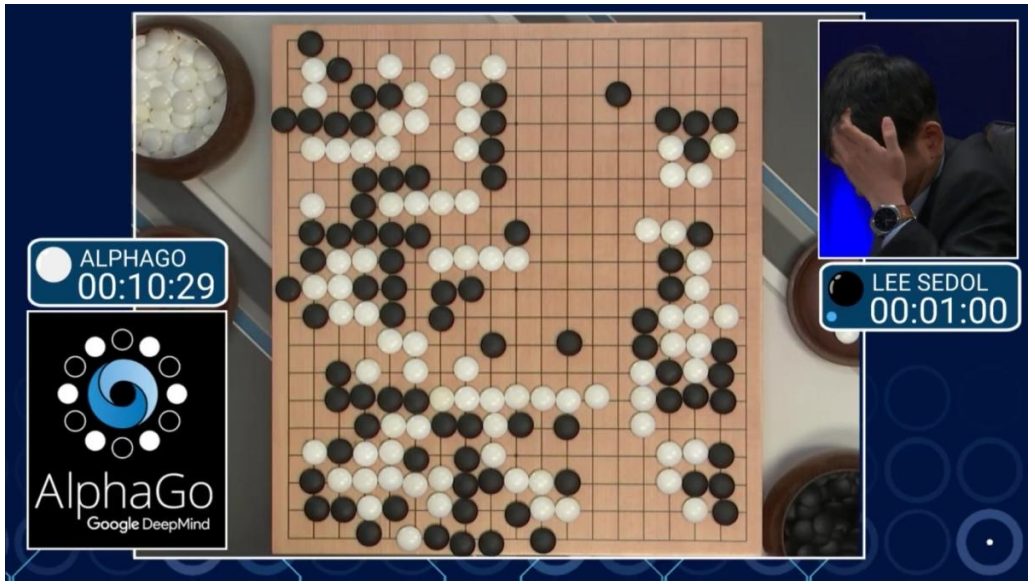


AlexNet architecture

Krizhevsky, A., Sutskever, I., & Hinton, G. E. (2012). Imagenet classification with deep convolutional neural networks. In Advances in neural information processing systems (pp. 1097-1105).

2010—2017: Big Data, GPUs, Deep Learning

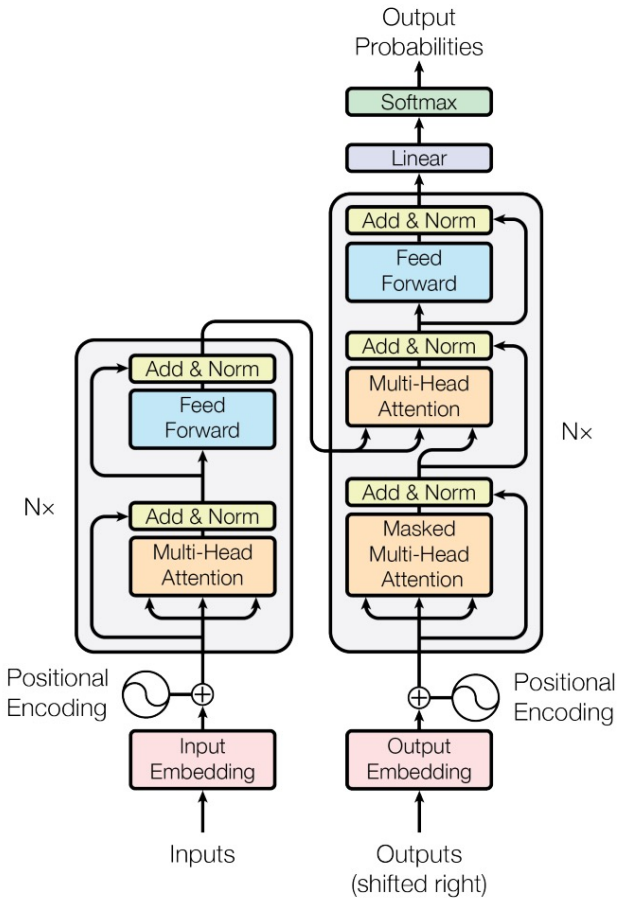
- 2011: Apple releases Siri
- 2012: AlexNet wins ImageNet competition
- 2015: DeepMind achieves “human-level” control in Atari games
- 2016: DeepMind’s AlphaGo defeats Lee Sedol at Go
- 2016: Google Translate migrates to neural networks



Silver, D., Huang, A., Maddison, C. J., Guez, A., Sifre, L., Van Den Driessche, G., ... & Dieleman, S. (2016). Mastering the game of Go with deep neural networks and tree search. nature, 529(7587), 484.

