Warm-up as you walk in

Candy Grab game!

1. Grab a pack of game pieces (candy/pretzels)
2. Groups of 3
3. Play the game!
   a. Select 2 players
      (third player will observe)
   a. 11 pieces on the table
   b. Take turns taking 1 or 2 pieces
   c. Person that takes the last piece wins!
4. Keep playing the game
   (rotate which two students are playing)

Think about:

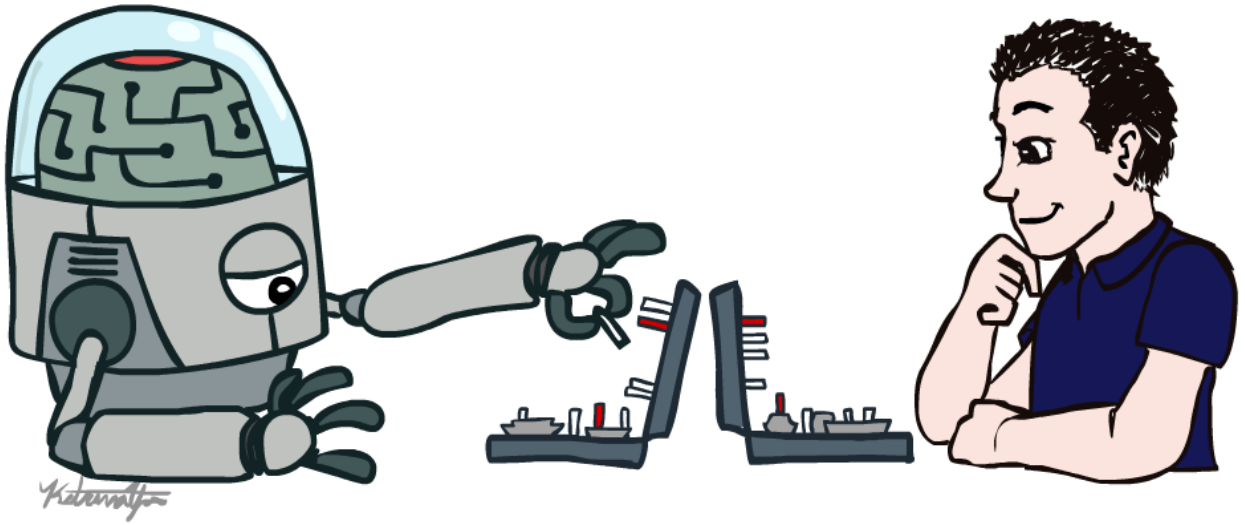
How humans learn to play

How you might implement an Agent bot to play this in code:

```
class Agent:
    def getAction(state)
        return action
```

AI: Representation and Problem Solving

Introduction



Instructor: Pat Virtue

Slide credits: CMU AI & http://ai.berkeley.edu

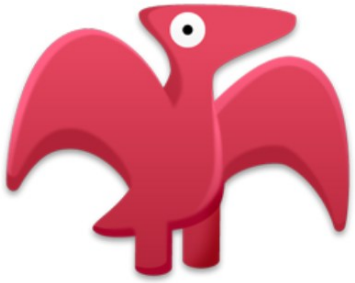
Course Team

Instructor

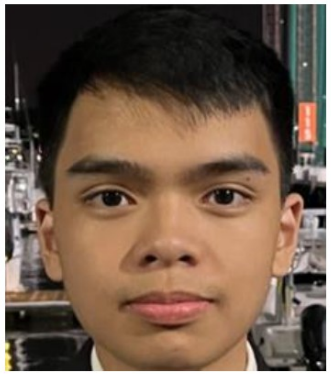
Pat Virtue
pvirtue

Teaching Assistants

Max
myagnyat



Lisa
wenleh

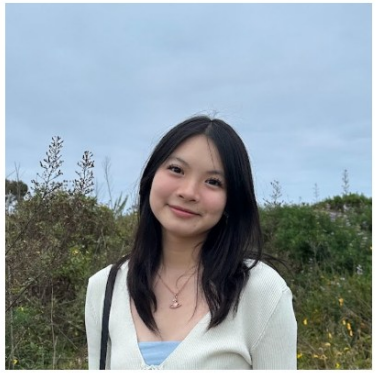


Johnny
johnnyt

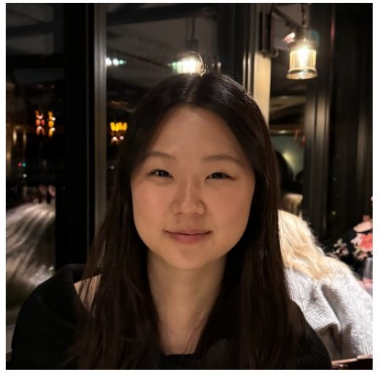
AJ
ajseo

Roy
roypark

Steven
yiy6



Ellyse
ellysel



Sunny
minjeon2

Course Team

Students!!

Course Information

Website: https://www.cs.cmu.edu/~15281

Communication:

https://edstem.org/

- Including any messages to Pat
- (e-mail Pat if Ed doesn't work pvirtue@andrew.cmu.edu)

ed

Important posts coming soon!

