

CS181: Artificial Intelligence

Introduction

Kan Ren

Fall 2024

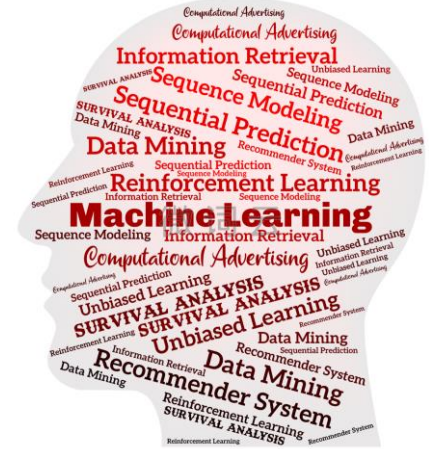
Outlines

- Administrative stuff
- A brief introduction to AI
- Course content overview

ADMINISTRATIVE STUFF

Administrative stuff

- Instructor: Kan Ren
 - Email: renkan@shanghaitech.edu.cn
 - Office: SIST 1C-303A
- First-year assistant professor at VDI, SIST
 - Machine learning for perception, cognition, and decision making upon multi-modal big data, e.g., foundation model research and AI agents.
 - How to conduct foundation models on more modalities, e.g., time series data?
 - Explore and understand the underlying mechanisms of large models.
 - Improve reasoning and decision making of large models in real-world scenarios.
 - Previous Senior Researcher at Microsoft Research Asia.



Administrative stuff

- TAs

- Our talented staff team!



吴昊一



张峥



李昌明



顾书齐

Administrative stuff

- Classes

- Wed/Fri 10:15 – 11:55am @教学中心303
- 16 weeks
- Language: Written materials in English, lectures in Chinese

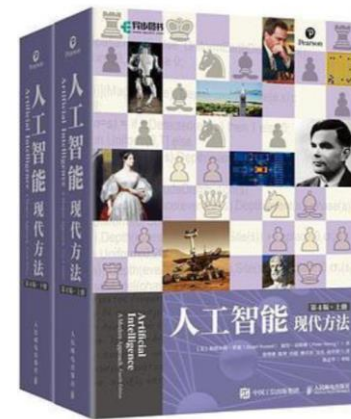
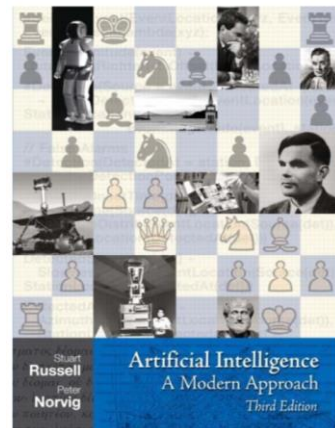
- Office hour

- TBA

Administrative stuff

- Main textbook

- [AIMA] Artificial Intelligence: A Modern Approach, Stuart Russell and Peter Norvig, 4th edition, 2020.
- [中译版] 人工智能：现代方法（第4版），2022



- Additional reference books will also be used

Administrative stuff

- Blackboard
 - Announcements, homework assignments, slides, etc.
- Piazza
 - Discussion and QA
 - <https://piazza.com/shanghaitech.edu.cn/fall2024/cs181>
- AutoLab
 - Programming assignments
- GradeScope
 - Exam grading

Administrative stuff

- Grading
 - 6 homework assignments (10%)
 - 6 programming assignments (25%)
 - Project (15%): 2nd half of the semester
 - Midterm exam (25%): around mid Nov.
 - Final exam (25%): in week 17-18
- You have 5 slip days to use across the semester

Administrative stuff

- Plagiarism

- All assignments must be done individually
 - You may not look at solutions from any other source
 - You may not share solutions with any other students
 - Plagiarism detection software will be used on all the programming assignments
- Way of collaboration
 - You may discuss together or help another student debug code
 - However, you cannot dictate or give the exact solution

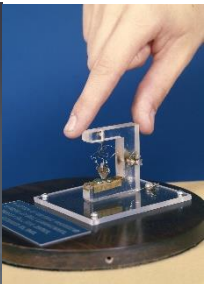
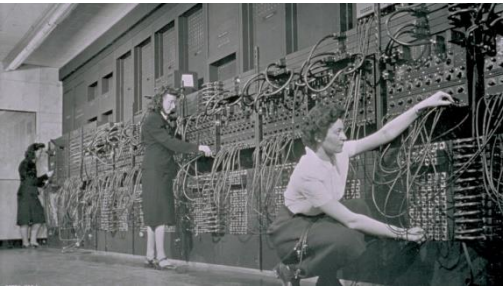
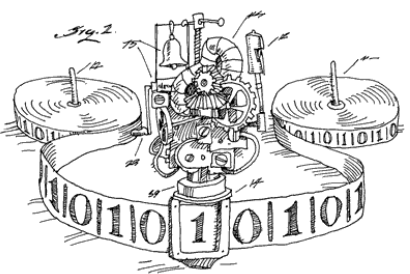
Administrative stuff

- Plagiarism punishment

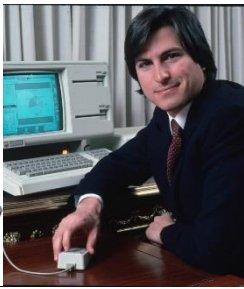
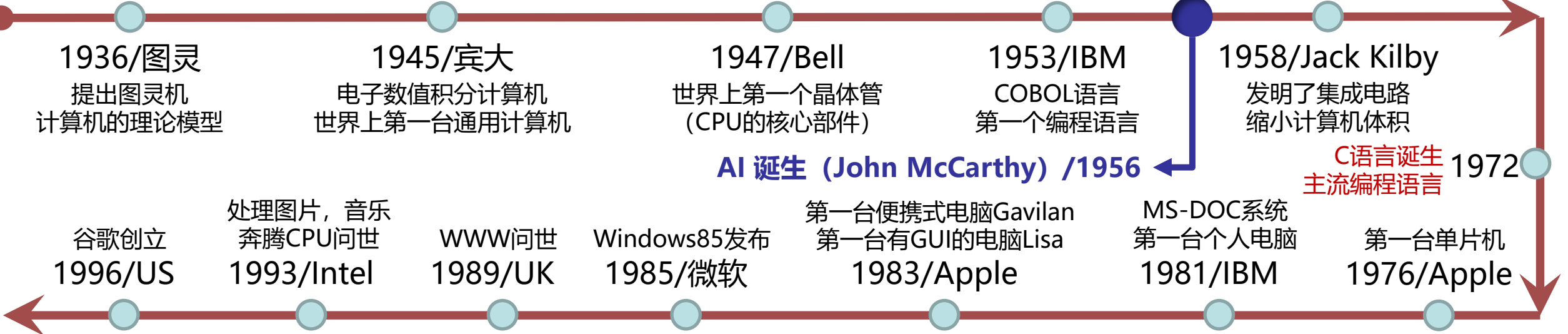
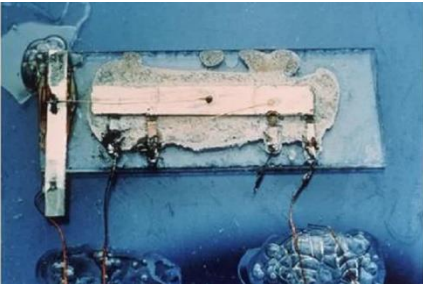
- When one student copies from another student, both students are responsible
- Zero point on the assignment or exam in question
- Repeated violation will result in an F grade for this course as well as further discipline at the school/university level

A BRIEF INTRODUCTION TO AI

History of Computer Science ~ 2000



```
> setup the identification division
IDENTIFICATION DIVISION.
> setup the program id
PROGRAM-ID. HELLO.
> setup the procedure division (lik
PROCEDURE DIVISION.
  > print a string
  DISPLAY 'WILLKOMMEN'.
> end our program
STOP RUN.
```



History of Computer Science 2000 ~



1997/IBM

Deepblue首次打败人类
(国际象棋)



2003/AMD

Athlon 64
第一个64位CPU



2004/Mozilla

Firefox 1.0
挑战IE的网页浏览器



2005/谷歌

收购Android
开源手机操作系统



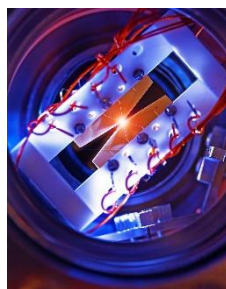
2006/Apple

MacBook Pro首次发布
第一台双核笔记本

首次打败人类
AlphaGo围棋系统
2017/Deepmind



量子计算机问世
2016/Maryland



Apple Watch
2015/Apple



首次打败人类
Watson抢答系统
2011/IBM



第一代手持平板电脑
iPad
2010/Apple

第一代智能手机
iPhone 1
2007/Apple



History of Computer Science 2000 ~



2022/Stability AI
Stable Diffusion



2022/OpenAI
ChatGPT 聊天机器人



2023/OpenAI
GPT-4 图文交互

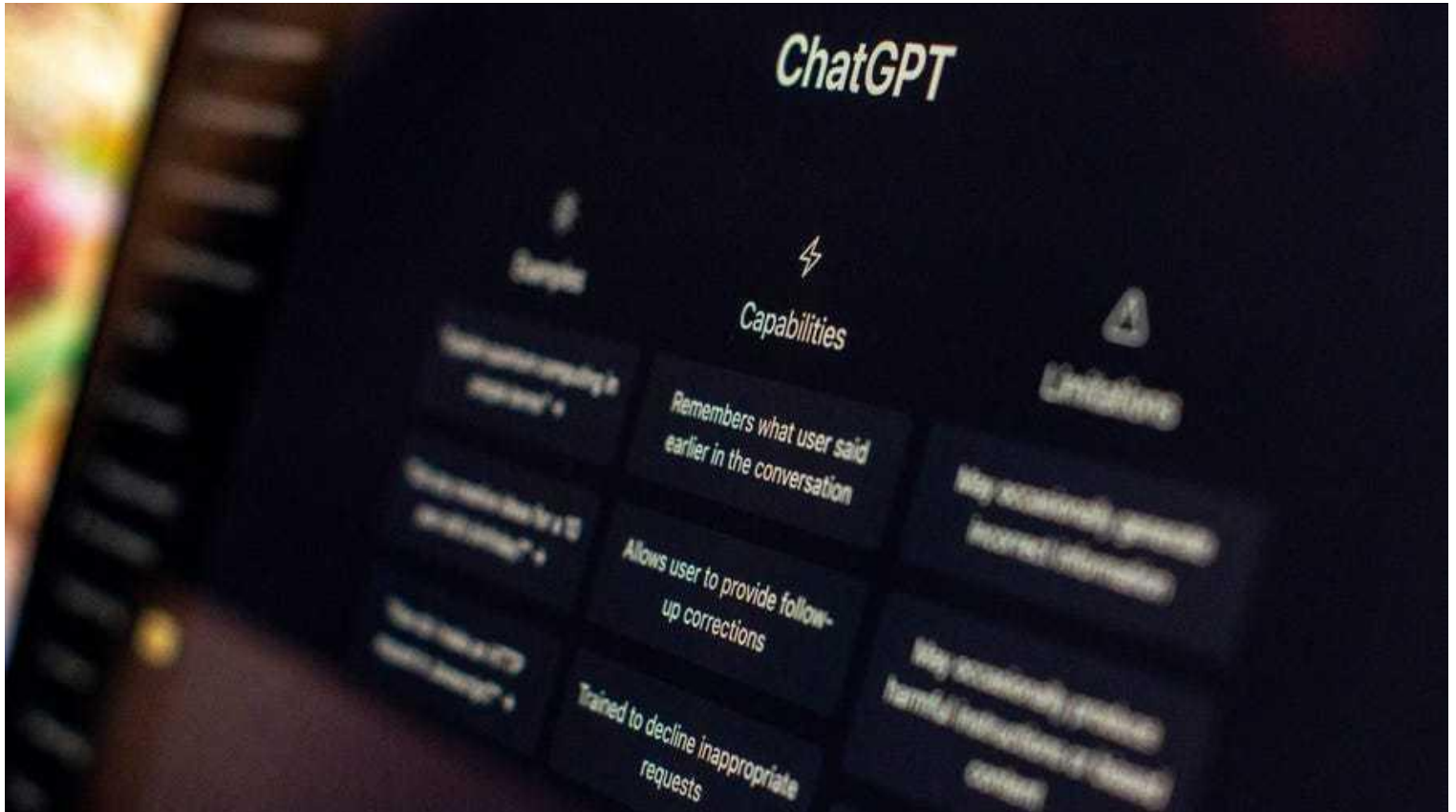


2024/OpenAI
Sora 视频生成

AI is shaping the future.

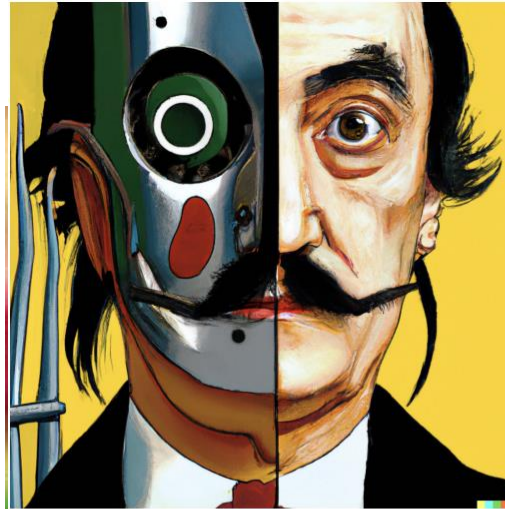
AI is having real-world impact

- Public imagination
 - Text assistants



AI is having real-world impact

- Public imagination
 - Text assistants
 - Image generation



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

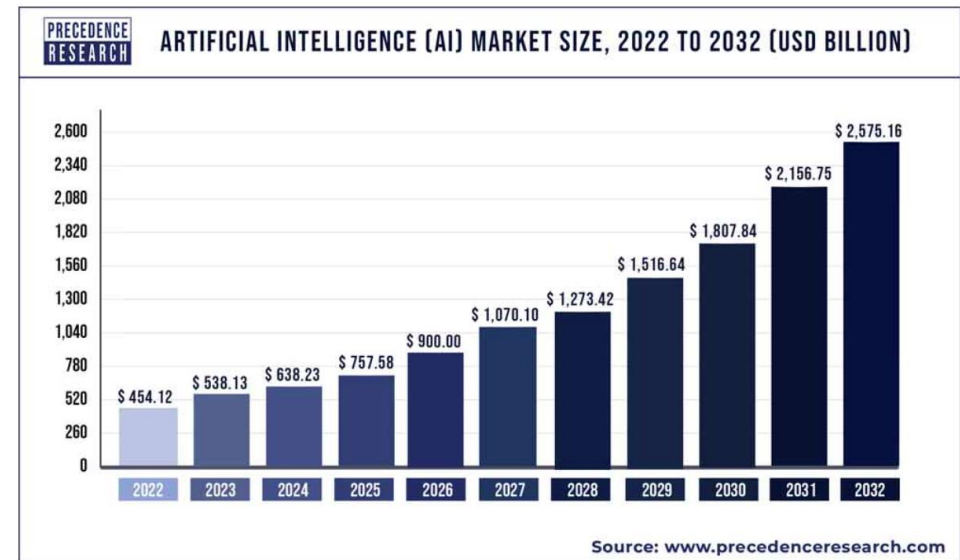


a corgi's head depicted as an explosion of a nebula

AI is having real-world impact

- Public imagination
- 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

- Public imagination
- Economy
- Politics



AI is having real-world impact

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AI is having real-world impact

- Public imagination
- Economy
- Politics



AI is having real-world impact

- Public imagination
- Economy
- Politics



AI is having real-world impact

- Public imagination
- Economy
- Politics
- Law

Aug. 18, 2023, 12:18 PM; Updated: Aug. 18, 2023, 12:48 PM

AI-Generated Art Lacks Copyright Protection, D.C. Court Says (1)



Riddhi Setty
Reporter



Isaiah Poritz
Legal Reporter



Bloomberg Law, 2023

AI is having real-world impact

- Public imagination
- Economy
- Politics
- Law
- 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

- Public imagination
- Economy
- Politics
- Law
- Labor
- Sciences

nature
BIOTECH

AlphaFold Developers Win \$3-Million Breakthrough Prize in Life Sciences

DeepMind's system for predicting the 3D structure of proteins is among five recipients of science's most lucrative awards

By Zeeya Merali, Nature magazine on September 22, 2022

Nature, 2022

AI is having real-world impact

- Public imagination
- Economy
- Politics
- Law
- Labor
- Sciences



Wired, 2022

AI is having real-world impact

- Public imagination
- Economy
- Politics
- Law
- Labor
- Sciences
- 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

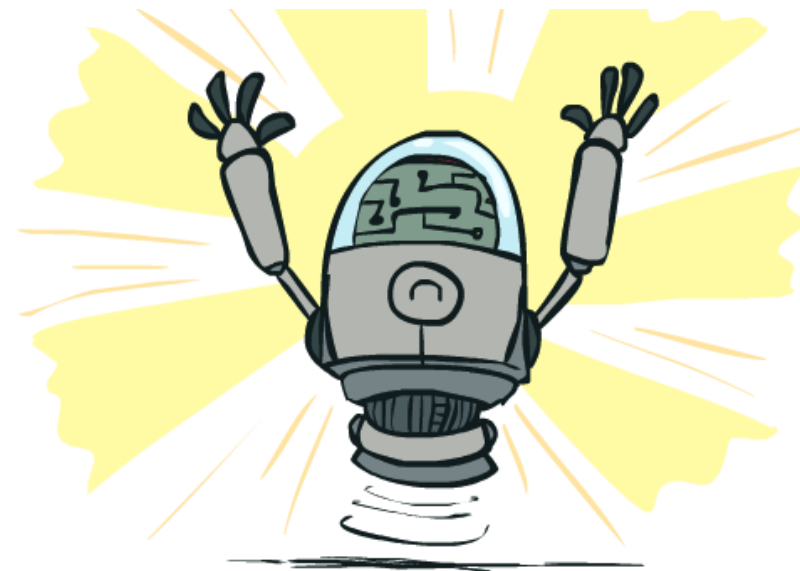
- Public imagination
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Ok, but what actually is AI???