2017—: Scaling Up, Large Language Models

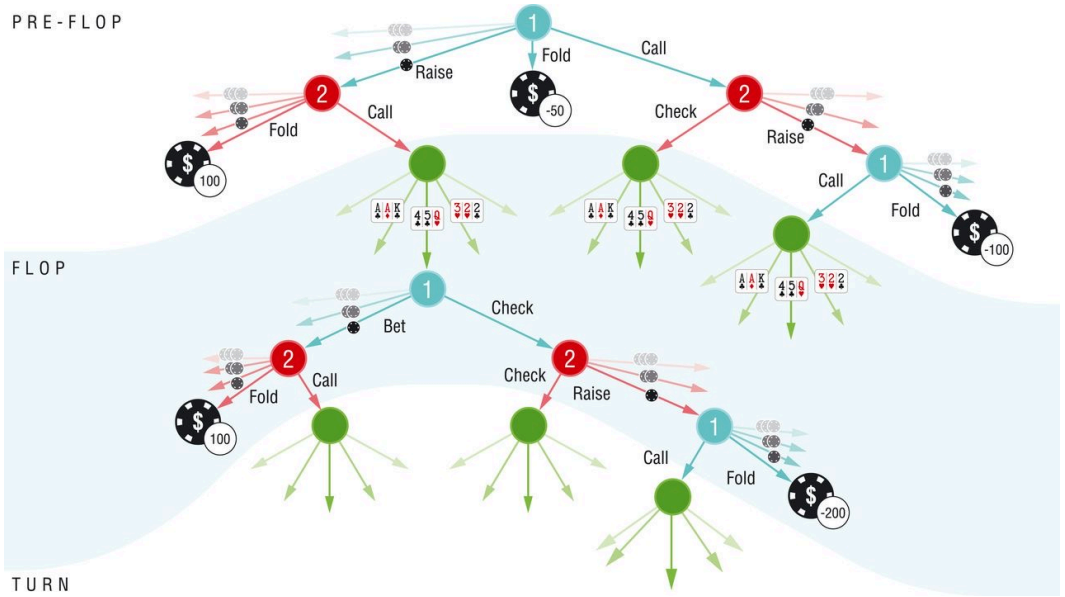
- 2017: Google invents Transformer architecture