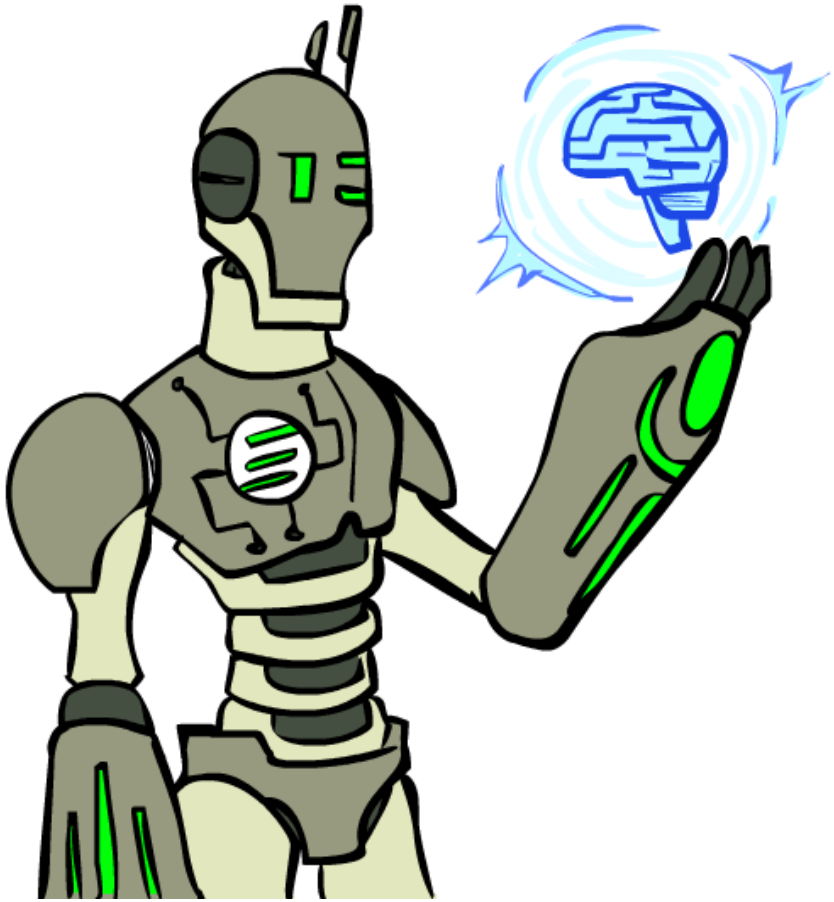
- Office Hours
- Recitation (Fri)
- P0
- HW1

Today

Agents

What is artificial intelligence?

A brief history of AI



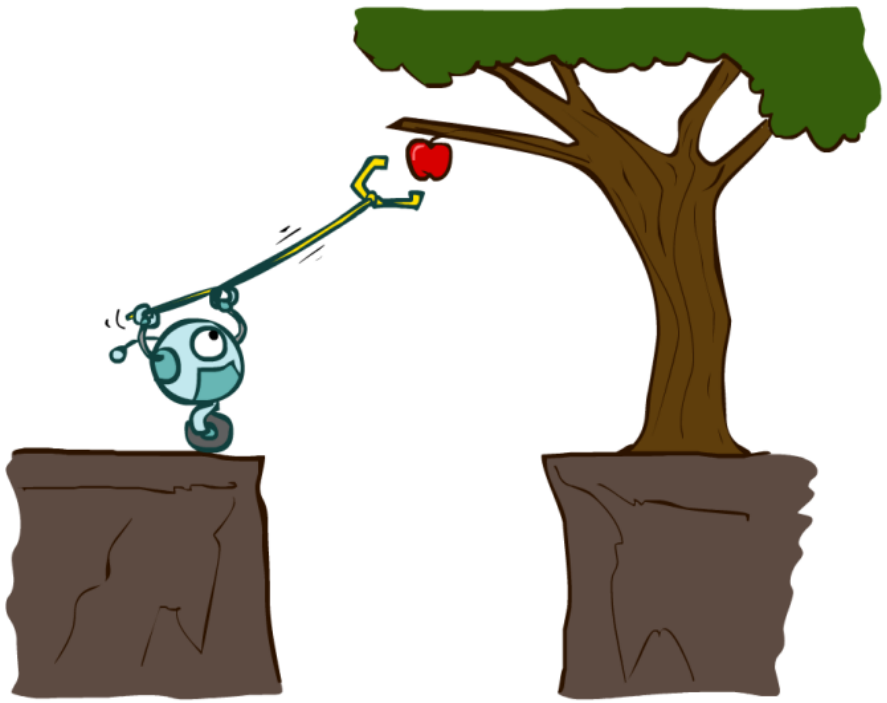
Designing Agents

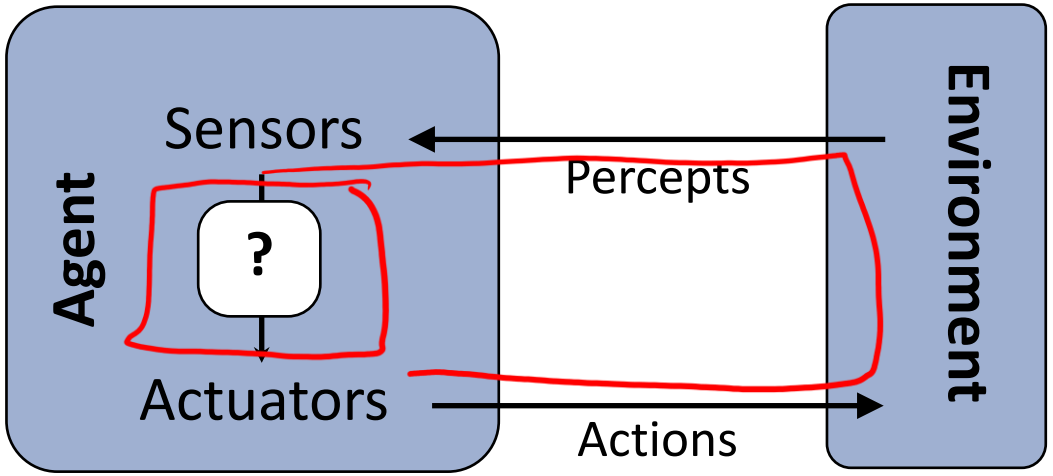
An **agent** is an entity that *perceives* and *acts*.