What Can AI Do?

Quiz: Which of the following can be done at present?

- ✓ Win against any human at chess?
- ✓ Win against the best humans at Go?
- Play a decent game of table tennis?
- Unload any dishwasher in any home?
- Drive safely along the highway?
- Drive safely along streets of Shanghai?
- Buy a week's worth of groceries on the web?
- Buy a week's worth of groceries at FamilyMart?
- Discover and prove a new mathematical theorem?
- Perform a surgical operation?
- Translate spoken Chinese into spoken English in real time?
- Trade in real-world markets?
- Make money for humans, so humans can take it easy.
- Construct a building?



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Google's AlphaGo beats Lee Sedol at Go in 2016



But ... a plot twist in 2023!

DEEP BLUE WAS JUST THE START —

Man beats machine at Go in human victory over AI

Amateur exploited weakness in systems that have otherwise dominated grandmasters.

RICHARD WATERS, FINANCIAL TIMES - 2/19/2023, 4:51 AM

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California just opened the floodgates for self-driving cars

After a state regulatory board ruling, San Francisco will have 24/7 robotaxis on its streets. A Washington Post analysis shows how it's a pivotal moment for the industry.

By [Trisha Thadani](#) and [Jeremy B. Merrill](#)

Updated August 10, 2023 at 10:06 p.m. EDT | Published August 10, 2023 at 9:15 p.m. EDT

The Register

California DMV hits brakes on Cruise's SF driverless fleet after series of fender benders

50% chop effective 'immediately' as department investigates traffic and safety issues

 [Jude Karabus](#)

Mon 21 Aug 2023 // 14:28 UTC

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OpenAI's new o1 model can solve 83% of International Mathematics Olympiad problems

By HT News Desk | Edited by Abhyjith K. Ashokan

Sep 14, 2024 03:42 PM IST



OpenAI's new o1 model can be used for scientific research in physics, chemistry, and engineering, where rigorous reasoning and complex problem-solving are prime



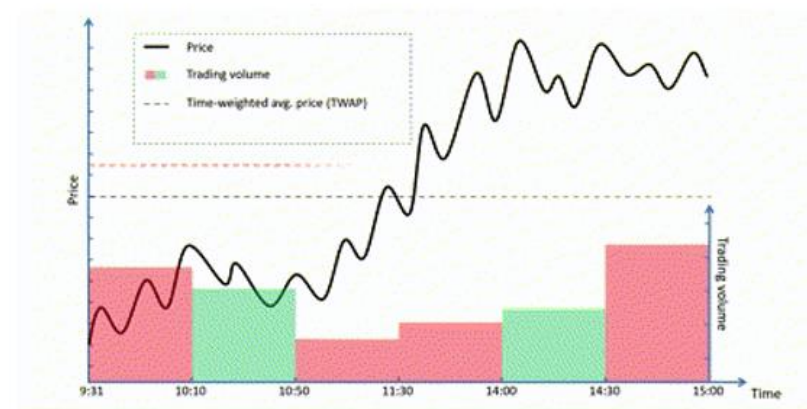
A symbol for the OpenAI virtual assistant on a smartphone, arranged in Riga, Latvia, on Friday, Aug. 16, 2024. (Andrey Rudakov/Bloomberg)

OpenAI will launch o1, its latest artificial intelligence (AI) model in two weeks. This will mark the debut of a new class of reasoning AI models and comes amid the speculation of the release of "Strawberry" AI.

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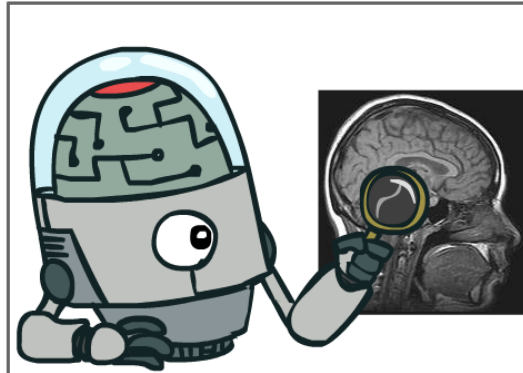
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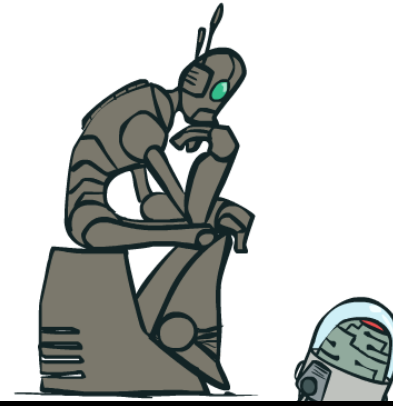
What should we build?

Should we make machines that...

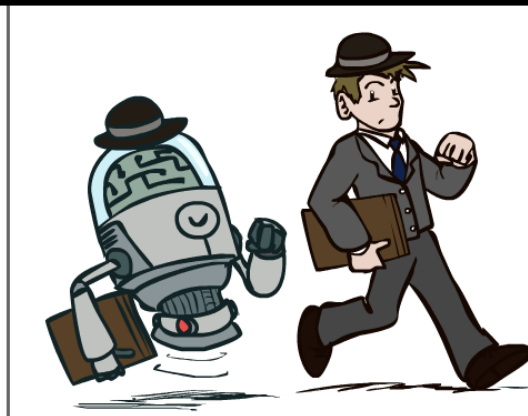
Think like people?



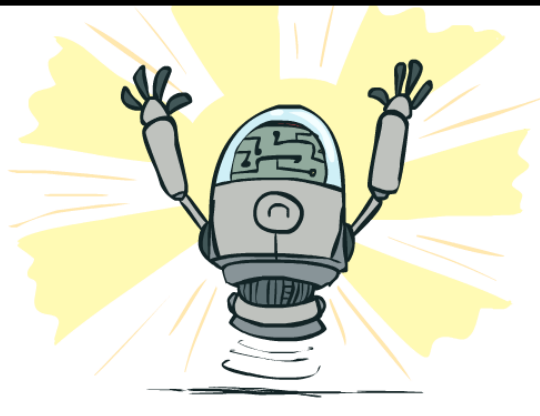
Think rationally?



Act like people?

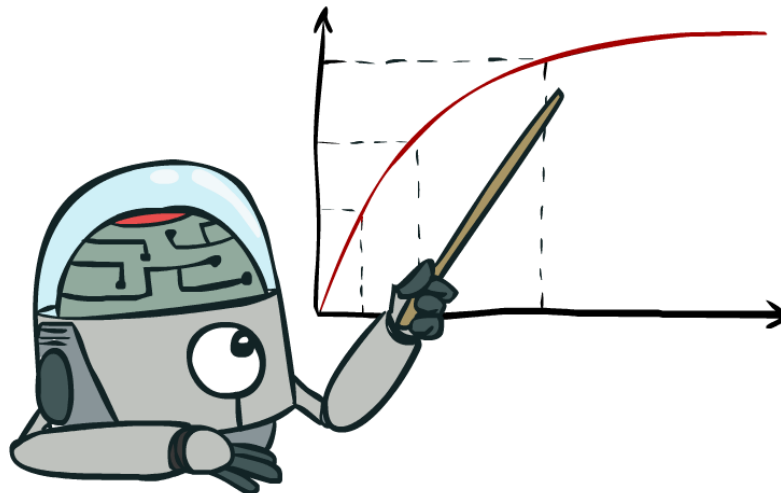


Act rationally?



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**



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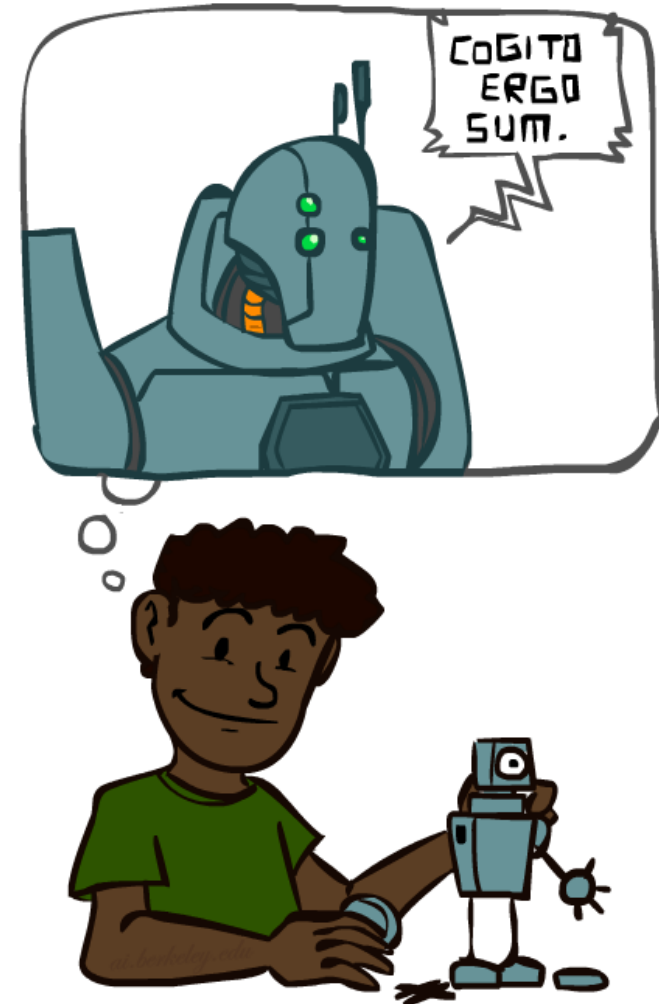
A better title for this course might be:

Computational Rationality

A (Short) 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

*“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.”*



Turing Test

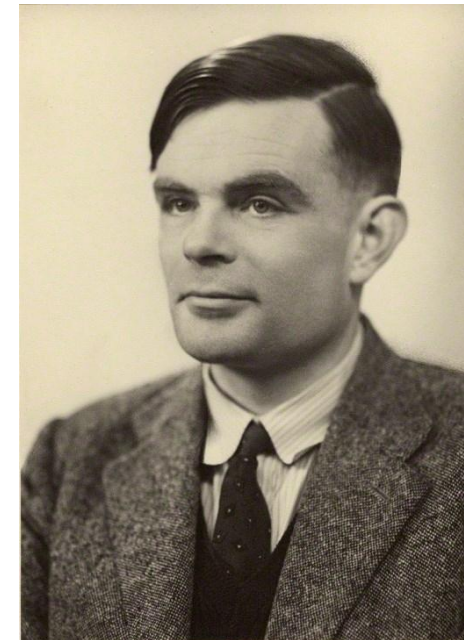
- Lots of early speculation & research
 - Turing: “Computing Machinery and Intelligence” (1950)

I.—COMPUTING MACHINERY AND INTELLIGENCE

BY A. M. TURING

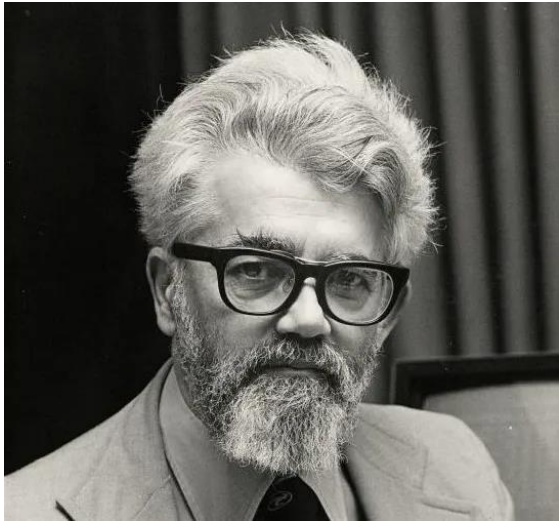
1. *The Imitation Game.*

I PROPOSE to consider the question, ‘Can machines think?’ This should begin with definitions of the meaning of the terms ‘machine’ and ‘think’. The definitions might be framed so as to reflect so far as possible the normal use of the words, but this attitude is dangerous. If the meaning of the words ‘machine’ and ‘think’ are to be found by examining how they are commonly used it is difficult to escape the conclusion that the meaning and the answer to the question, ‘Can machines think?’ is to be sought in a statistical survey such as a Gallup poll. But this is absurd. Instead of attempting such a definition I shall replace the question by another, which is closely related to it and is expressed in relatively unambiguous words.