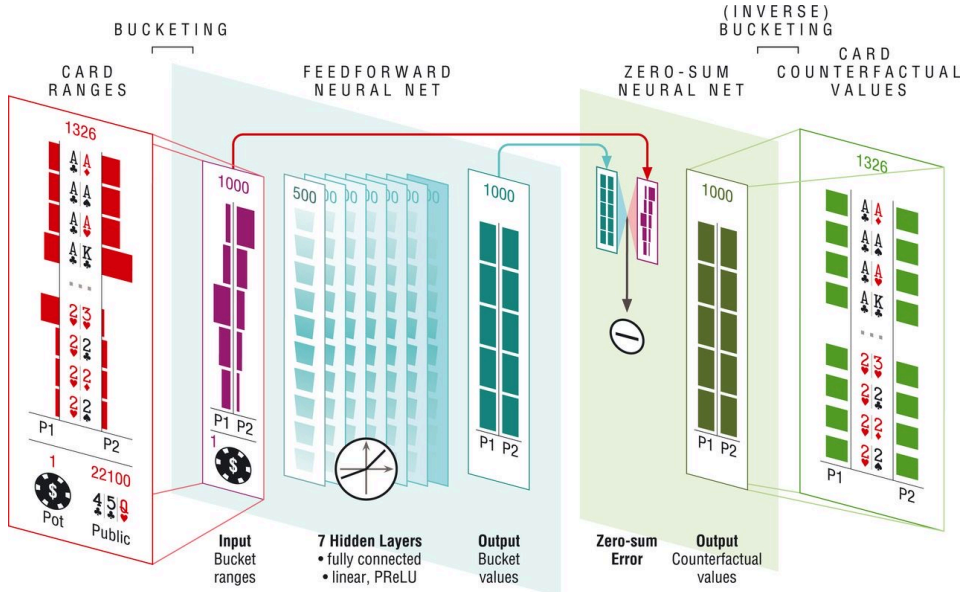


Vaswani, A., Shazeer, N., Parmar, N., Uszkoreit, J., Jones, L., Gomez, A. N., ... & Polosukhin, I. (2017). Attention is all you need. *Advances in neural information processing systems*, *30*.

2017—: Scaling Up, Large Language Models

- 2017: Google invents Transformer architecture
- 2017: DeepStack/Libratus defeat humans at poker

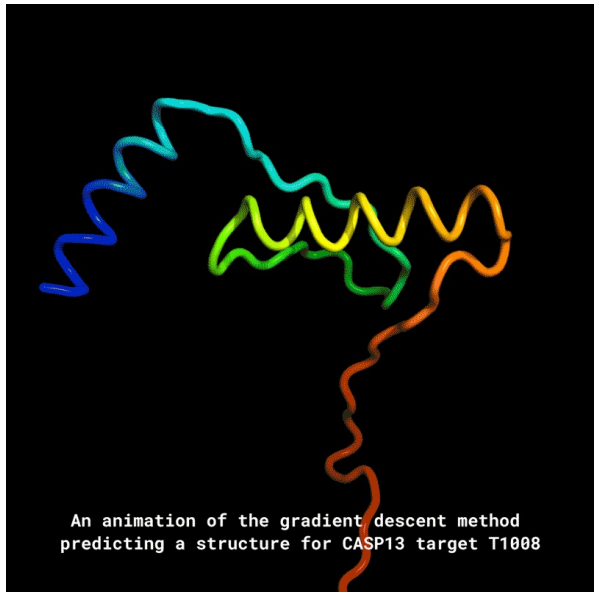




Moravčík, M., Schmid, M., Burch, N., Lisý, V., Morrill, D., Bard, N., ... & Bowling, M. (2017). Deepstack: Expert-level artificial intelligence in heads-up no-limit poker. Science, 356(6337), 508-513.

2017—: Scaling Up, Large Language Models

- 2017: Google invents Transformer architecture
- 2017: DeepStack/Libratus defeat humans at poker
- 2018-2020: AlphaFold predicts protein structure from amino acids