Characteristics of the **percepts, environment,** and **action space** dictate techniques for selecting actions

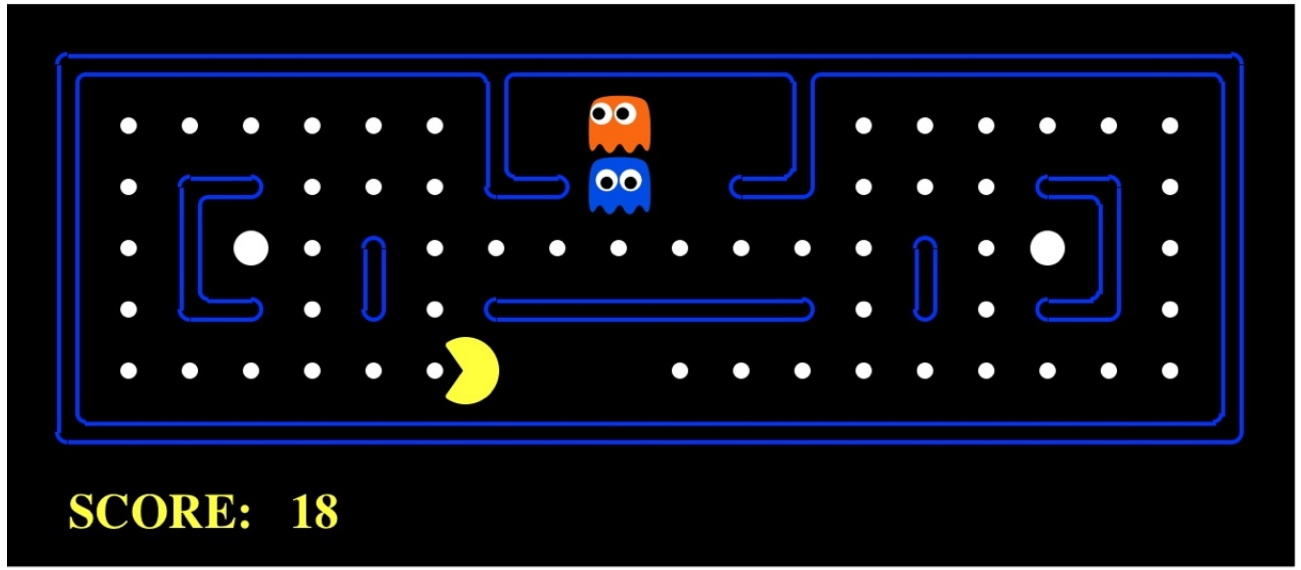
This course is about:

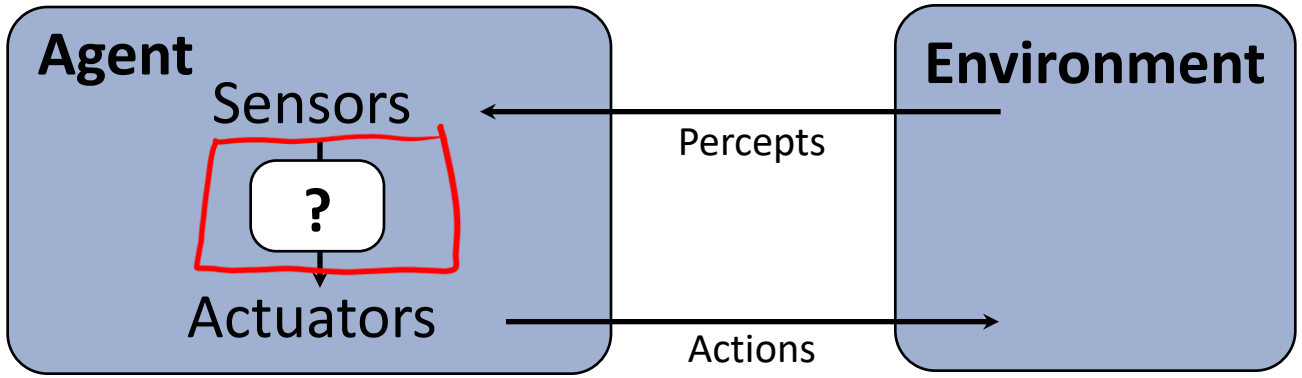
- General AI techniques for a variety of problem types
- Learning to recognize when and how a new problem can be solved with an existing technique





Pac-Man as an Agent





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

Candy Grab (Nim) Agent

```
class Agent

    function getAction(state)

        return action
```

Nim Agent

Agent 001 – Always choose 1

```
function getAction(                    )

    return 1
```

Nim Agent

Agent 002 – Always choose 2

```
function getAction( numPiecesAvailable )

    return 2
```

Nim Agent

Agent 004 – Choose the opposite of opponent

```
function getAction( numPiecesAvailable )

    return ?
```

Nim Agent

Agent 007 – Whatever you think is best

```
function getAction( numPiecesAvailable )

    return ?
```

Nim Agent

Agent 007 – Whatever you think is best

```
function getAction( numPiecesAvailable )

    if numPiecesAvailable % 3 == 2
        return 2
    else
        return 1
```