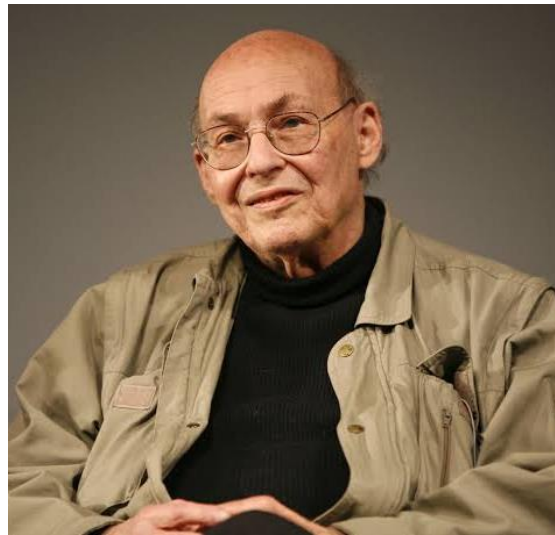


Dartmouth Conference

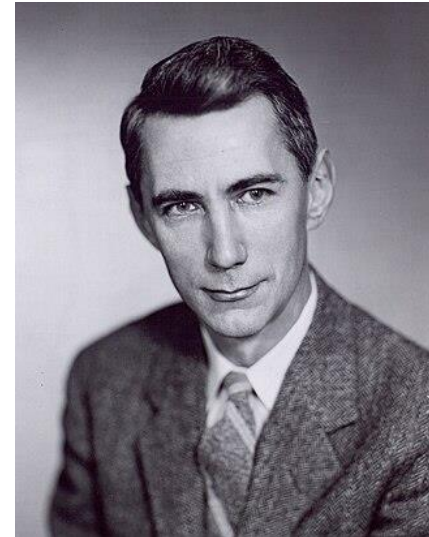
- Dartmouth Summer Research Project on Artificial Intelligence
 - The birth of artificial intelligence (AI) as a formal academic discipline



John McCarthy
Father of AI and Lisp



Marvin Minsky
Perceptrons



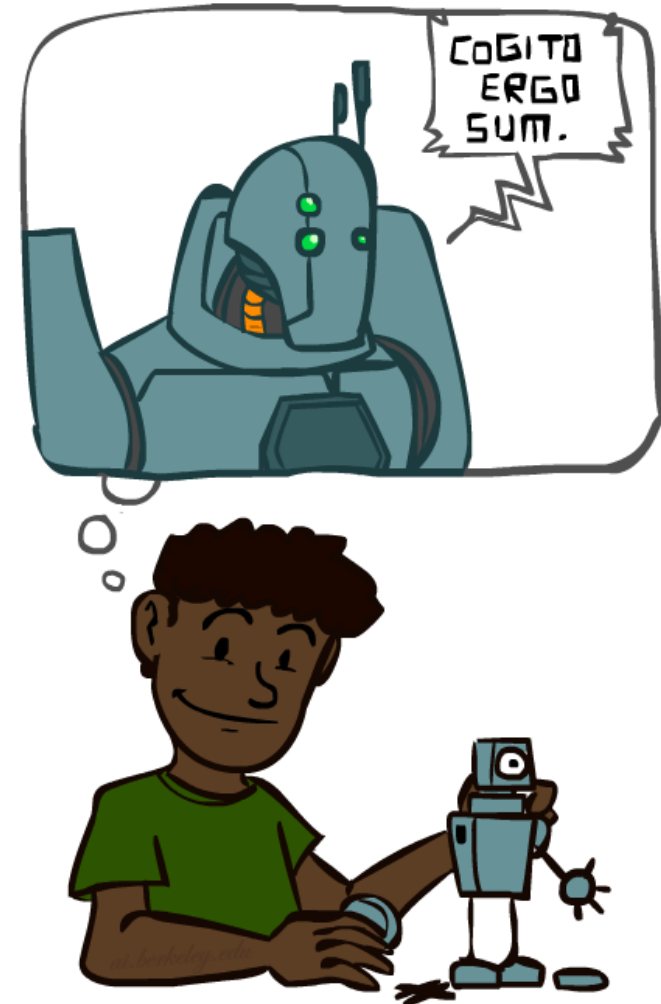
Claude Shannon
Information Theory



Nathaniel Rochester
Architect of IBM 701

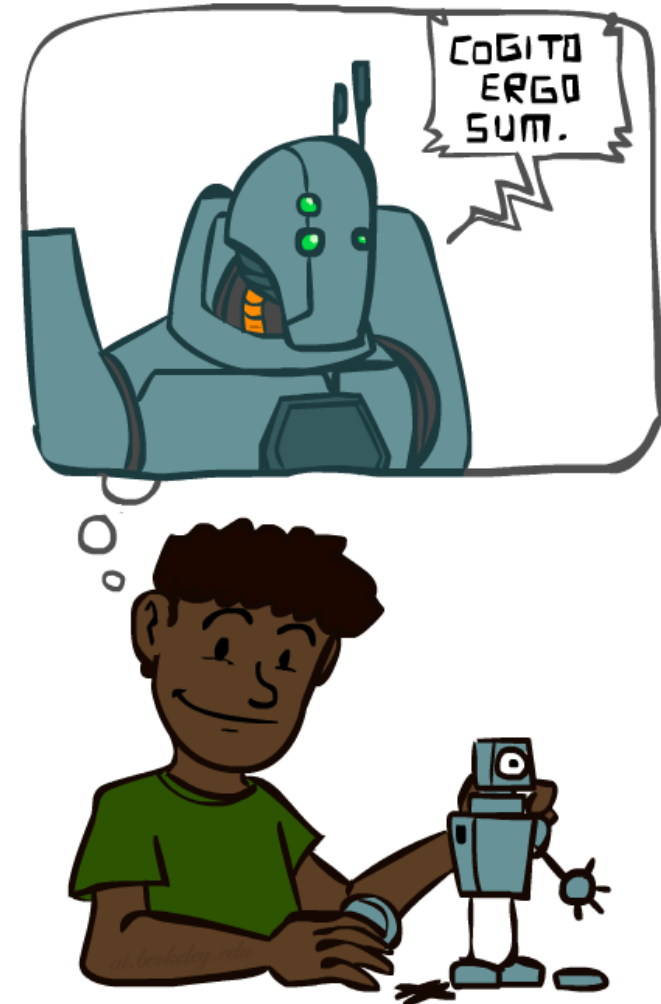
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 - 1950s: Early AI programs, including Samuel's checkers program, Newell & Simon's Logic Theorist, Gelernter's Geometry Engine
 - 1956: Dartmouth meeting: “Artificial Intelligence” adopted
 - 1969: Minsky & Papert: perceptrons can't learn XOR/parity!
- **1970—90: Knowledge-based approaches**
 - 1969—79: Early development of knowledge-based systems
 - 1980—88: Expert systems industry booms; backpropagation makes it feasible to train multi-layer neural networks
 - 1988—93: Expert systems industry busts: “AI Winter”
- **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



A (Short) History of AI

- **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
- **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



AI Trends

- 2024 AI Index Report

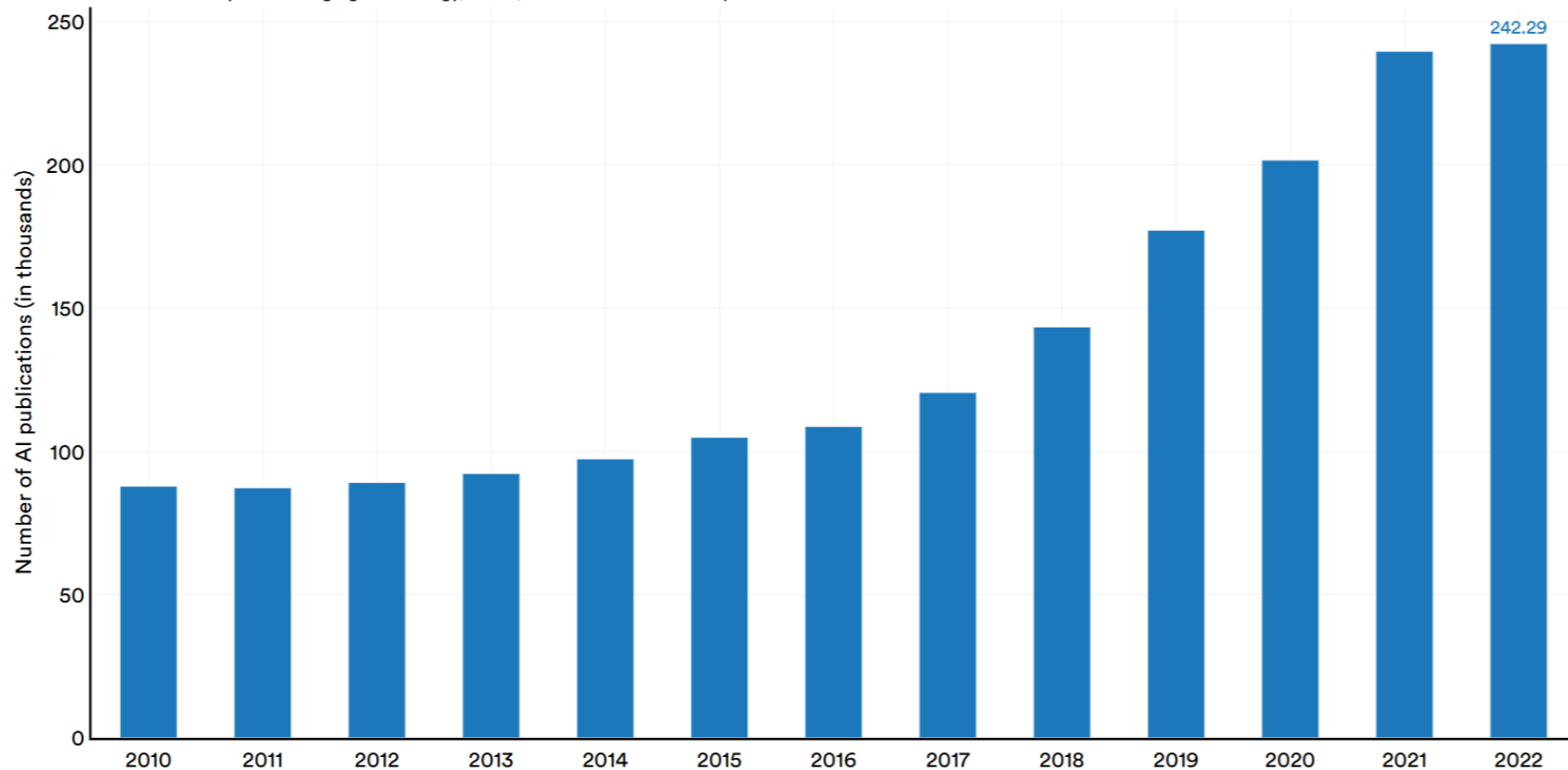


<https://aiindex.stanford.edu/report/>

AI Publications

Number of AI publications in the world, 2010–22

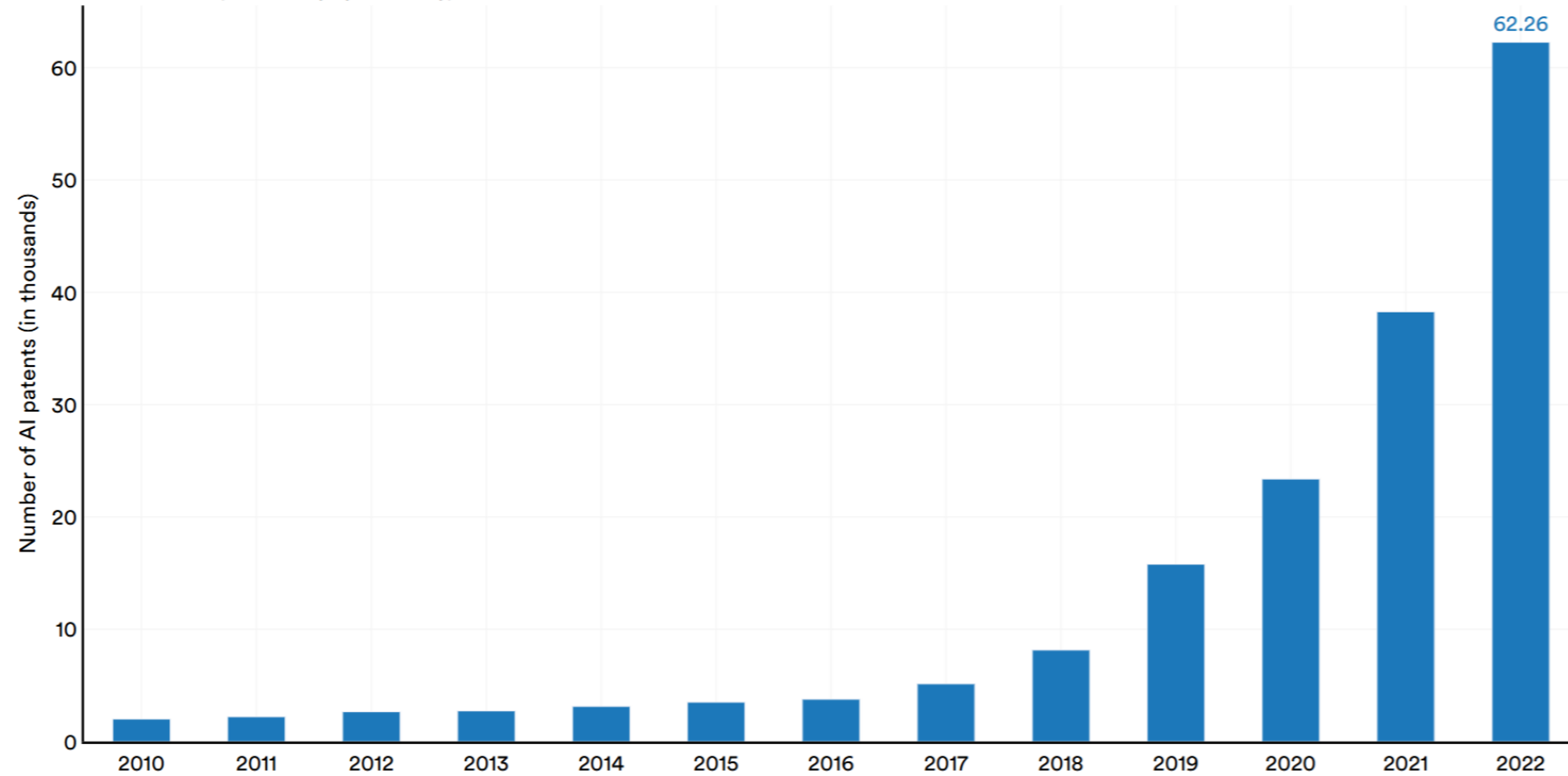
Source: Center for Security and Emerging Technology, 2023 | Chart: 2024 AI Index report



AI Patents

Number of AI patents granted, 2010–22

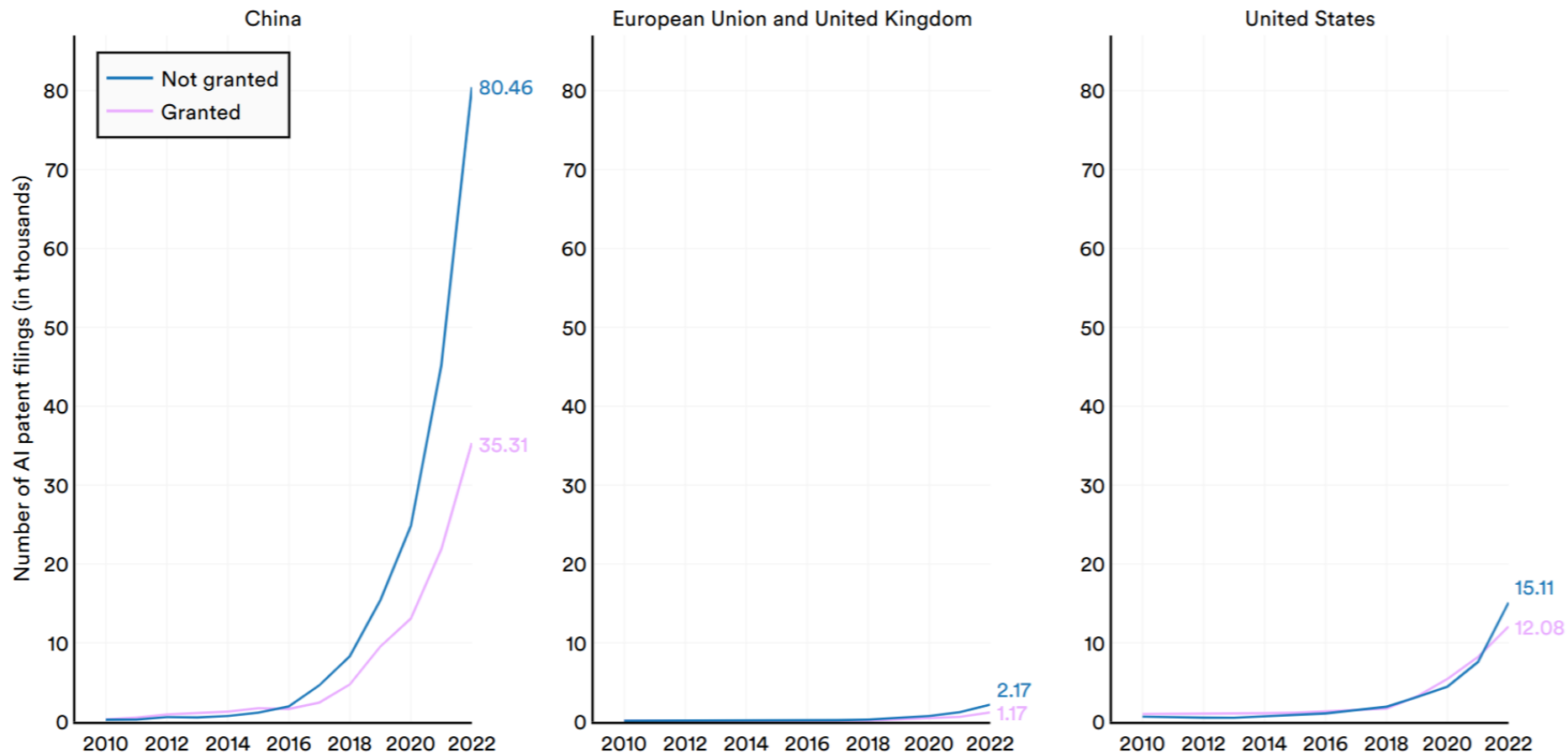
Source: Center for Security and Emerging Technology, 2023 | Chart: 2024 AI Index report