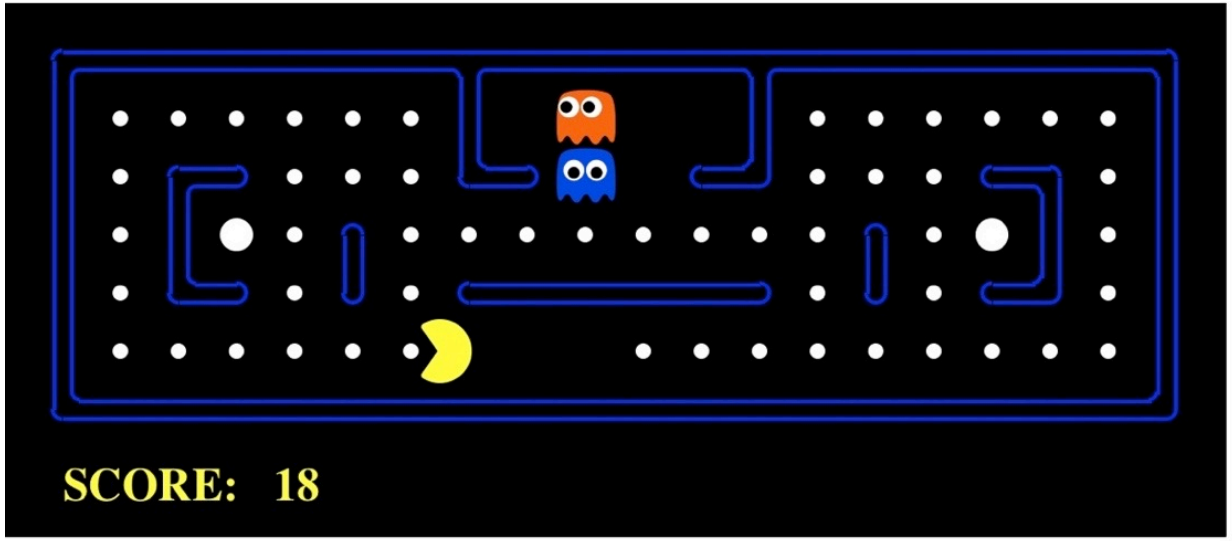


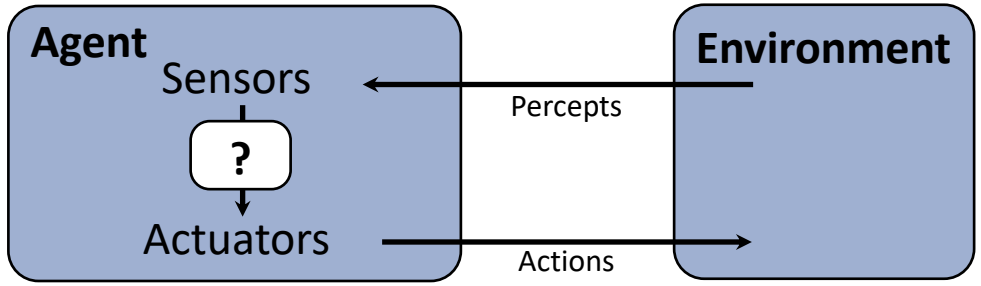
https://www.theguardian.com/science/2018/dec/02/google-deepminds-ai-program-alphafold-predicts-3d-shapes-of-proteins

2017—: Scaling Up, Large Language Models

- 2017: Google invents Transformer architecture
- 2017: DeepStack/Libratus defeat humans at poker
- 2018-2020: AlphaFold predicts protein structure from amino acids
- 2021-2022: Modern text-to-image generation
- 2022: OpenAI releases ChatGPT
- 2023: Every other company also releases a chatbot

Pac-Man as an Agent

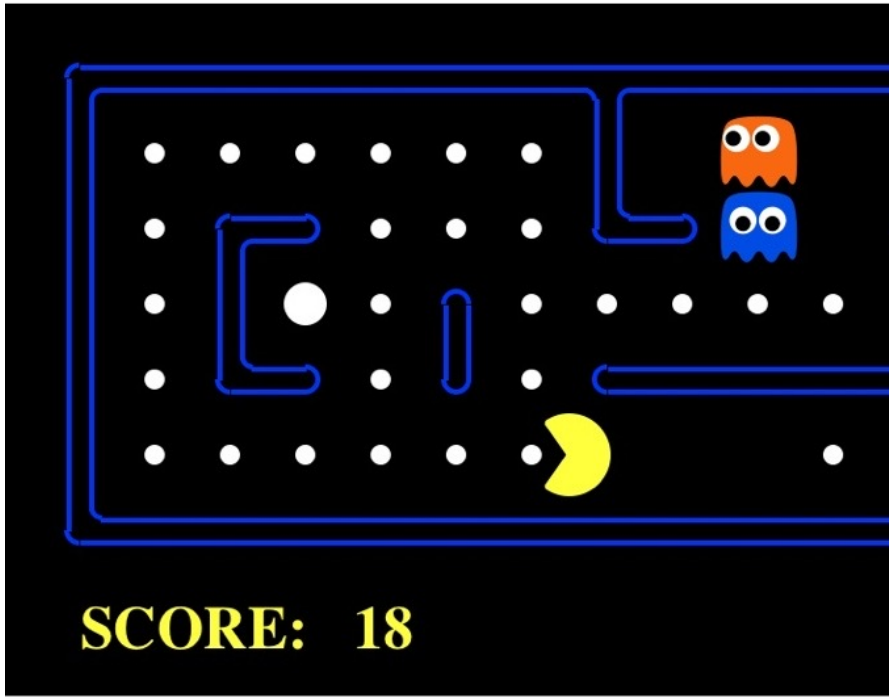




Pac-Man is a registered trademark of Namco-Bandai Games, used here for educational purposes