Participation Polls

See Ed for link to Drive

Seat form

More details on participation later

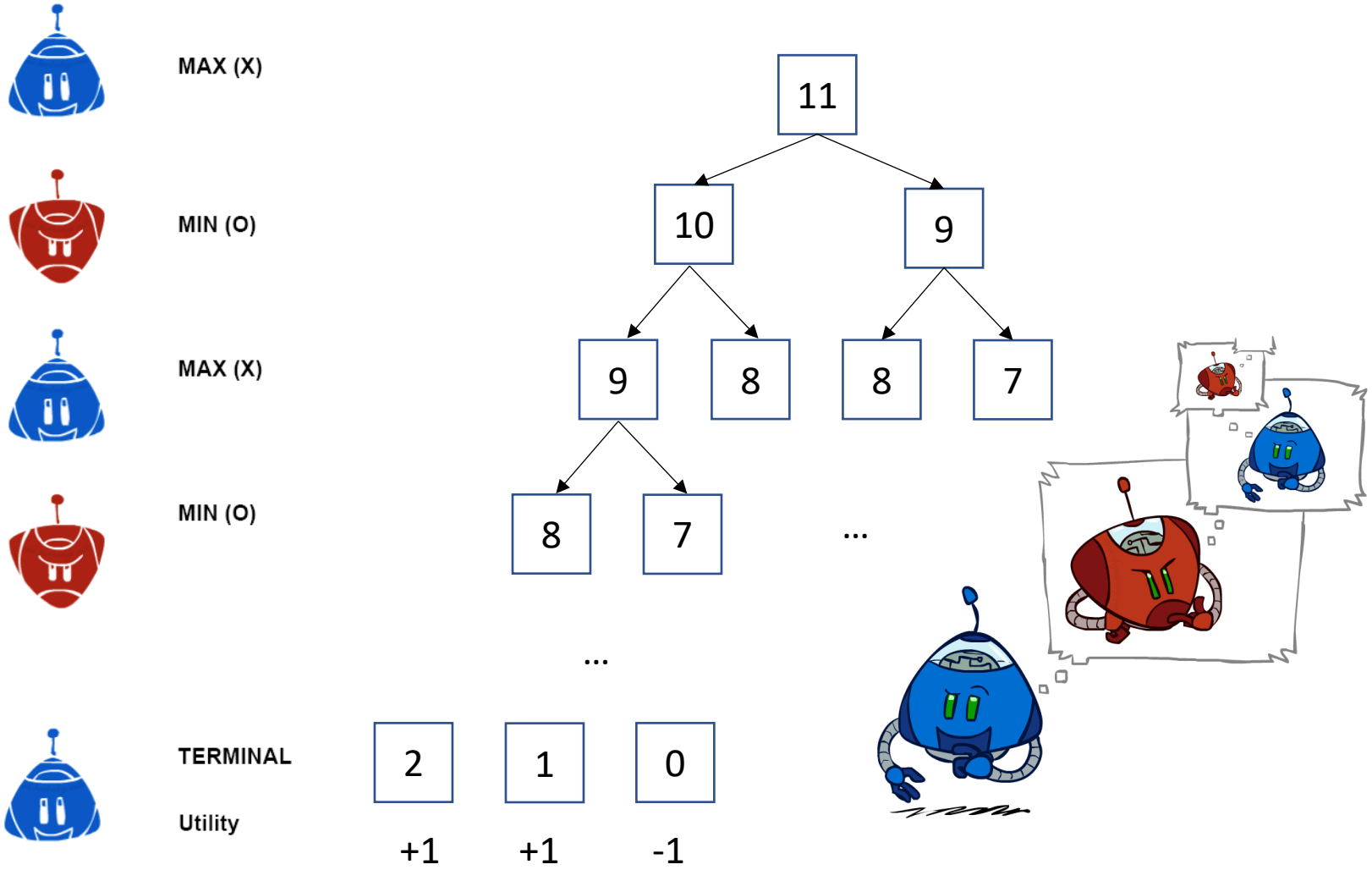
Poll 1

Games – Three “Intelligent” Agents

Which agent code is the most “intelligent”?

Games – Three “Intelligent” Agents

A: Search / Recursion



Games – Three “Intelligent” Agents

B: Encode the pattern

```
function getAction( numPiecesAvailable )

     if numPiecesAvailable % 3 == 2
          return 2
     else
          return 1
```

```
10’s value:Win
9’s  value:Lose
8’s  value:Win
7’s  value:Win
6’s  value:Lose
5’s  value:Win
4’s  value:Win
3’s  value:Lose
2’s  value:Win
1’s  value:Win
0’s  value:Lose
```

Games – Three "Intelligent" Agents

C: Record statistics of winning positions

state →

Pieces Available	Take 1	Take 2
2		W
3		
4	W	
5		
6		
7		W

Games – Three “Intelligent” Agents

C: Record statistics of winning positions

Pieces Available	Take 1	Take 2
2		100%
3		
4	100%	
5		
6		
7		100%

Games – Three “Intelligent” Agents

C: Record statistics of winning positions

Pieces Available	Take 1	Take 2
2		W
3	L	
4	W	
5		
6		
7		L W

Games – Three “Intelligent” Agents

C: Record statistics of winning positions

Pieces Available	Take 1	Take 2
2		100%
3	0%	
4	100%	
5		
6		
7		50%

Games – Three “Intelligent” Agents

C: Record statistics of winning positions

Pieces Available	Take 1	Take 2
2	0%	**100%**
3	2%	0%
4	**75%**	2%
5	4%	**68%**
6	5%	6%
7	**60%**	5%

Poll 1

Games – Three “Intelligent” Agents

Which agent code is the most “intelligent”?

A. Search / Recursion 25%

B. Encode multiple of 3 pattern 13%

C. Keep stats on winning positions 61%

Games – Three “Intelligent” Agents

C: Record statistics of winning positions

Pieces Available	Take 1	Take 2
2	0%	**100%**
3	2%	0%
4	**75%**	2%
5	4%	**68%**
6	5%	6%
7	**60%**	5%

AI Breakthrough!

READ SOMETHING THAT MEANS SOMETHING.
$1 A WEEK ›
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FEBRUARY 25, 2015

ARTIFICIAL INTELLIGENCE GOES TO THE ARCADE

BY NICOLA TWILLEY

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ELEMENTS

A shaky video, recorded with a mobile phone and smuggled out of the inaugural First Day of Tomorrow technology conference, in April, 2014, shows an artificially intelligent computer program in its first encounter with Breakout, the classic Atari

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https://www.youtube.com/watch?v=EfGD2qveGdQ

What is "Aritifical Intelligence"?