AI Patents

AI patents by application status by geographic area, 2010–22

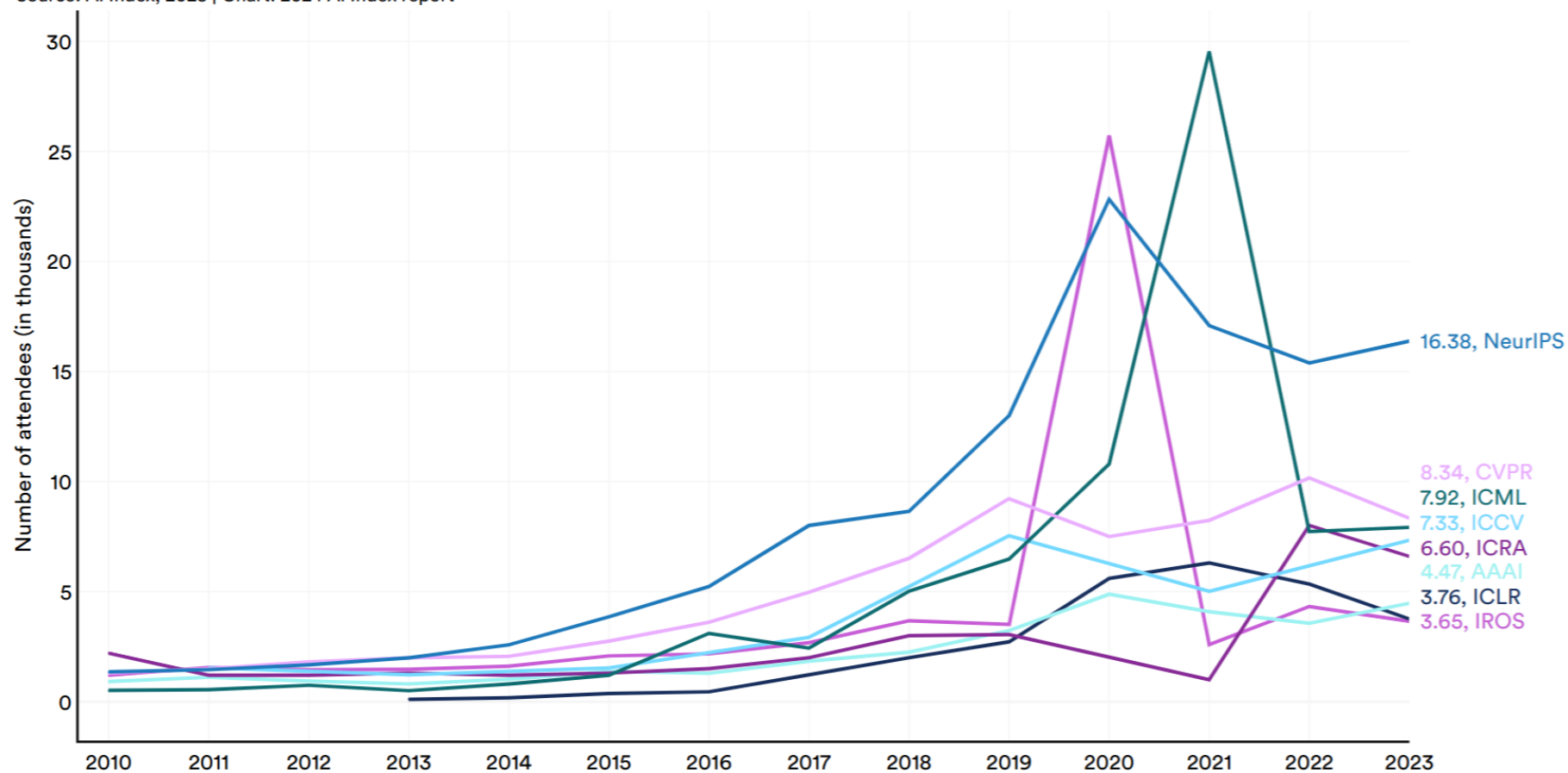
Source: Center for Security and Emerging Technology, 2023 | Chart: 2024 AI Index report



Conference Attendance

Attendance at large conferences, 2010–23

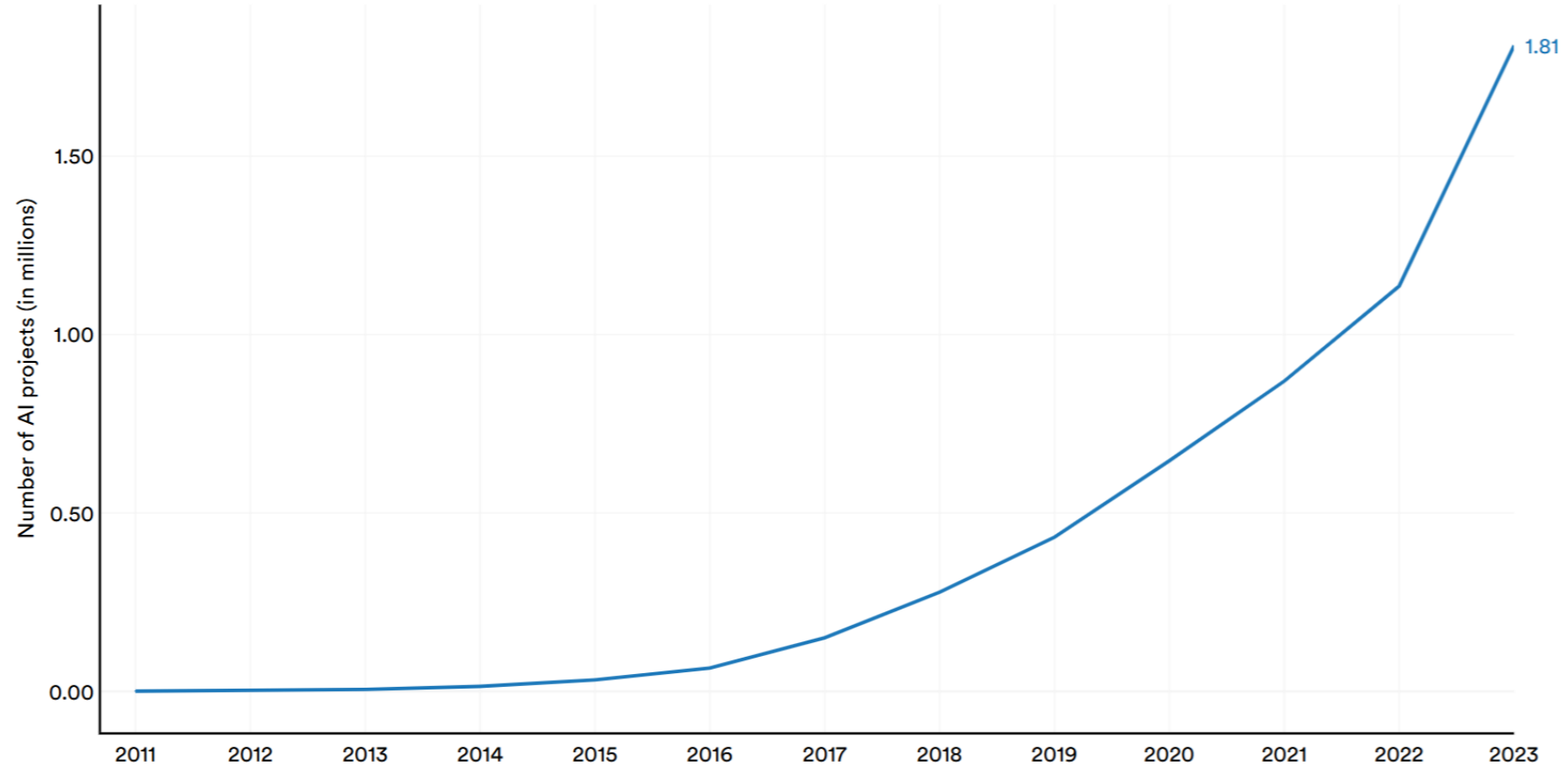
Source: AI Index, 2023 | Chart: 2024 AI Index report



Open-source Projects

Number of GitHub AI projects, 2011–23

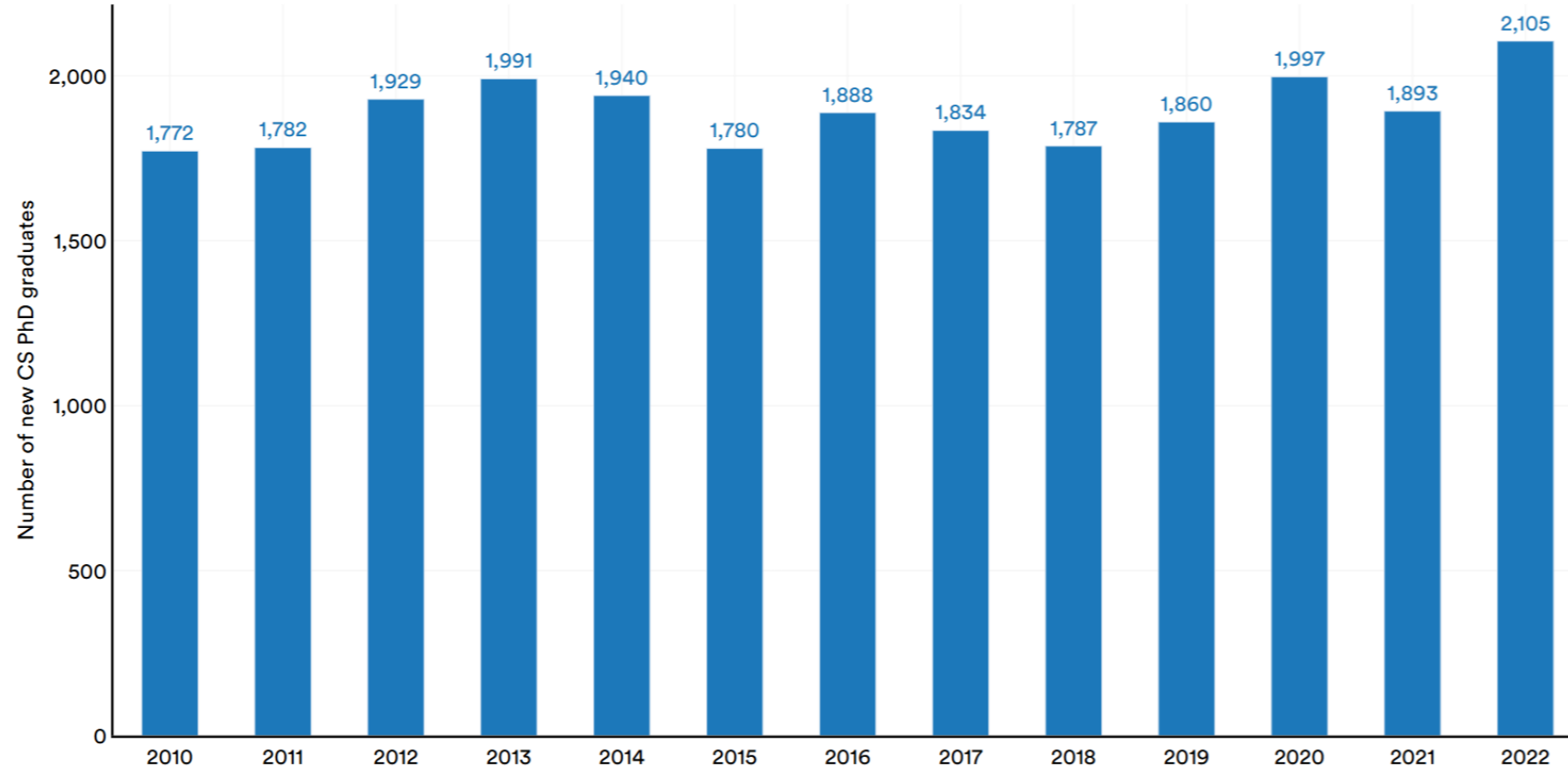
Source: GitHub, 2023 | Chart: 2024 AI Index report



CS PhD

New CS PhD graduates in the United States and Canada, 2010–22

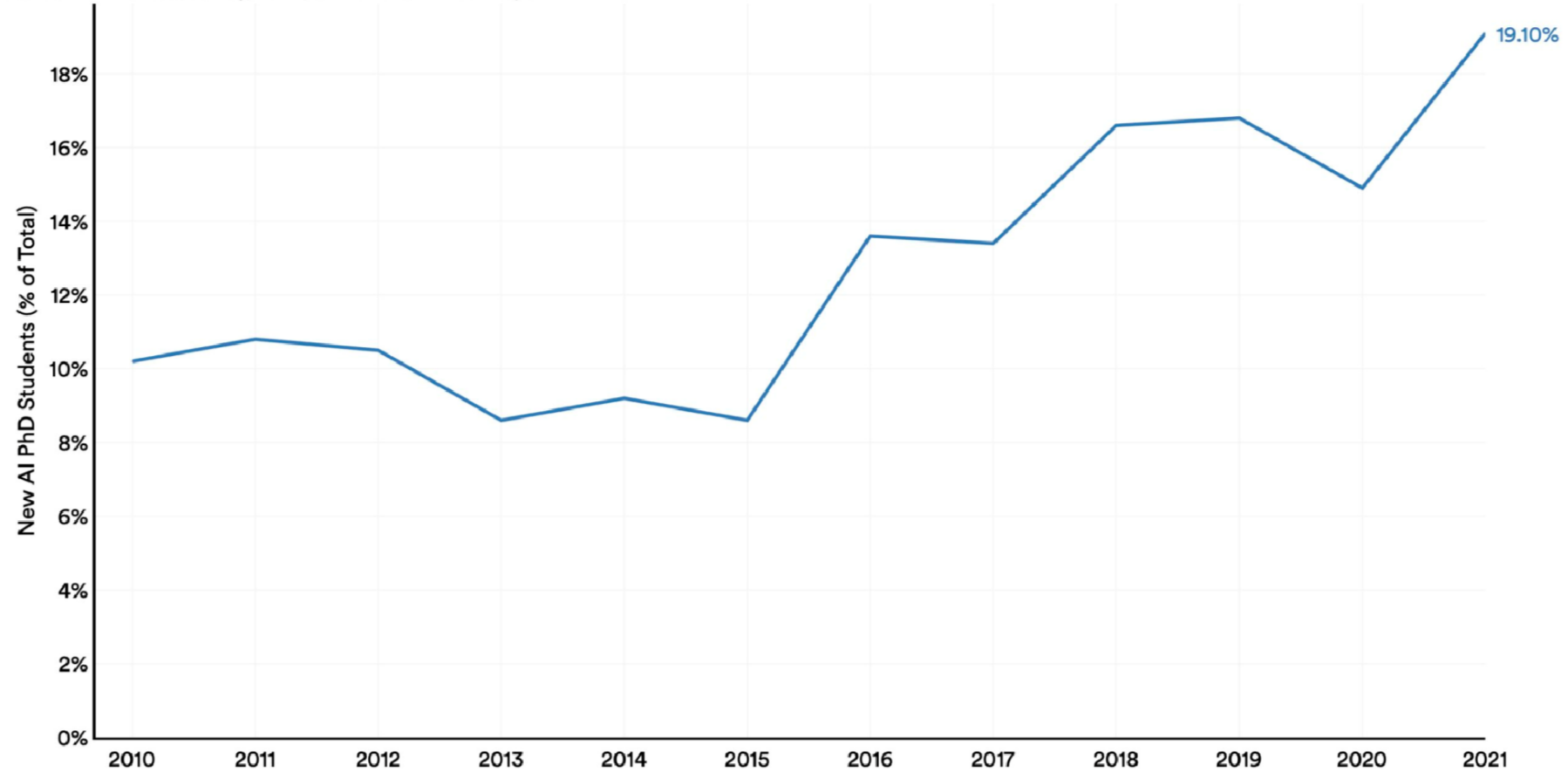
Source: CRA Taulbee Survey, 2023 | Chart: 2024 AI Index report