The task environment: Pacman

- Performance measure
  - -1 per step; + 10 food; +500 win; -500 die; +200 hit scared ghost
- Environment
  - Pacman dynamics (incl ghost behavior)
- Actuators
  - Left Right Up Down or NSEW
- Sensors
  - Entire state is visible (except power pellet duration)



The task environment: Automated taxi

- Performance measure
  - Income, happy customer, vehicle costs, fines, insurance premiums
- Environment
  - Streets, other drivers, customers, weather, police…
- Actuators
  - Steering, brake, gas, display/speaker
- Sensors
  - Camera, radar, accelerometer, engine sensors, microphone, GPS

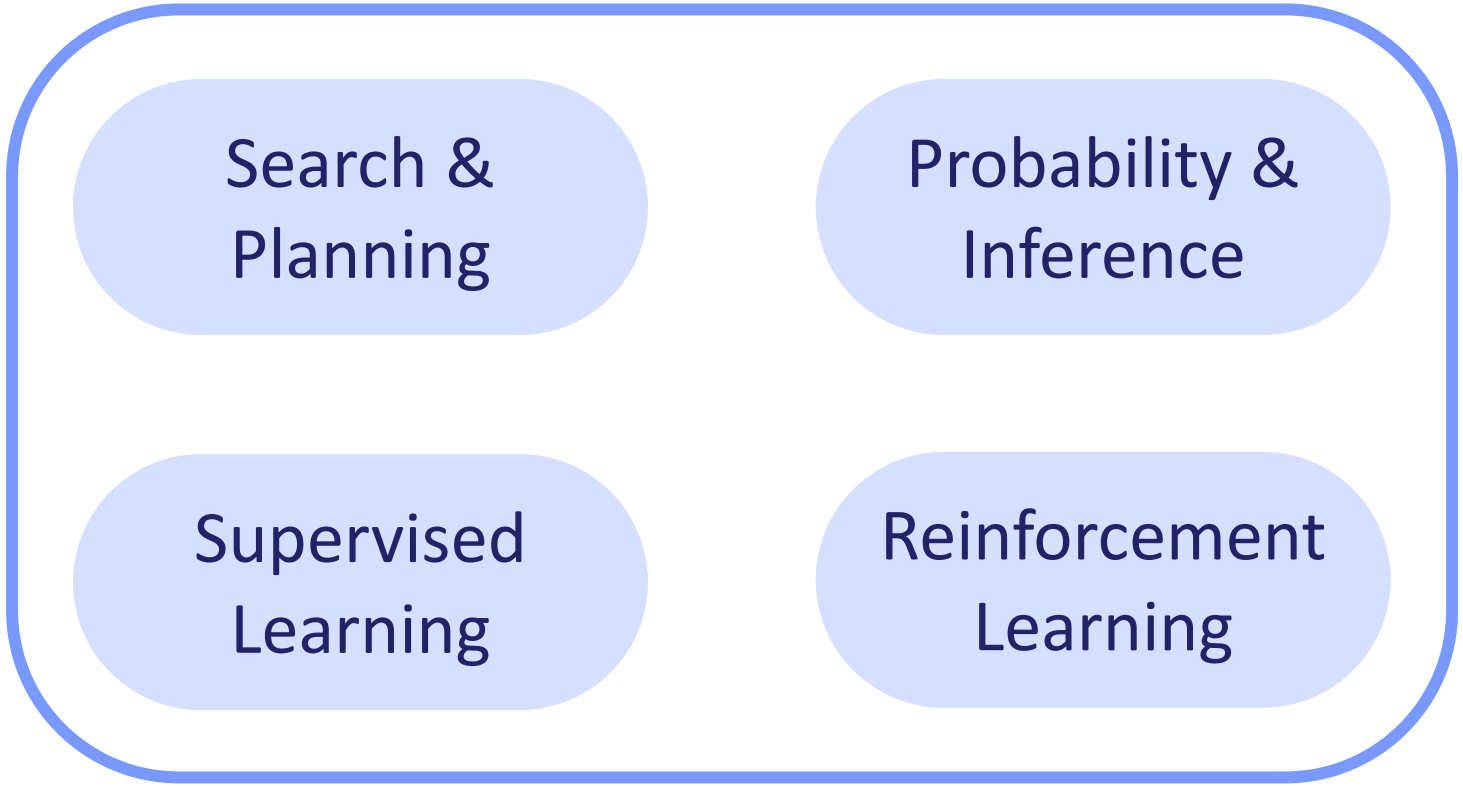
https://www.sfchronicle.com/sf/article/cruise-waymo-driverless-cars-in-s-f-18282902.php