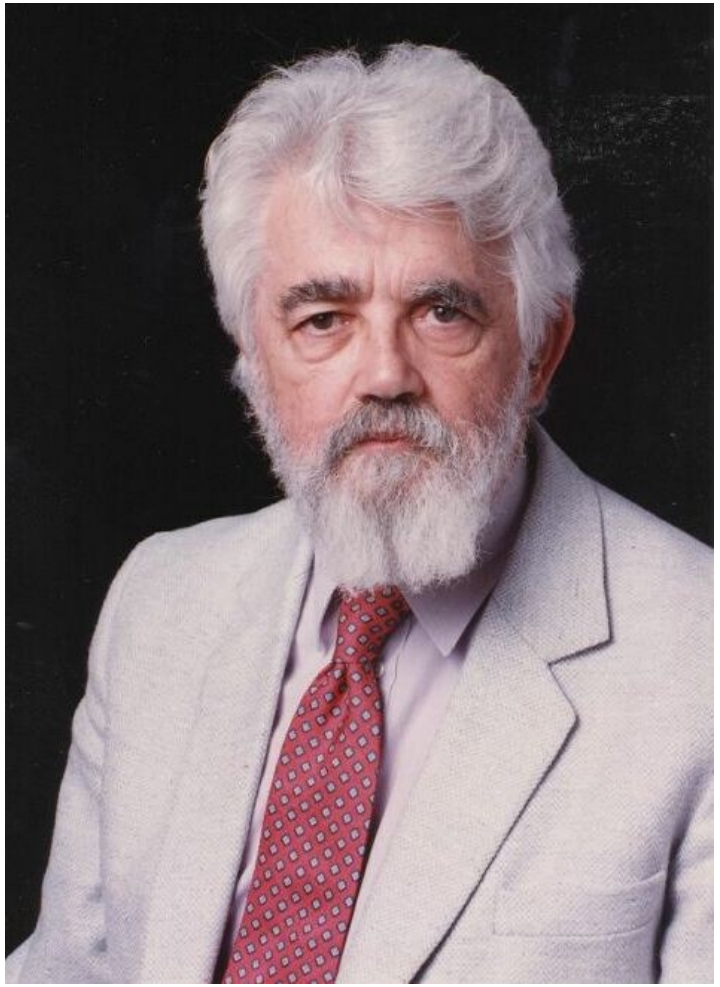
AI Definition by John McCarthy

What is artificial intelligence

- It is the science and engineering of making intelligent machines, especially intelligent computer programs

What is intelligence

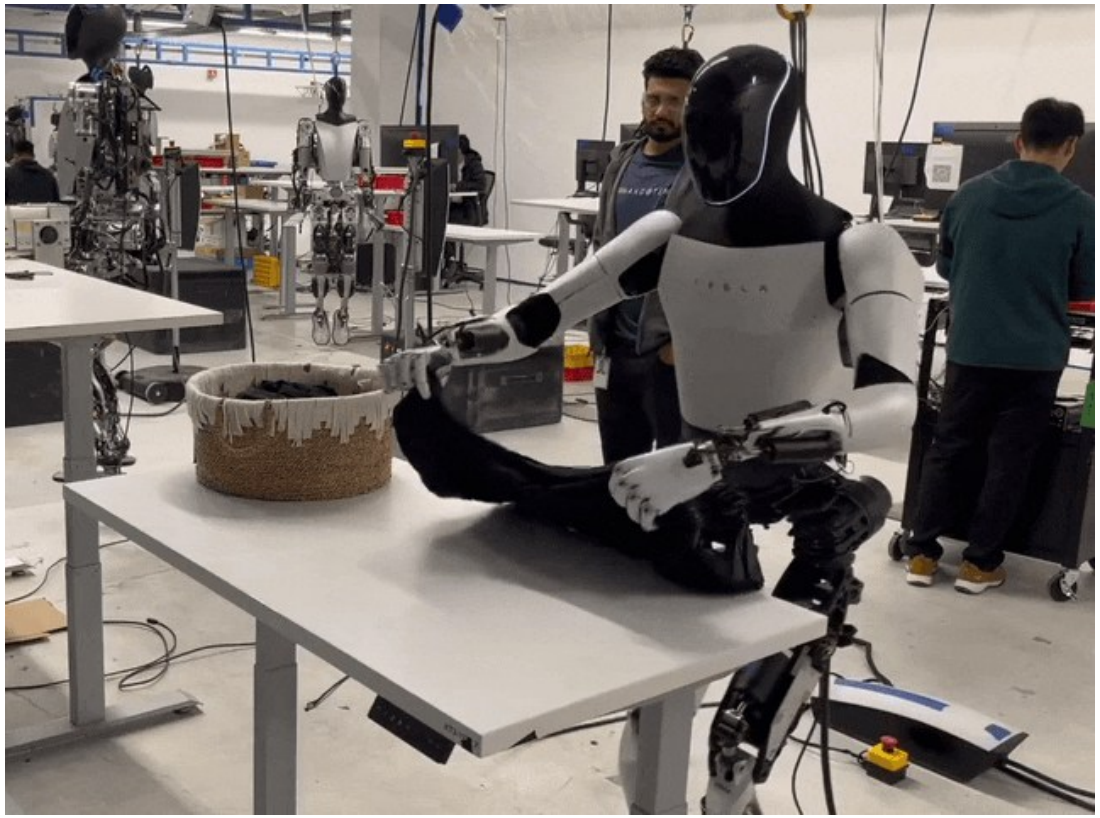
- Intelligence is the computational part of the ability to achieve goals in the world



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

What is artificial Intelligence?

Why is folding clothes a research problem while robots are actively being used to assemble cars in factories?