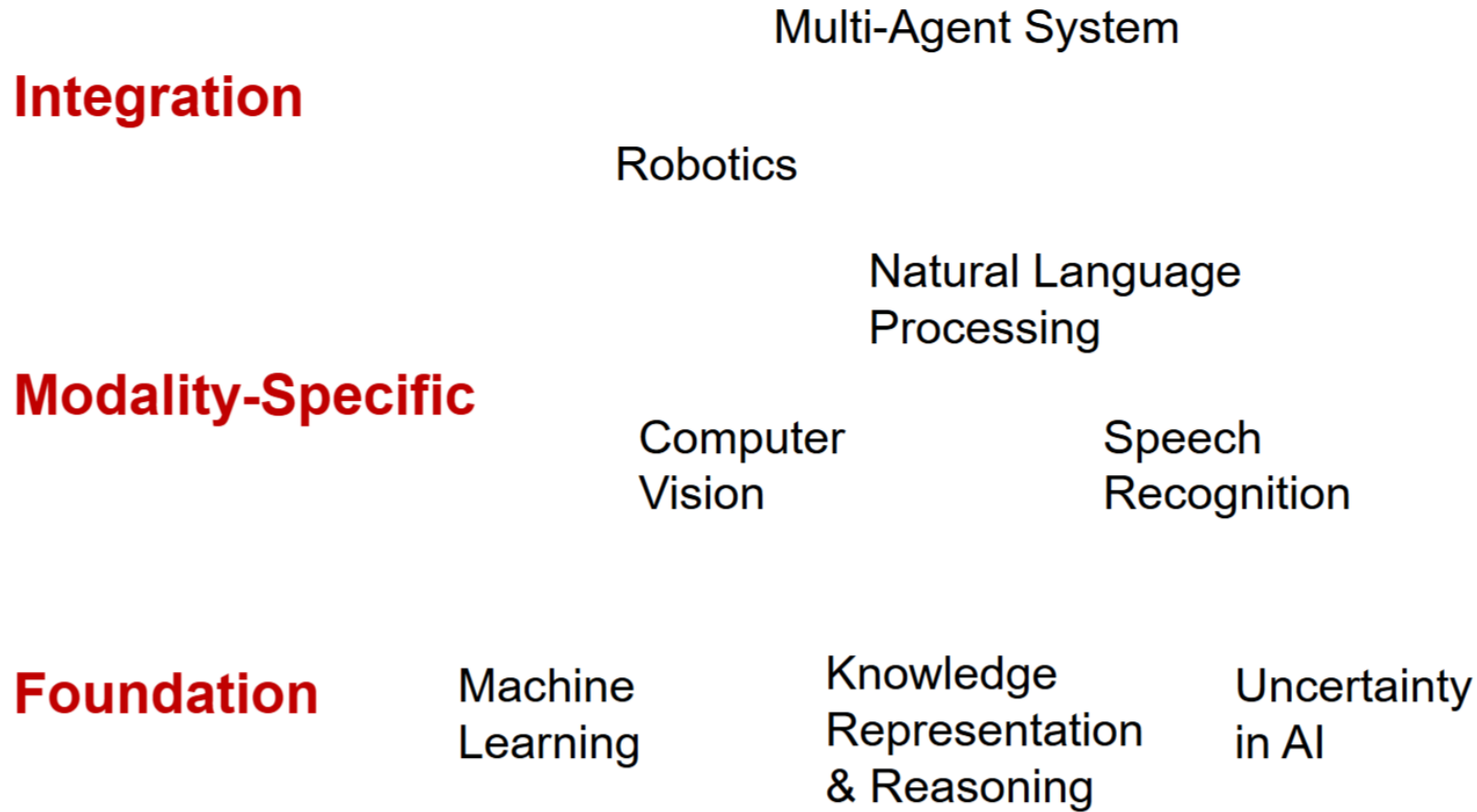
CS PhD

New CS PhD Students (% of Total) Specializing in AI, 2010–21

Source: CRA Taulbee Survey, 2022 | Chart: 2023 AI Index Report

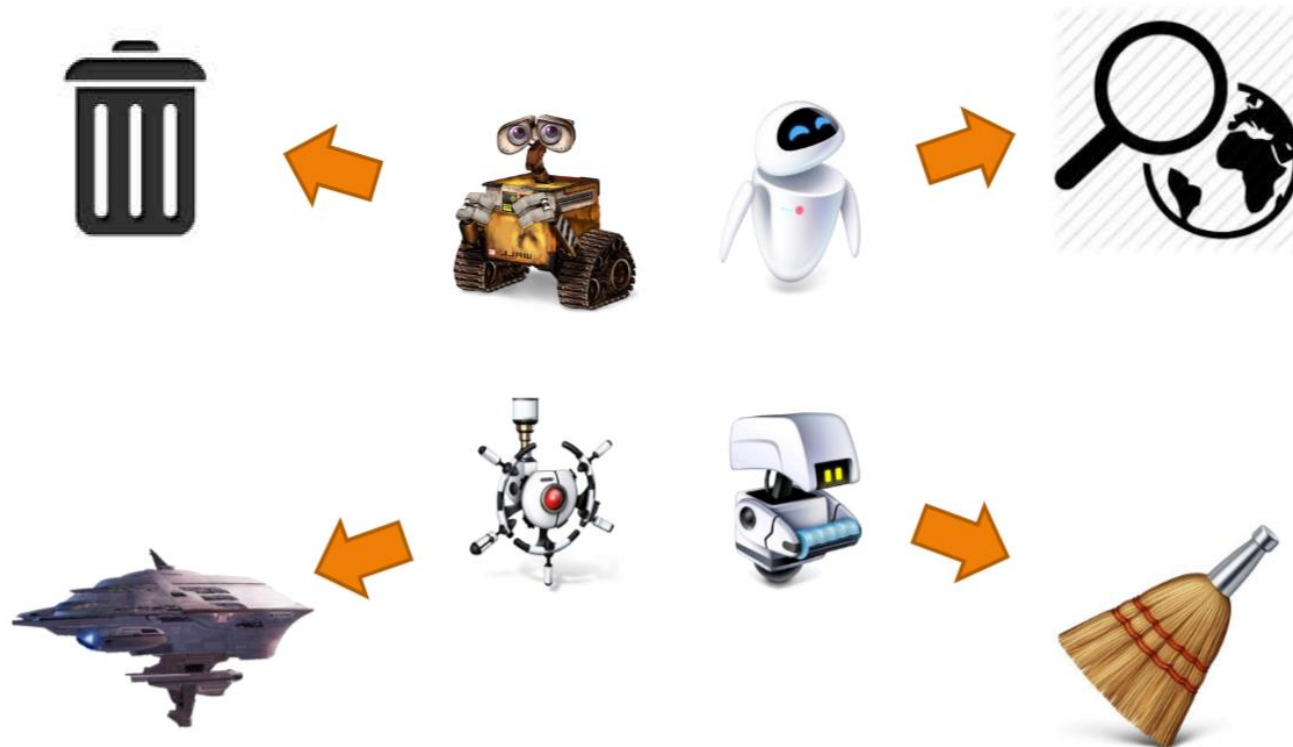


Subfields of AI



Weak & Strong AI

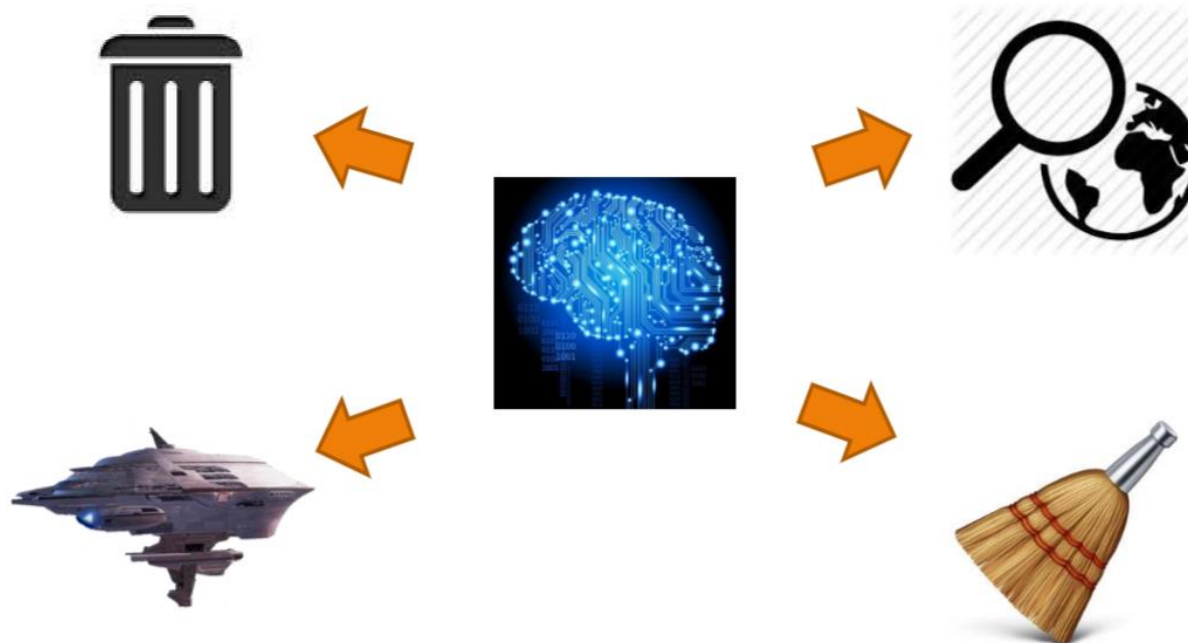
- Weak AI (Applied AI)
 - AI that accomplishes specific tasks



Weak & Strong AI

- Strong AI (General AI)

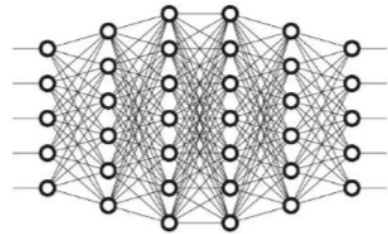
- human-like intelligence – AI that could successfully perform any intellectual task that a human can



Three Types of AI Approaches

Symbolism

$+$	$-$	$\times$	$\div$
$\neg$	$\vee$	$\perp$	$\cong$
$\in$	$\cap$	$\subseteq$	Σ
∂	∇	$\wedge$	Π



Connectionism



*Statistical
Approaches*

Symbolism

- Representing knowledge with symbols and their compositions (expressions)
 - Inference and learning is done by manipulating symbols (e.g., logic)

$$\begin{aligned} \forall x \forall y, Human(x) \wedge Place(y) \wedge At(x, y) \wedge Rain(y) \\ \rightarrow \exists z, Umbrella(z) \wedge Use(x, z) \end{aligned}$$

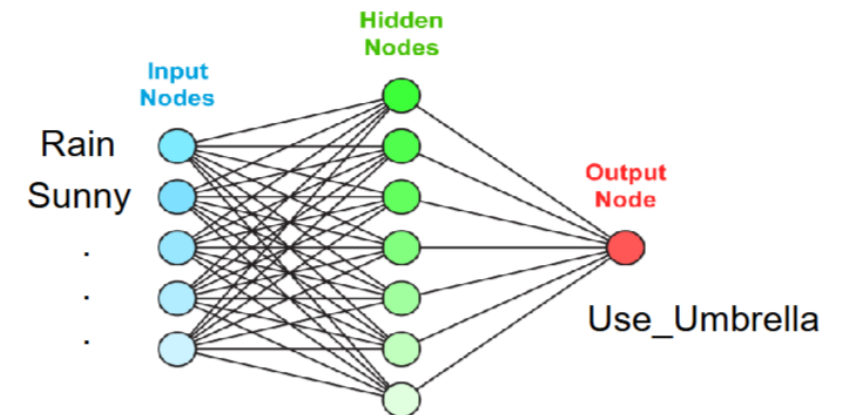
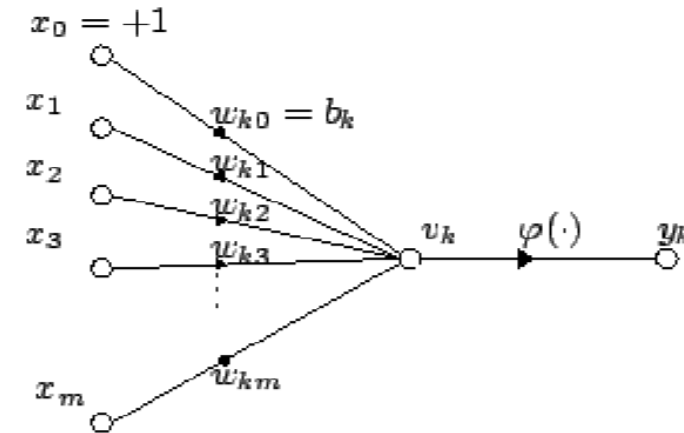
Symbolism

- History

- Dominant during 1950s – 1980s
- Fell out of favor in 1980s – 1990s
- Integration with statistical approaches (2000s)
- Integration with neural approaches (2010s)

Connectionism

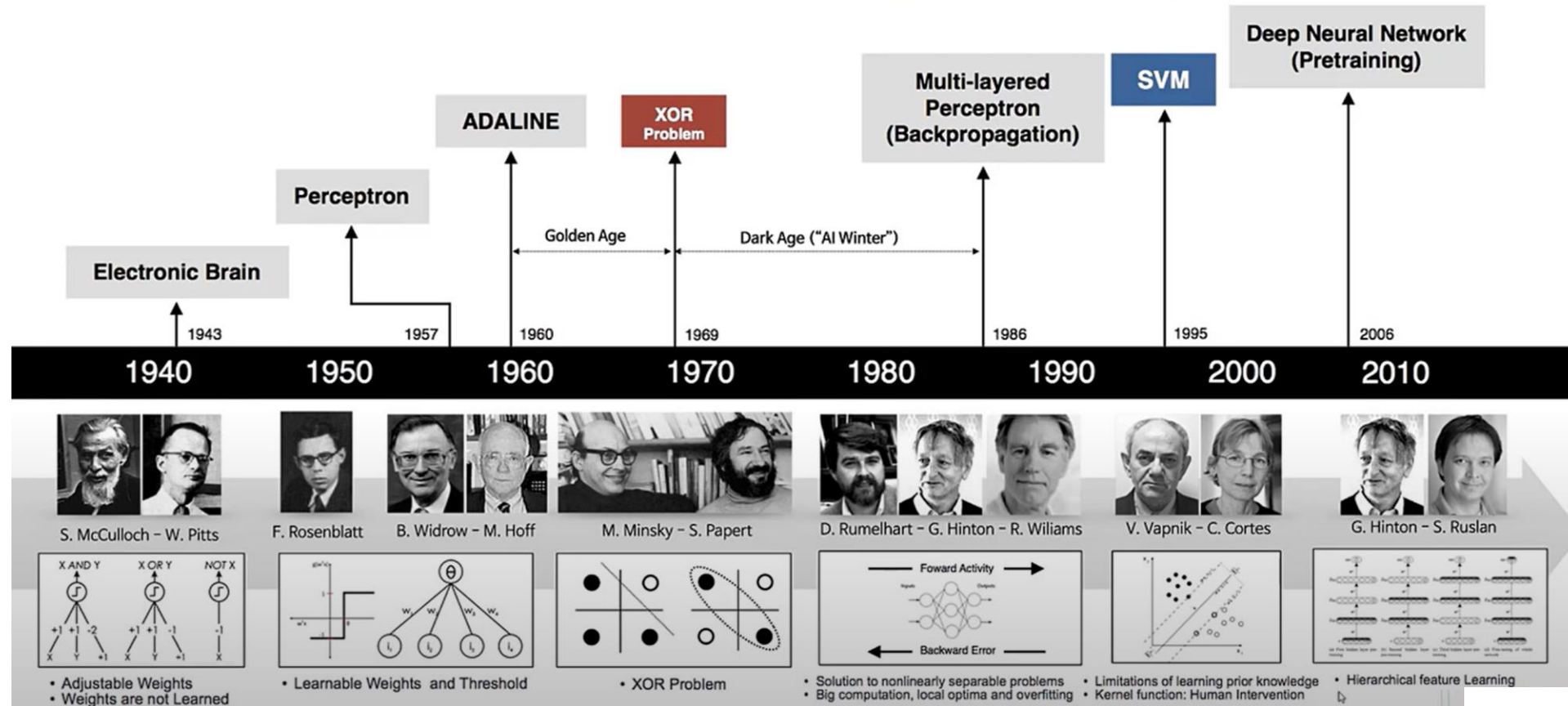
- Representing knowledge with interconnected networks of simple units
 - Neural networks
- Inference
 - Follow the computation specified by the network from input to output
- Learning
 - optimization of connection weights