Environment types influence the agent design

- Partially observable => agent requires memory (internal state)
- Stochastic => agent may have to prepare for contingencies
- Multi-agent => agent may need to behave randomly
- Static => agent has time to compute a rational decision
- Continuous time => continuously operating controller
- Unknown physics => need for exploration
- Unknown perf. measure => observe/interact with human principal

Course Topics

Core Components of Rational Agents:



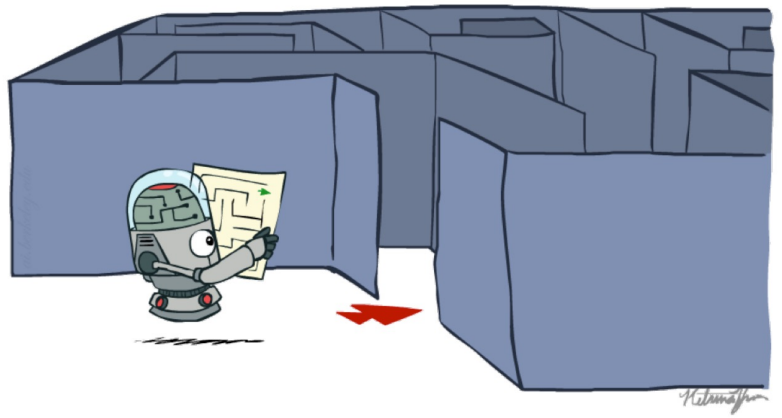
Course Topics

Search & Planning

Probability & Inference

Supervised Learning

Reinforcement Learning



How can I use my ***model*** of the world to find a ***sequence of actions*** to achieve my ***goal***?

Course Topics

Search & Planning

Probability & Inference

Supervised Learning

Reinforcement Learning

How can I make sense of ***uncertainty***?

Course Topics

Search & Planning

Probability & Inference

Supervised Learning

Reinforcement Learning

How can I learn a ***model*** of the world from ***data***?