Whoops

January 15, 2024

Elon's Tesla robot is sort of 'ok' at folding laundry in pre-scripted demo

Musk said that eventually, it will "certainly be able to do this fully autonomously," however, and without the highly artificial constraints in place for this demo, including the fixed-height table and single article of clothing in the carefully placed basket.

https://techcrunch.com/2024/01/15/elons-tesla-robot-is-sort-of-ok-at-folding-laundry-in-pre-scripted-demo
https://x.com/elonmusk/status/1746964887949934958

Intelligence and Uncertainty

Another way to think about intelligence is to consider how much uncertainty is involved

Uncertainty comes into play whenever it is not feasible to determine exact information

Uncertainty requires decisions to be made

Intelligence and Uncertainty

Uncertainty can have lots of sources, including anything we attribute to random chance

- Hidden information
  - Cards in another player's hand
- Noise
  - Sensor noise
- Way to complicated to model
  - Leaves blowing in the wind
- Infinite number of possible configurations
- More possibilities than any computer can compute in a reasonable time
  - Tic-tac-toe → Checkers → Chess

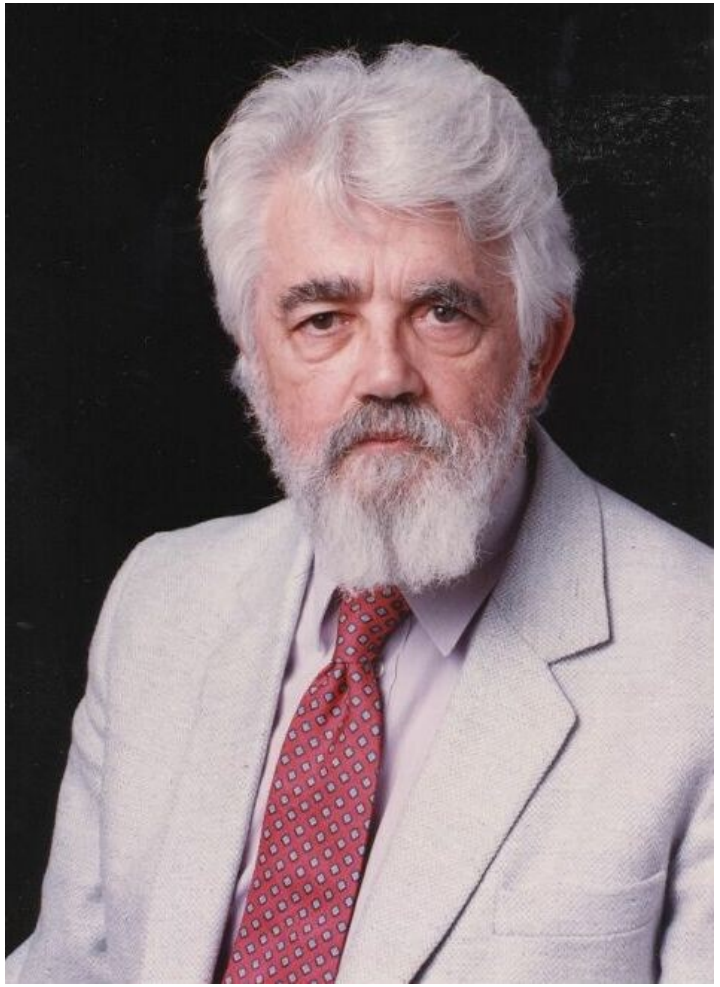
AI Definition by John McCarthy

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



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

AI Definition (Pat's Version)

What is intelligence

- Intelligence is the ability to perform well on a task that involves uncertainty

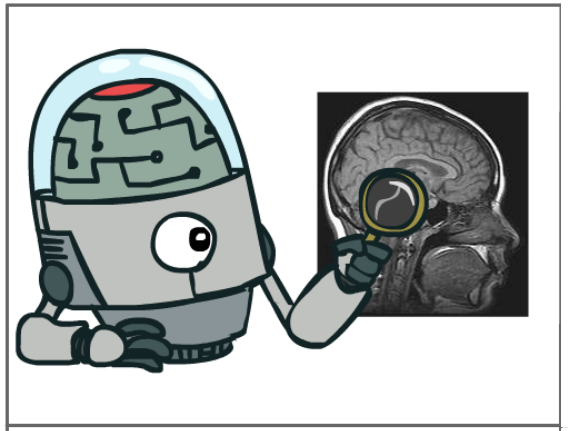
Intelligence is not binary

- How **well** an agent performs and how much **uncertainty** is involved will determine how intelligent we consider the agent to be

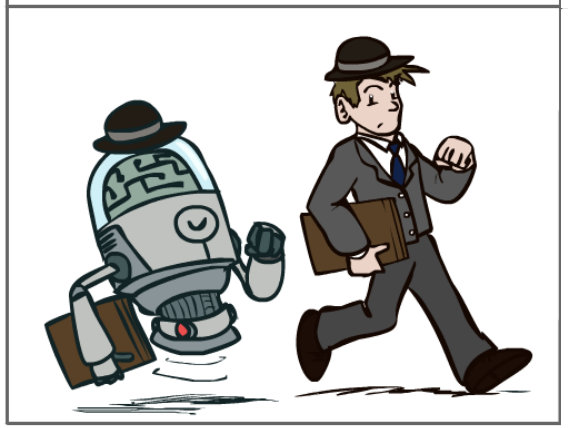
What is AI?

The science of making machines that:

Think like people



Act like people



Turing Test

In 1950, Turing defined a test of whether a machine could “think”

“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”