Connectionism

- History of connectionism: rose and fell for several times
 - 1940s: pioneer work, e.g., McCulloch-Pitts model
 - 1958: invention of perceptron (Rosenblatt)
1969: “Perceptron” published (Minsky & Papert)
 - Publicized key issues of perceptron (e.g., XOR)
 - 1970s: AI winter
 - 1980s: revival of connectionism
 - Hopfield net, BP algorithm
 - Rumelhart & McClelland (1986): Parallel Distributed Processing
 - 1990s-2000s: overtaken in popularity by other methods
 - 2010s: rise of deep learning
 - Since ~2012: dominates CV
 - Since ~2015: dominates NLP

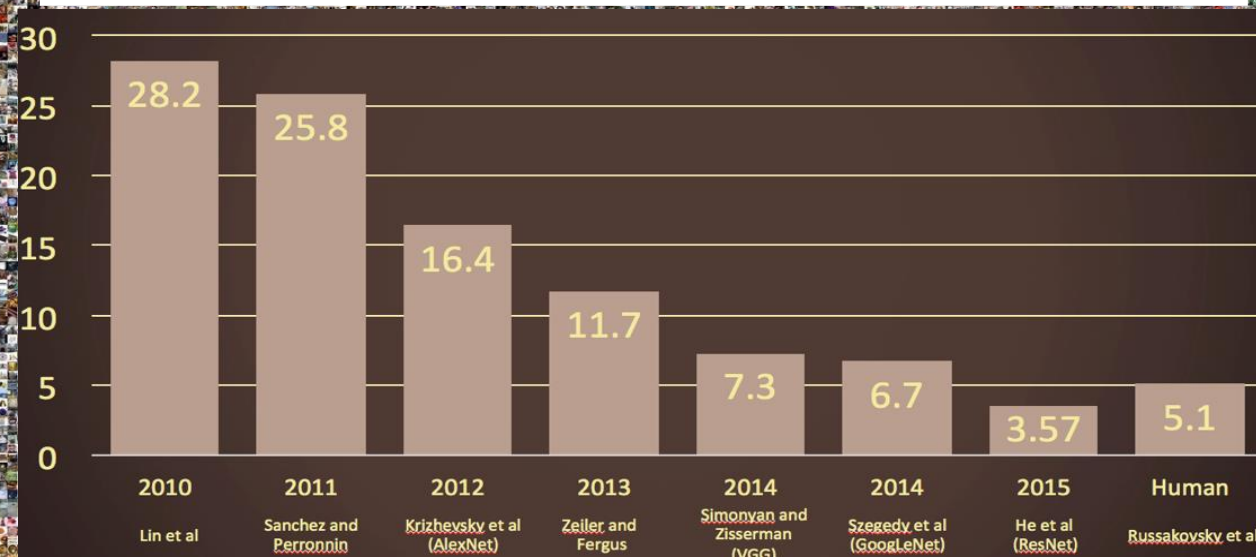
Connectionism



Connectionism

IMAGENET Large Scale Visual Recognition Challenge

The Image Classification Challenge:
1,000 object classes
1,431,167 images



Russakovsky et al: arXiv, 2014.

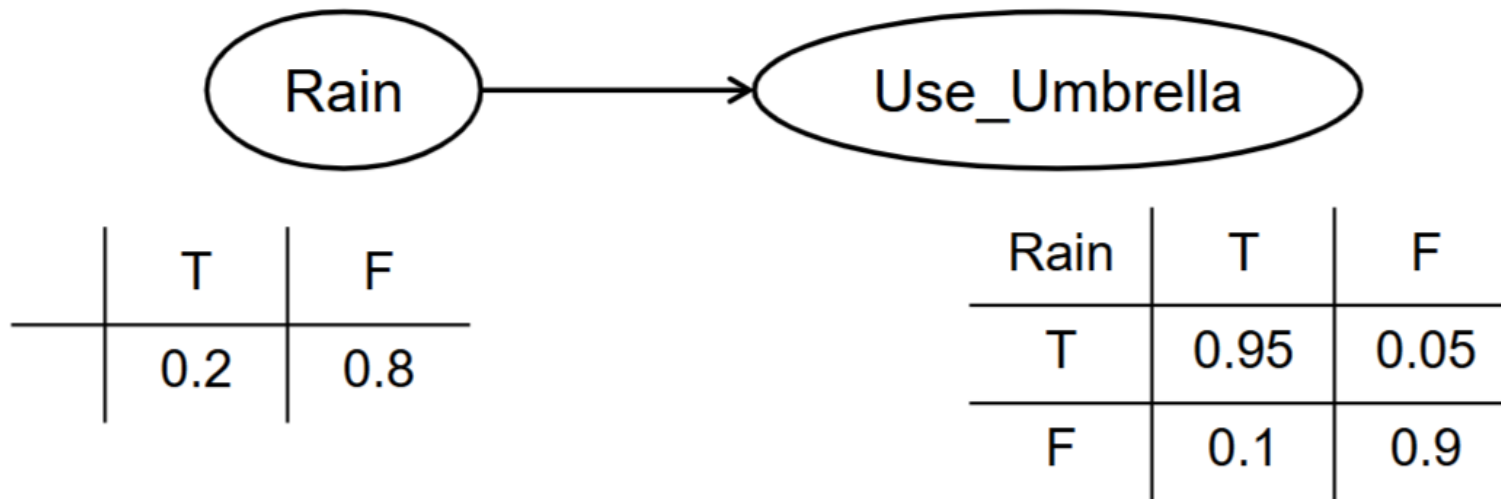
Connectionism



ACM Turing Award 2019 (*Nobel Prize of Computing*)
Yann LeCun, Geoffrey Hinton, and Yoshua Bengio

Statistical Approaches

- Representing knowledge with probabilistic models
- Inference and learning is done by probabilistic inference



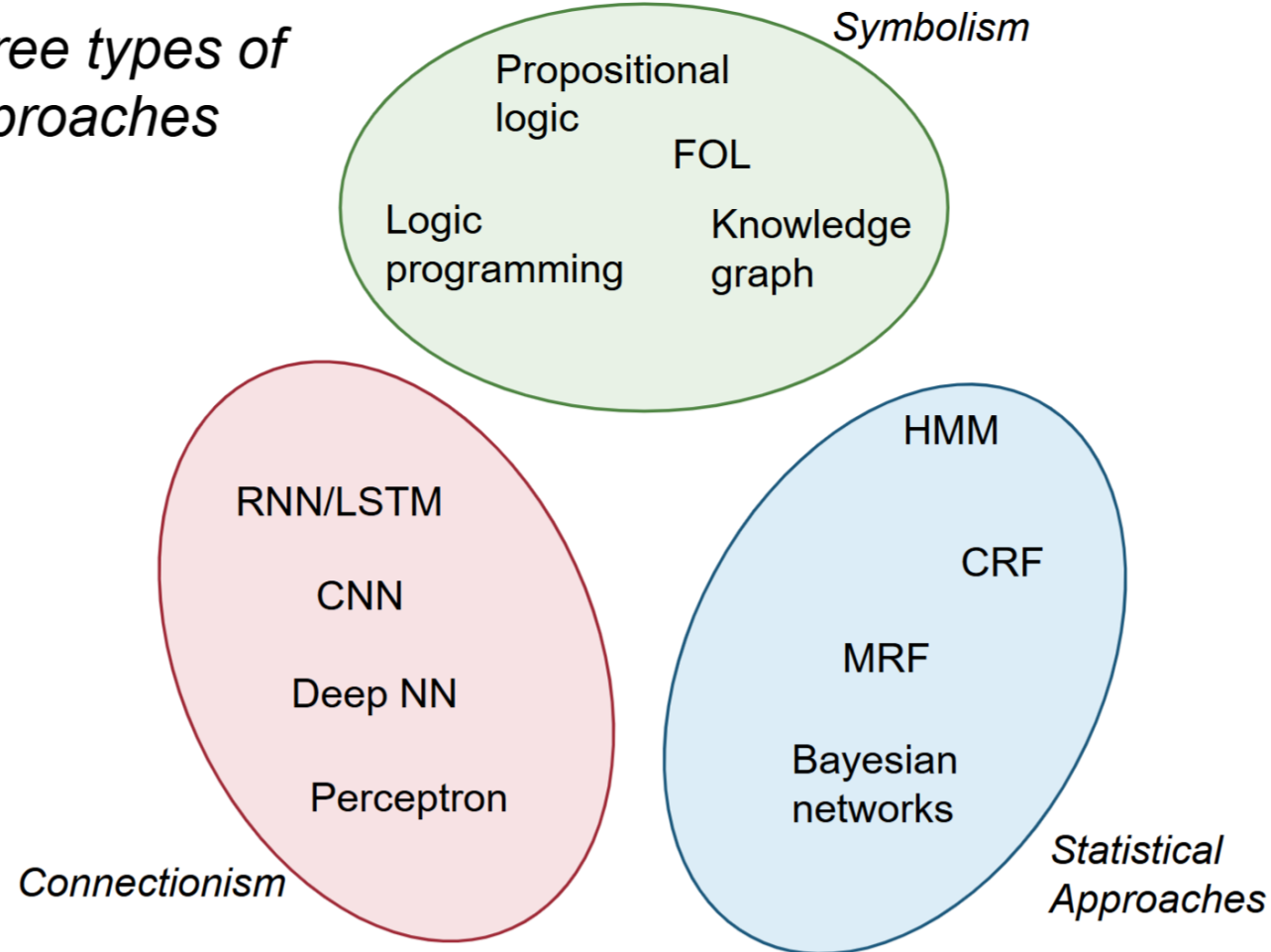
Statistical Approaches

- History

- Become popular since 1990s
- Dominant during 2000s
- Overshadowed by deep learning in 2010s