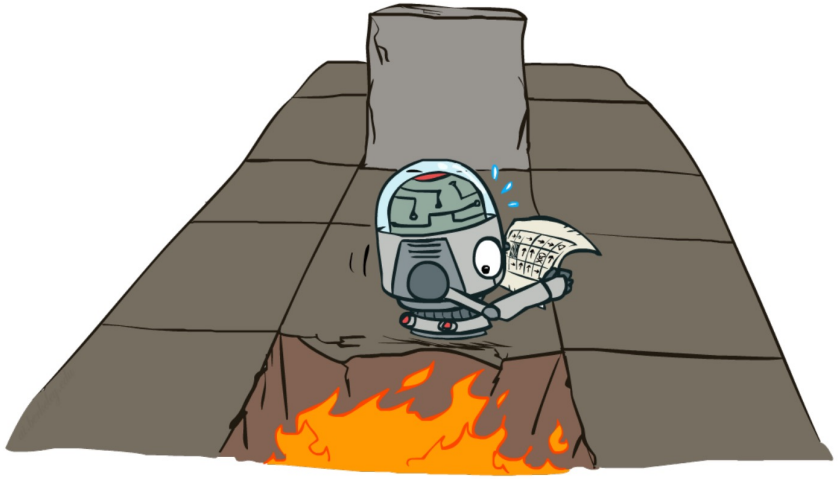
Course Topics

Search & Planning

Probability & Inference

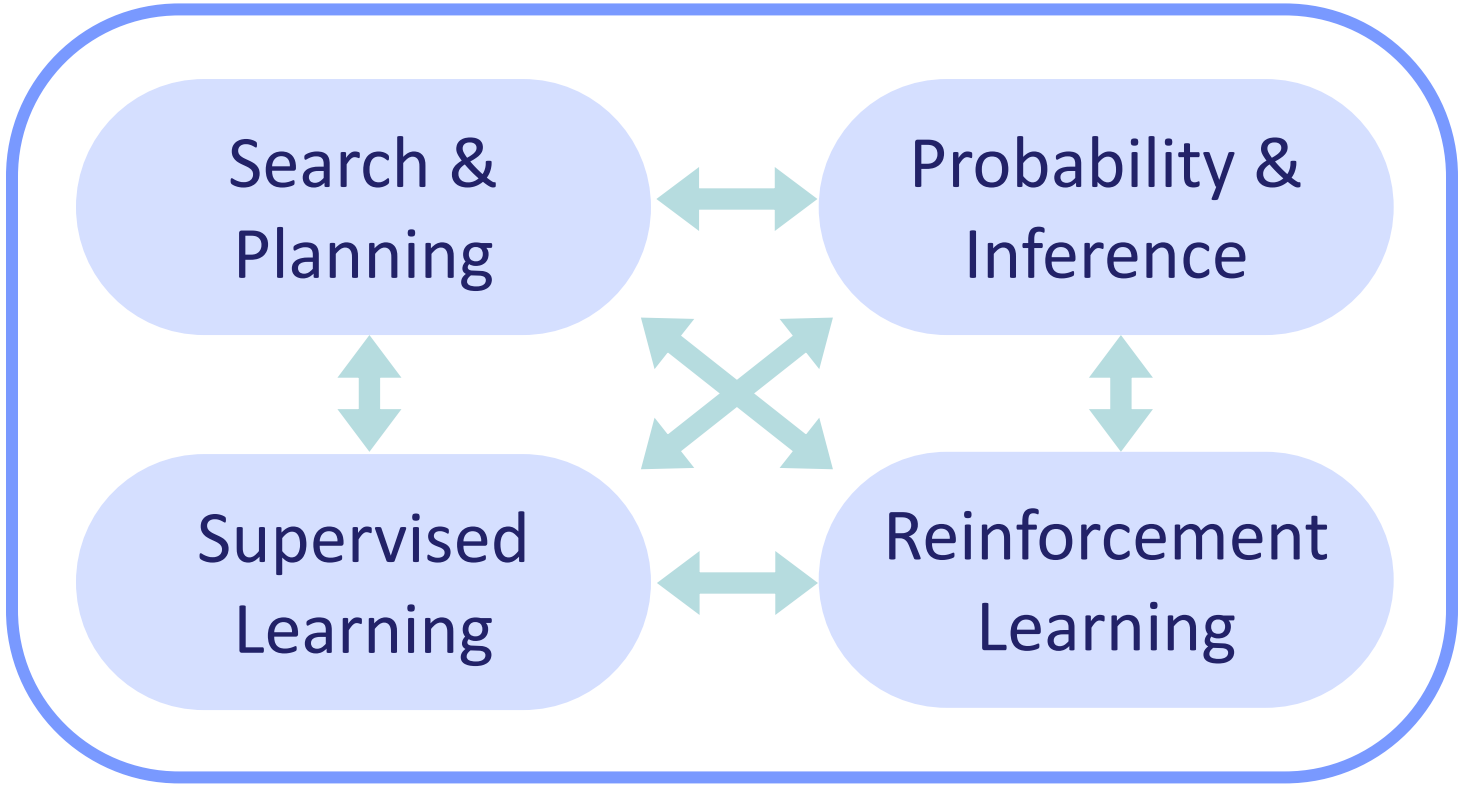
Supervised Learning

Reinforcement Learning

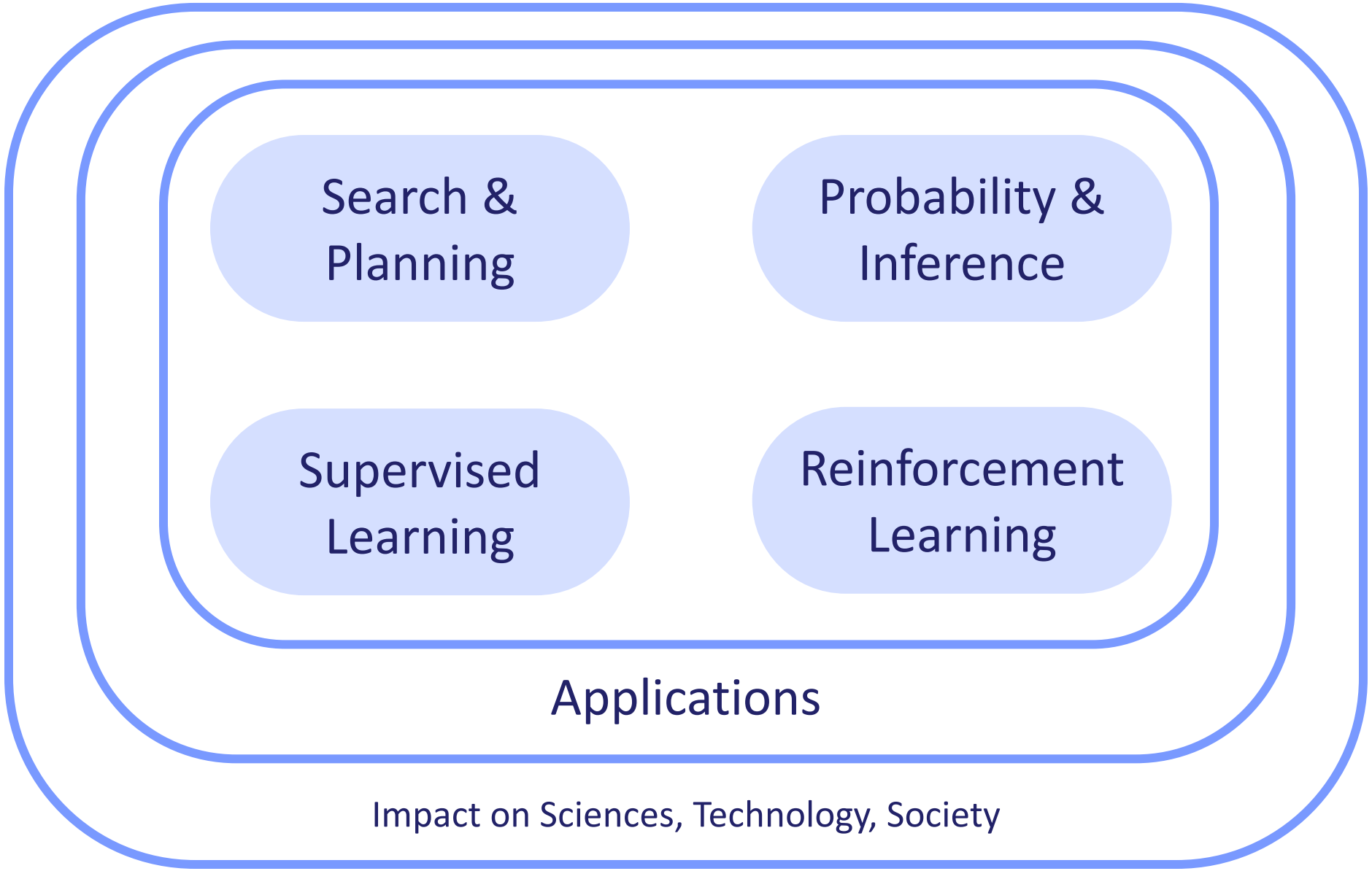


How can I learn a ***policy*** for any situation so that I can ***maximize utility***?

Course Topics

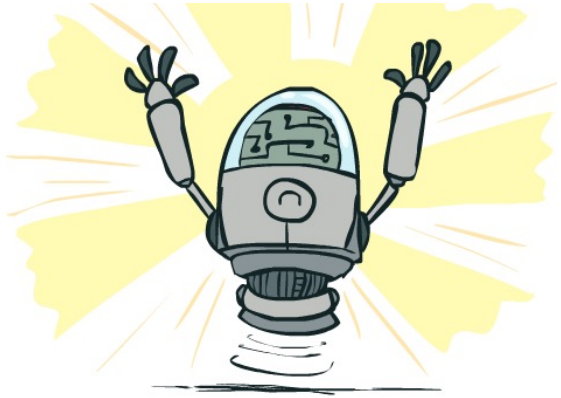


Course Topics



By the end of this course you'll:

- Build and understand math of rational, learning agents
- Select and apply the right AI methods for wide range of problems
- Recognize how these methods are used in modern AI systems
- Be prepared to make decisions on how AI is used in society



Next Lecture: Search