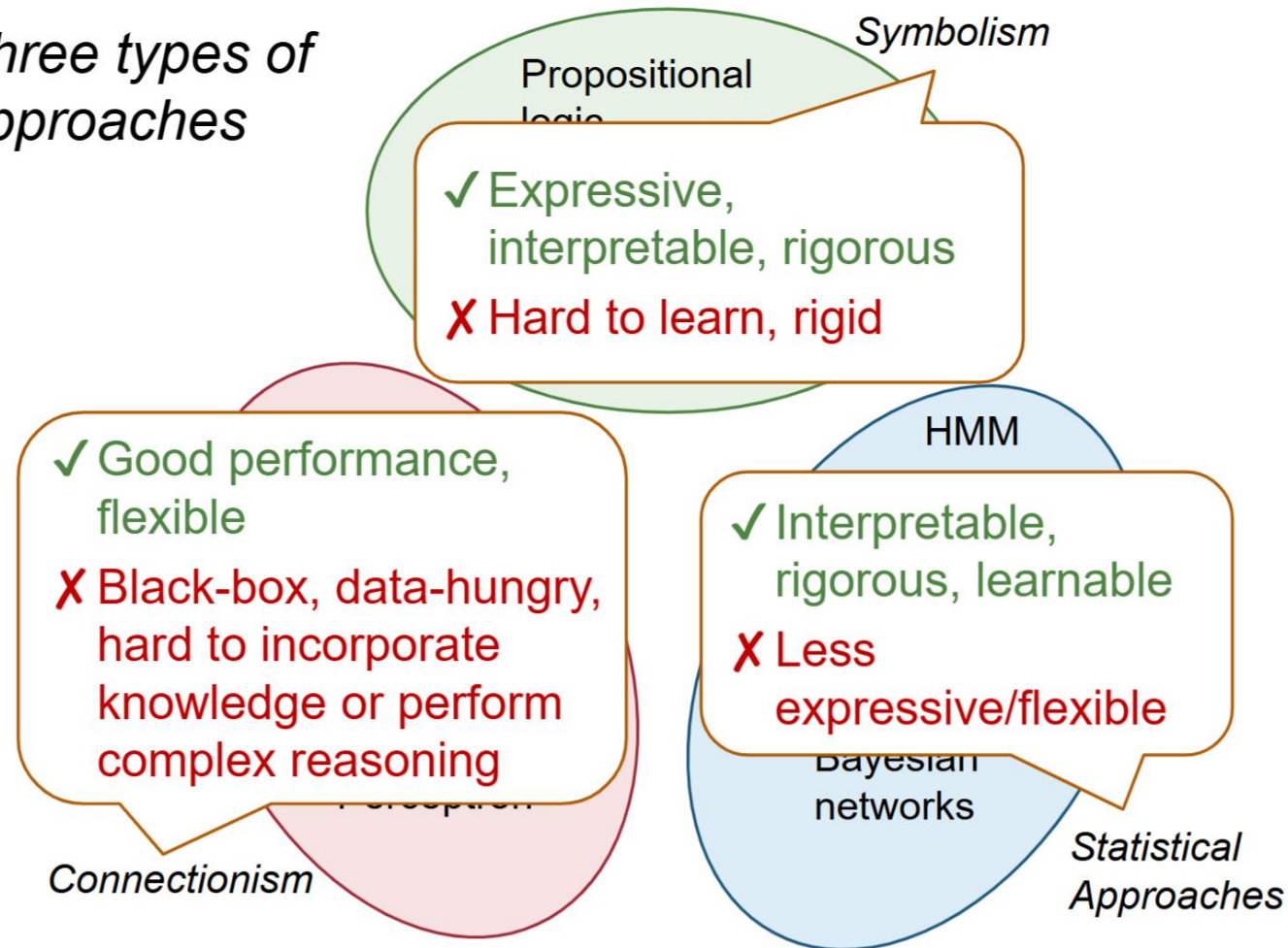
Three types of AI approaches

Three types of approaches

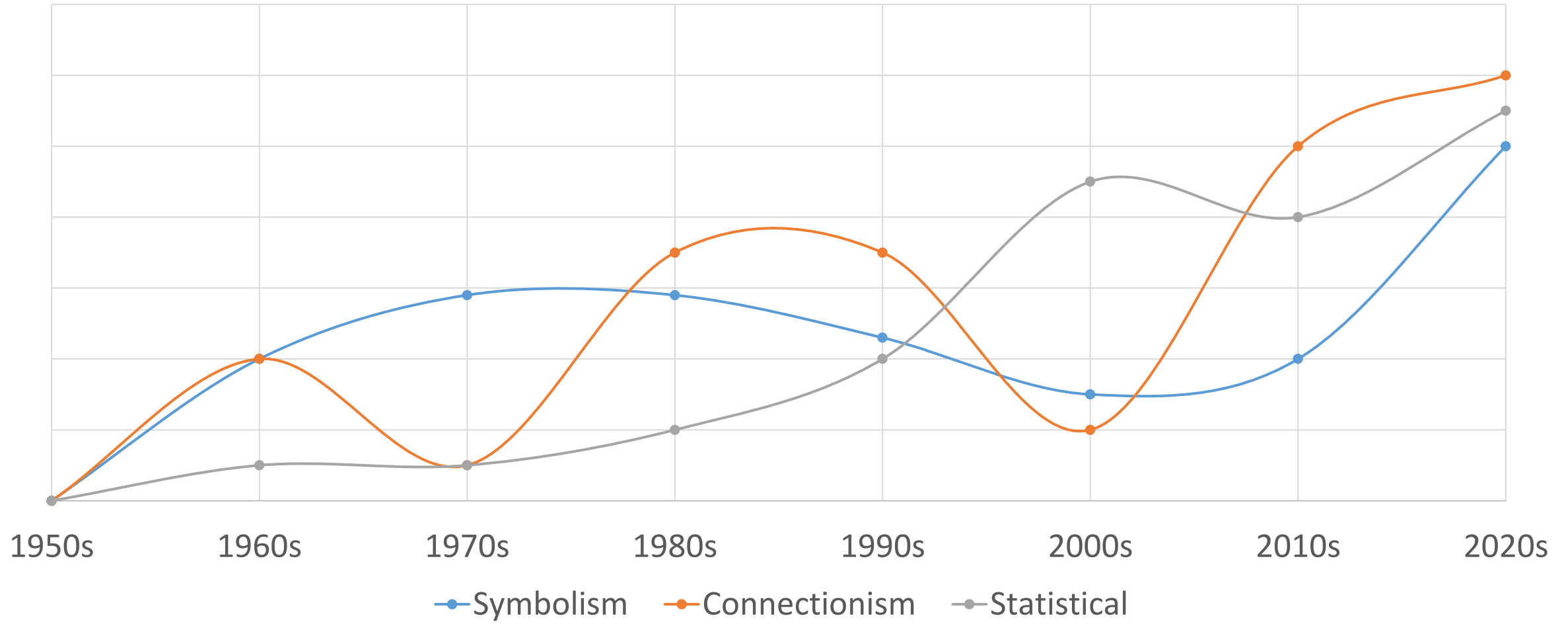


Three types of AI approaches

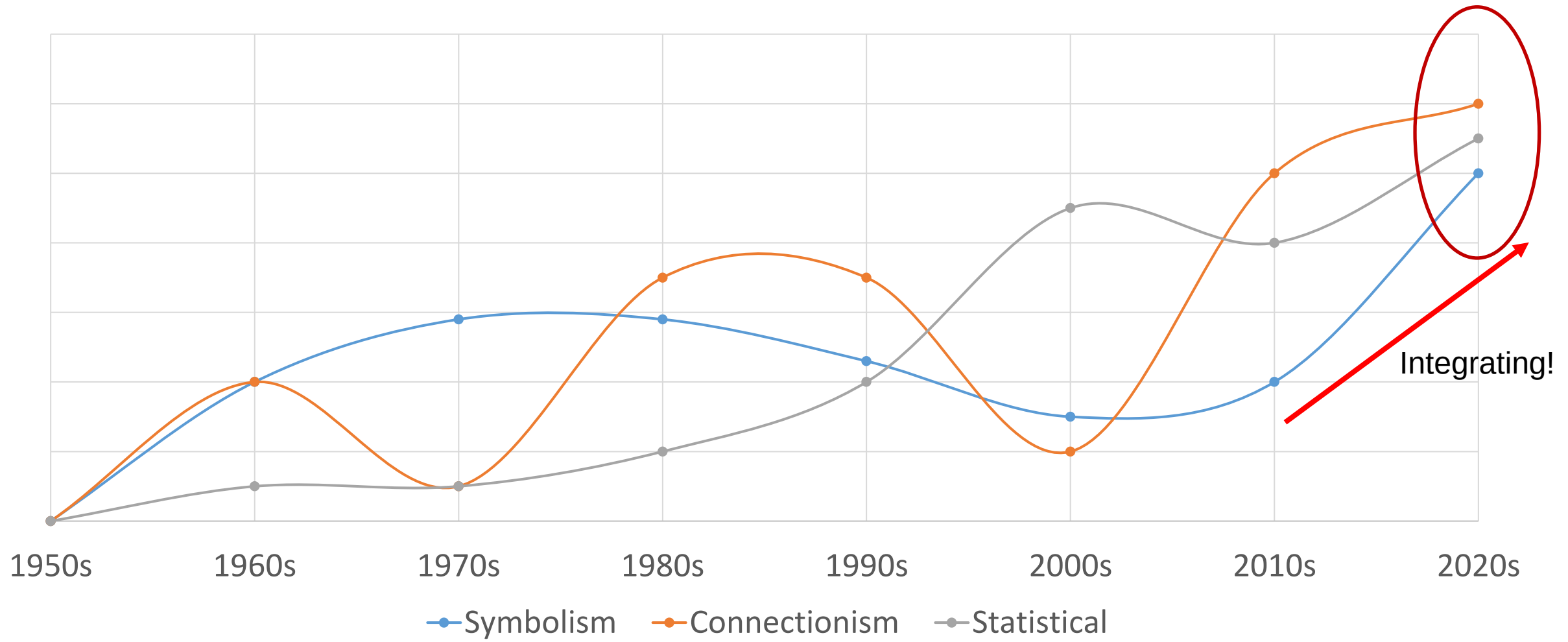
Three types of approaches



Three types of AI approaches



Three types of AI approaches



AI Agents

- Three main streams of AI technique are merging.

Large Language Models Are Implicitly Topic Models: Explaining and Finding Good Demonstrations for In-Context Learning

Xinyi Wang¹ Wanrong Zhu¹ Michael Saxon¹ Mark Steyvers² William Yang Wang¹

LOGIC-LM: Empowering Large Language Models with Symbolic Solvers for Faithful Logical Reasoning

Liangming Pan Alon Albalak Xinyi Wang William Yang Wang

University of California, Santa Barbara

{liangmingpan, alon_albalak, xinyi_wang, wangwilliamyang}@ucsb.edu

Q*: Improving Multi-step Reasoning for LLMs with Deliberative Planning

Chaojie Wang^{1*} Yanchen Deng^{2*} Zhiyi Lv² Liang Zeng¹ Jujie He¹

Shuicheng Yan¹ Bo An^{1,2}

¹Skywork AI ²Nanyang Technological University

Faithful Logical Reasoning via Symbolic Chain-of-Thought

Jundong Xu¹, Hao Fei^{1*}, Liangming Pan², Qian Liu³, Mong-Li Lee¹, Wynne Hsu¹

¹ National University of Singapore, Singapore

² University of California, Santa Barbara, USA

³ University of Auckland, New Zealand

jundong.xu@u.nus.edu; haofei37@nus.edu.sg; liangmingpan@ucsb.edu
liu.qian@auckland.ac.nz; dcsleem1@nus.edu.sg; whsu@comp.nus.edu.sg

ICLR 2022

LINC: A Neurosymbolic Approach for Logical Reasoning by Combining Language Models with First-Order Logic Provers

Theo X. Olausson^{*1} Alex Gu^{*1} Benjamin Lipkin^{*2} Cedegao E. Zhang^{*2}

Armando Solar-Lezama¹ Joshua B. Tenenbaum^{1,2} Roger Levy²

{theo_xo, gua, lipkinb, cedzhang}@mit.edu

¹MIT CSAIL ²MIT BCS

^{*}Equal contribution.

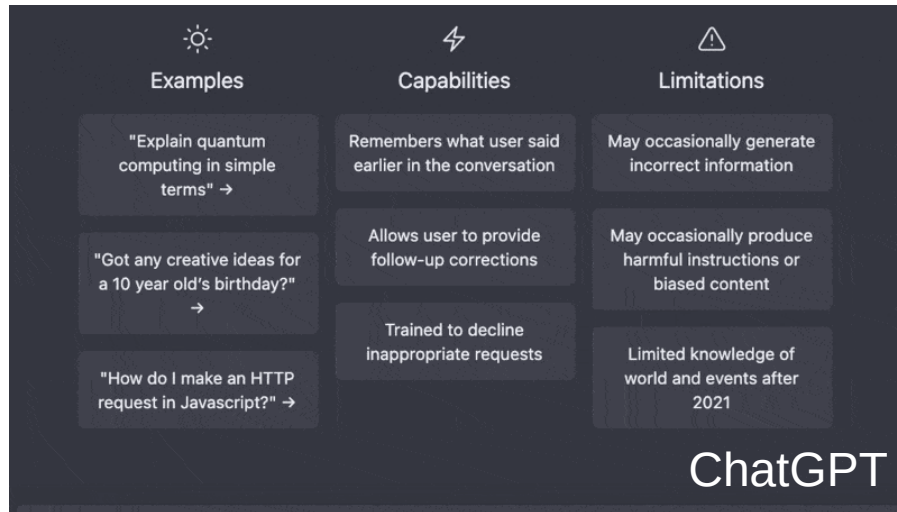
AN EXPLANATION OF IN-CONTEXT LEARNING AS IMPLICIT BAYESIAN INFERENCE

Sang Michael Xie, Aditi Raghunathan, Percy Liang, Tengyu Ma

Stanford University

{xie, aditir, pliang, tengyuma}@cs.stanford.edu

AI Agents



Model: Code Interpreter ALPHA

I want you to OCR an image and give me a .txt file

Trigger OCR functions

Sure, I can help you with that. Please provide me with the image you'd like to OCR (optical character recognition) so that I can extract the text and create a .txt file for you.

Finished working Show work

The text has been successfully extracted from the image and saved to a .txt file. You can download the .txt file from the following link: [ocr-output.txt](#).

Please let me know if there is anything else I can assist you with!

create a shepard tone and save it as a wav file. please also explain what's the mystery of this.

The Shepard tone is an auditory illusion that creates the impression of a continuously ascending or descending pitch that seems to rise or fall forever, without ever reaching a peak or bottom. This effect is achieved by layering multiple sine waves, each separated by an octave. As one pitch seems to ascend, the lower frequencies fade out, and higher frequencies fade in, giving the listener the perception of a never-ending rise or fall in pitch.

The Shepard Tone Illusion Breakdown:

- Multiple Octaves:** Several tones are played simultaneously, spaced one octave apart.
- Volume Modulation:** The higher-frequency tones gradually increase in volume, while lower-frequency tones decrease. This creates a seamless transition.
- Circularity:** When the highest tone fades out, the lowest tone fades in again at a tricking the listener into perceiving a continuous rise or fall.

This illusion plays on the brain's perception of sound and pitch, causing us to think we're hearing an endlessly rising or falling tone, even though there is no infinite range of sound.

Creating the Shepard Tone:

I'll create a Shepard tone now and save it as a WAV file for you.

已分析

I have created the Shepard tone and saved it as a WAV file. You can download it using [Download Shepard Tone](#)

Enjoy the mysterious illusion! Let me know if you need any more adjustments.

```
import numpy as np
import scipy.io.wavfile as wav

# Shepard tone parameters
duration = 10 # duration of the tone in seconds
sample_rate = 44100 # standard sample rate for audio
frequency_base = 440 # base frequency (A4 note)
num_octaves = 10 # number of octaves to cover
num_tones = 10 # number of sine waves

# Time array
t = np.linspace(0, duration, int(sample_rate * duration), endpoint=False)

# Generate the Shepard tone
shepard_tone = np.zeros_like(t)

for n in range(num_tones):
    # Create a rising Shepard tone by increasing frequency by powers of 2 (octaves)
    freq = frequency_base * 2 ** (n / num_tones)
    sine_wave = np.sin(2 * np.pi * freq * t)
    # Apply a volume envelope to simulate the rising/falling illusion
    envelope = np.sin(np.pi * t / duration) ** 2 # smooth rising
    shepard_tone += sine_wave * envelope

# Normalize to the range of [-1, 1]
shepard_tone /= np.max(np.abs(shepard_tone))

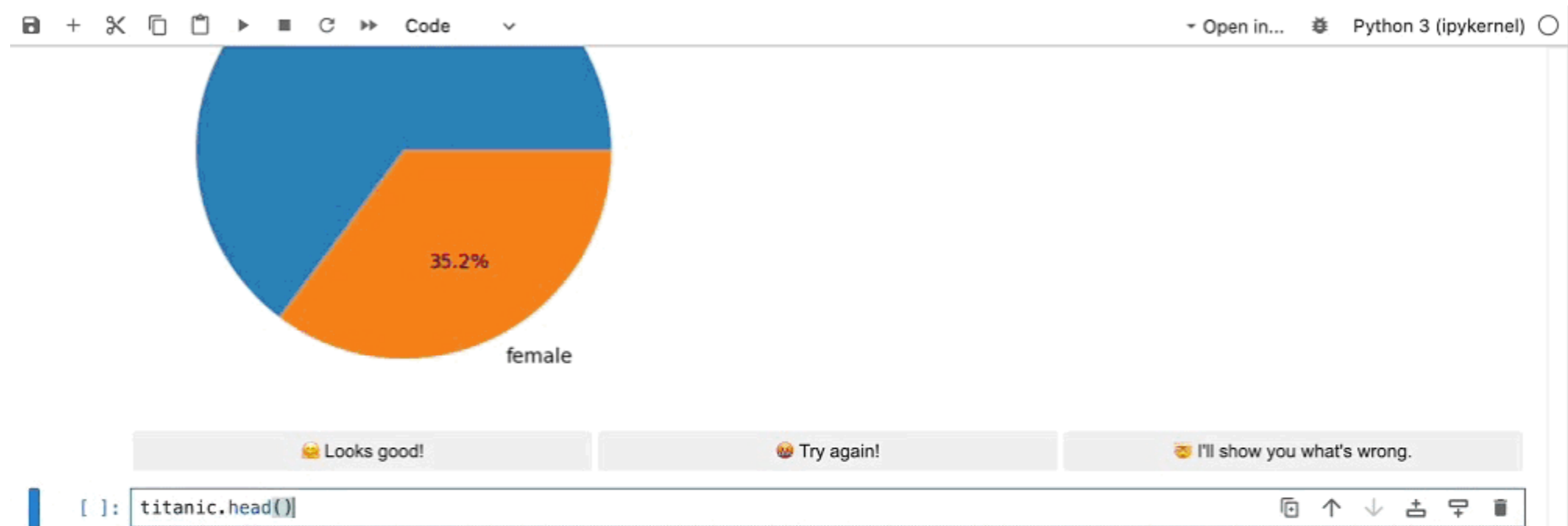
# Save the tone as a WAV file
output_file = "testdata/shepard_tone.wav"
wav.write(output_file, sample_rate, shepard_tone.astype(np.float32))

output_file # Returning the path of the saved file
```

Creating sound

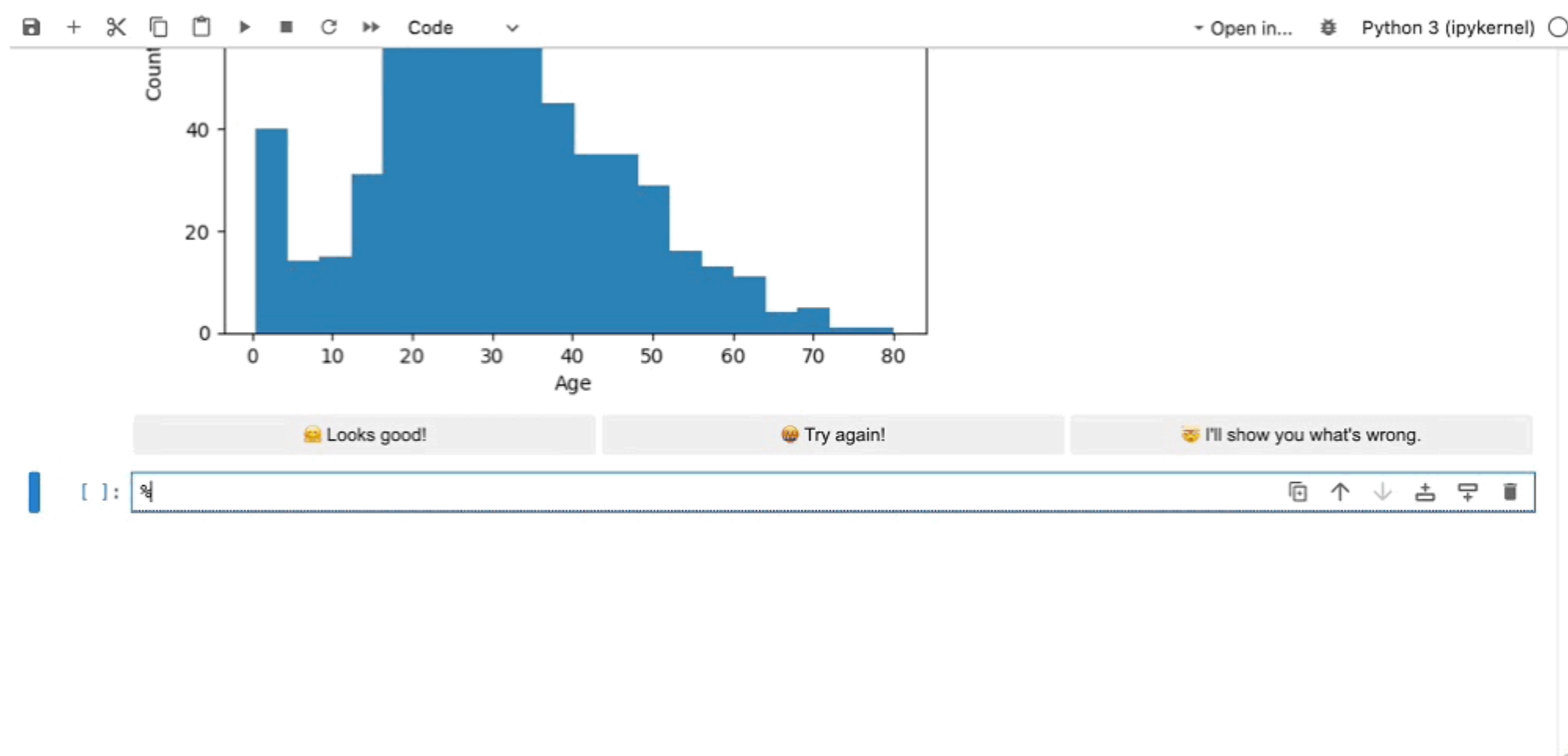
AI Agents

- Solving data science problem



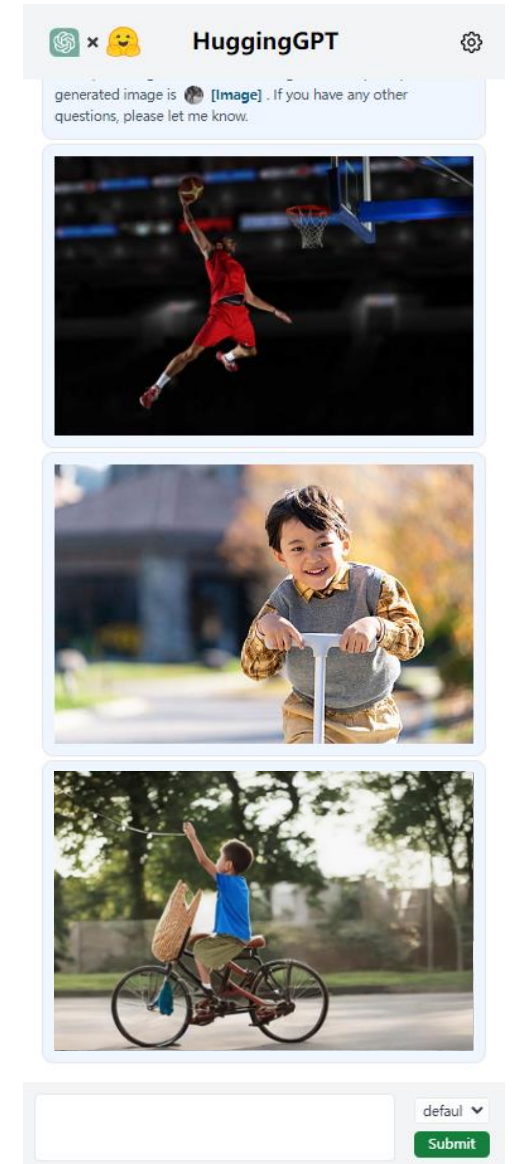
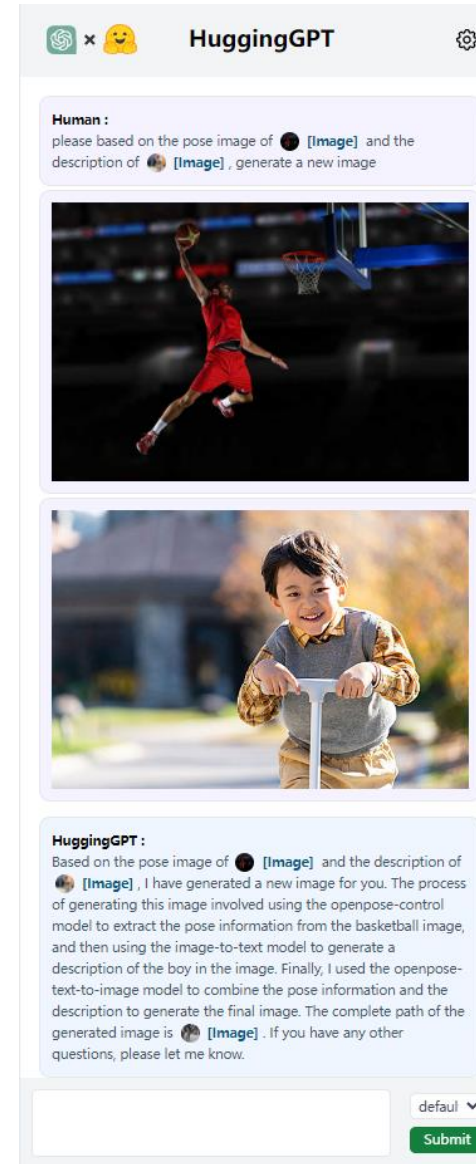
AI Agents

- Solving data science problem



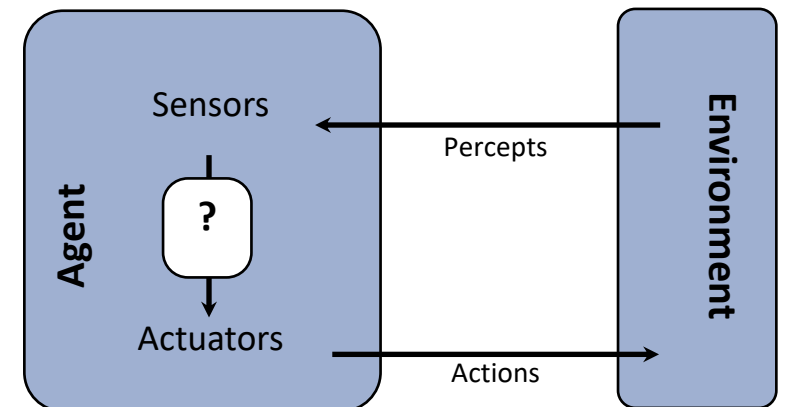
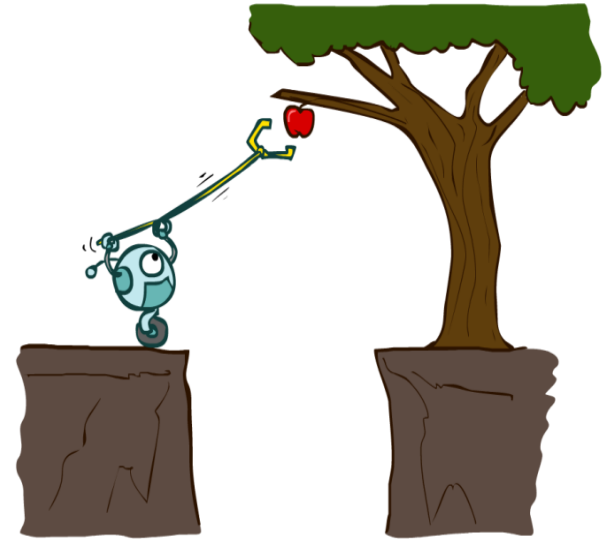
AI Agents

- Complex generative tasks
 - Please generate a new image based on the pose of IMAGE1 and the description of IMAGE2.



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



COURSE CONTENT OVERVIEW

Course Topics

Core Components of Rational Agents:

Search &
Planning

Probability &
Inference

Supervised
Learning

Reinforcement
Learning

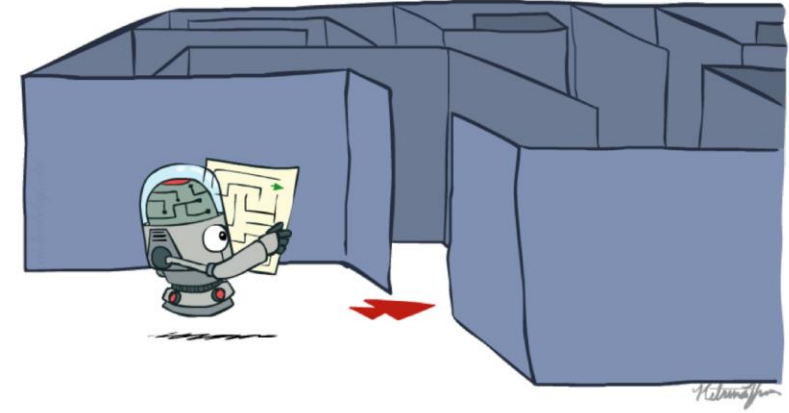
Course Topics

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***?

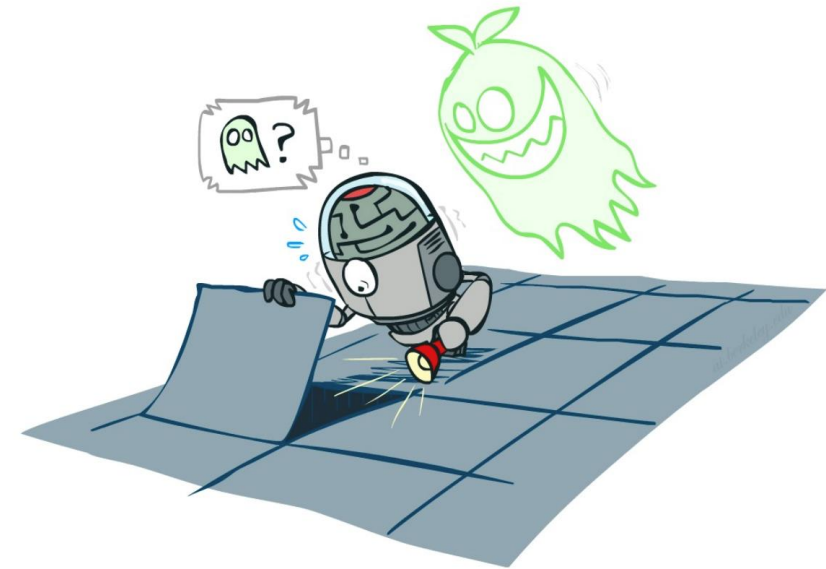
Course Topics

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***?

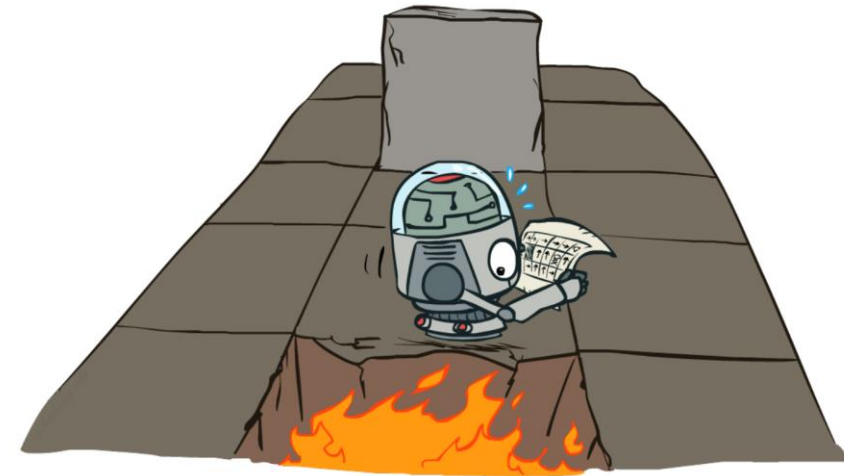
Course Topics

Search &
Planning

Probability &
Inference

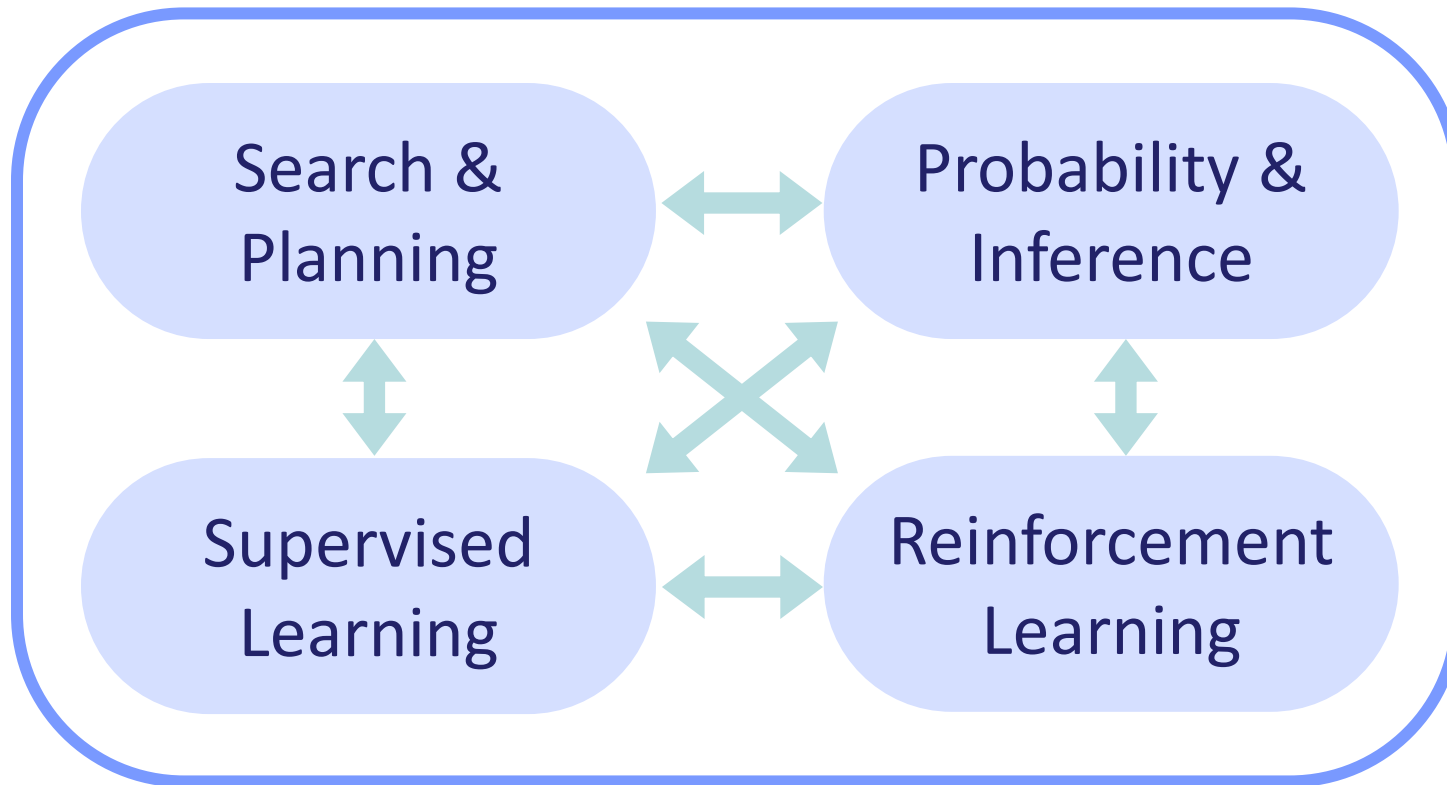
Supervised
Learning

Reinforcement
Learning



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

Course Topics



Course Topics

Search &
Planning

Probability &
Inference

Supervised
Learning

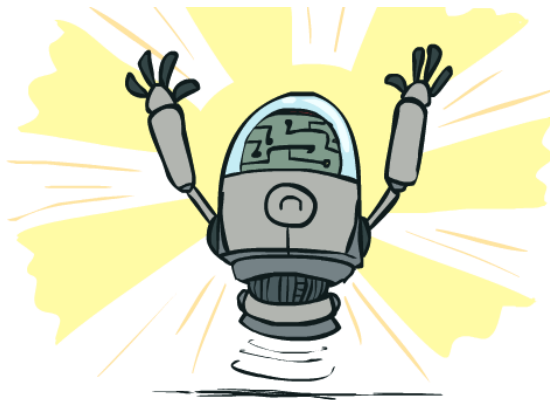
Reinforcement
Learning

Applications

Impact on Sciences, Technology, Society

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



Course Contents

- Search
- Constraint satisfaction problems
- Game
- Propositional logic
- First-order predicate logic
- Probabilistic graphical models
- Probabilistic temporal models
- Probabilistic logics
- Markov decision processes
- Reinforcement learning
- Deep reinforcement learning
- Machine learning
- Advanced topics of AI