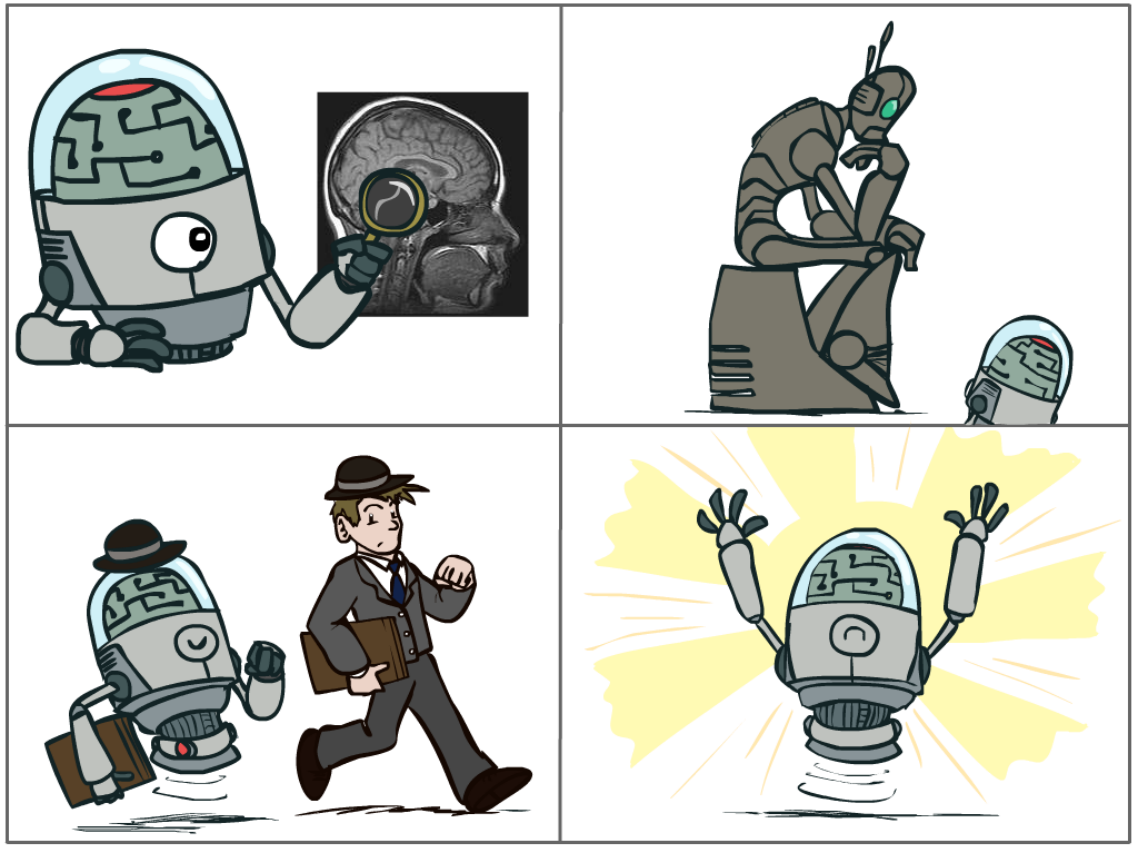
en.wikipedia.org/wiki/Turing_test

What is AI?

The science of making machines that:

Think like people

Think rationally



Act like people

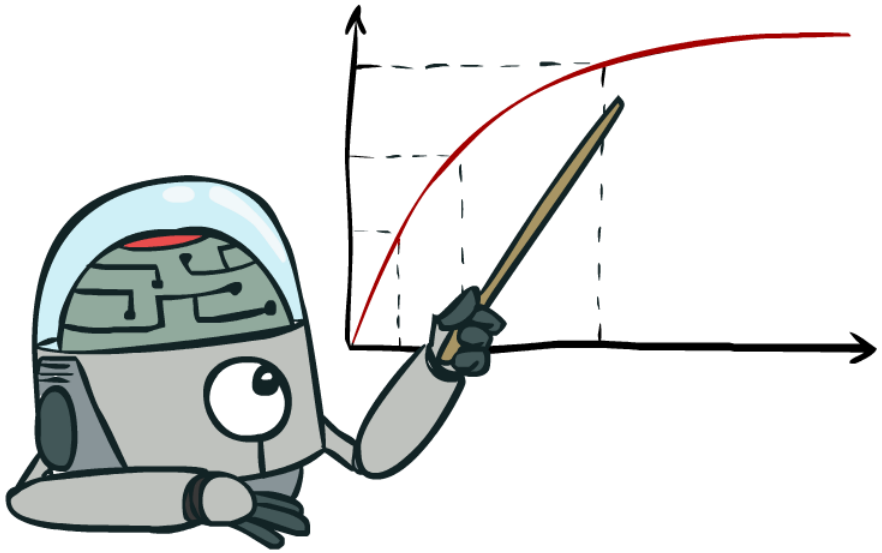
Act rationally

Rational Decisions

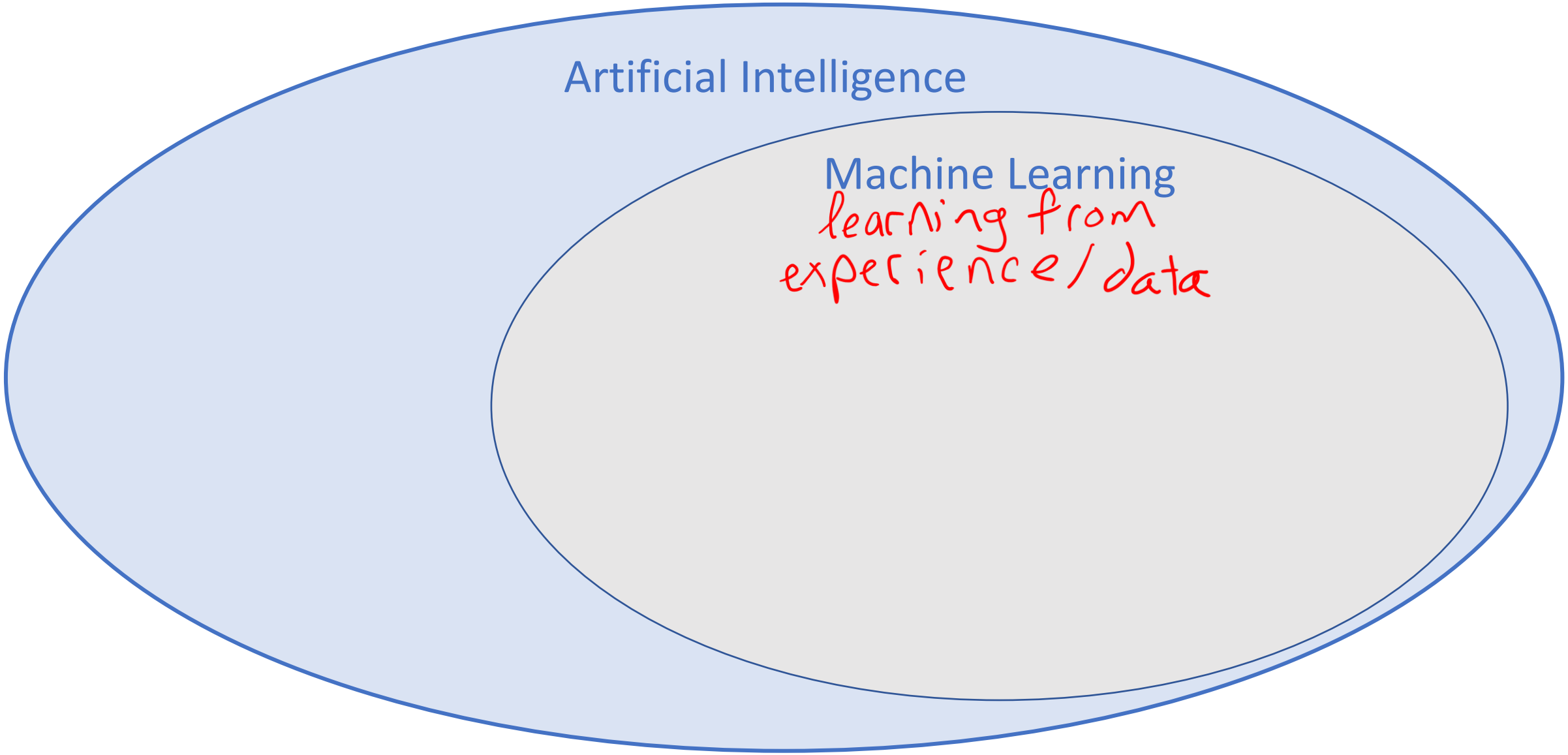
We'll use the term **rational** in a very specific, technical way:

- Rational: maximally achieving pre-defined goals
- Only concerned with what decisions are made (not the thought process behind them)
- Goals are expressed in terms of the **utility** of outcomes
- Being rational means **maximizing your expected utility**

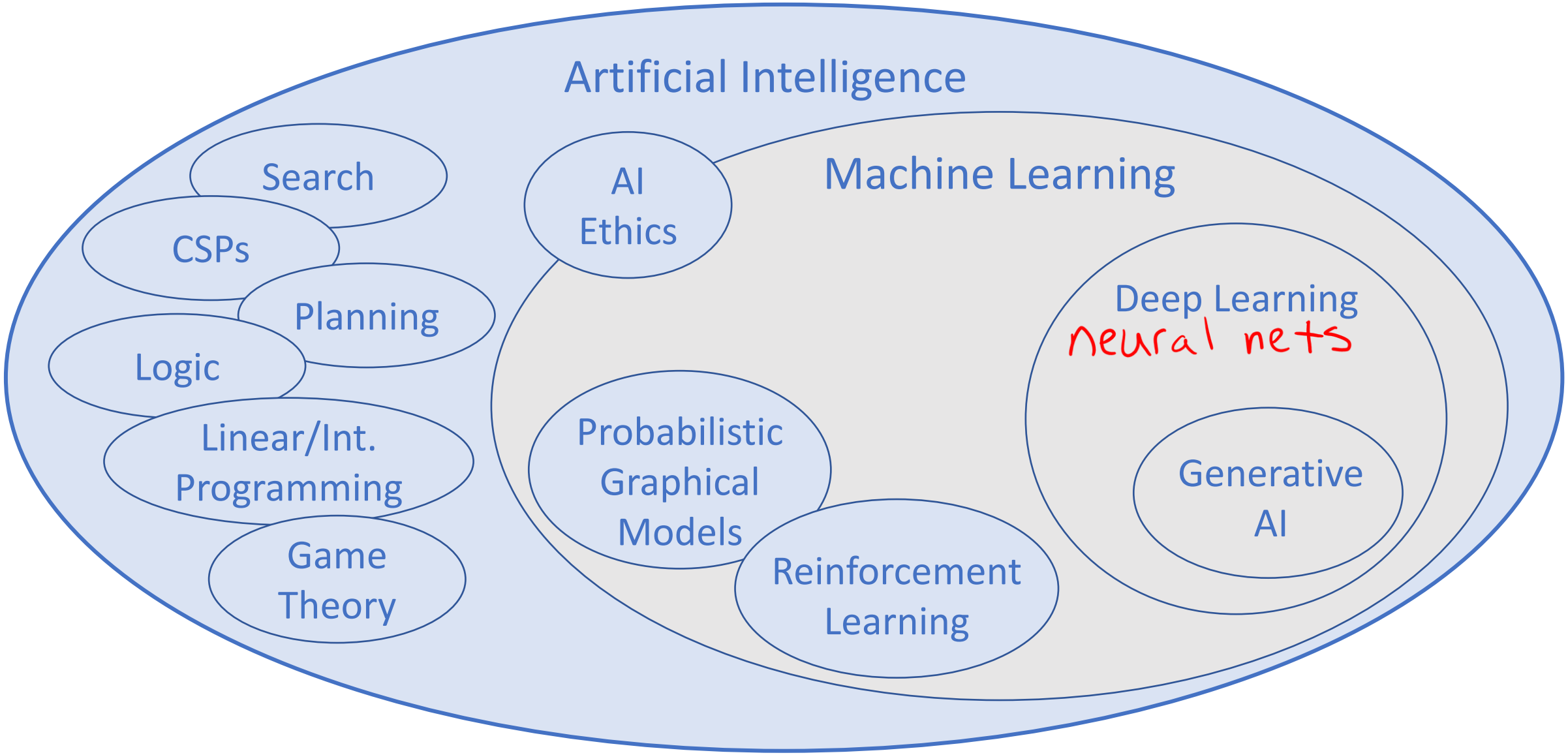
Maximize Your Expected Utility



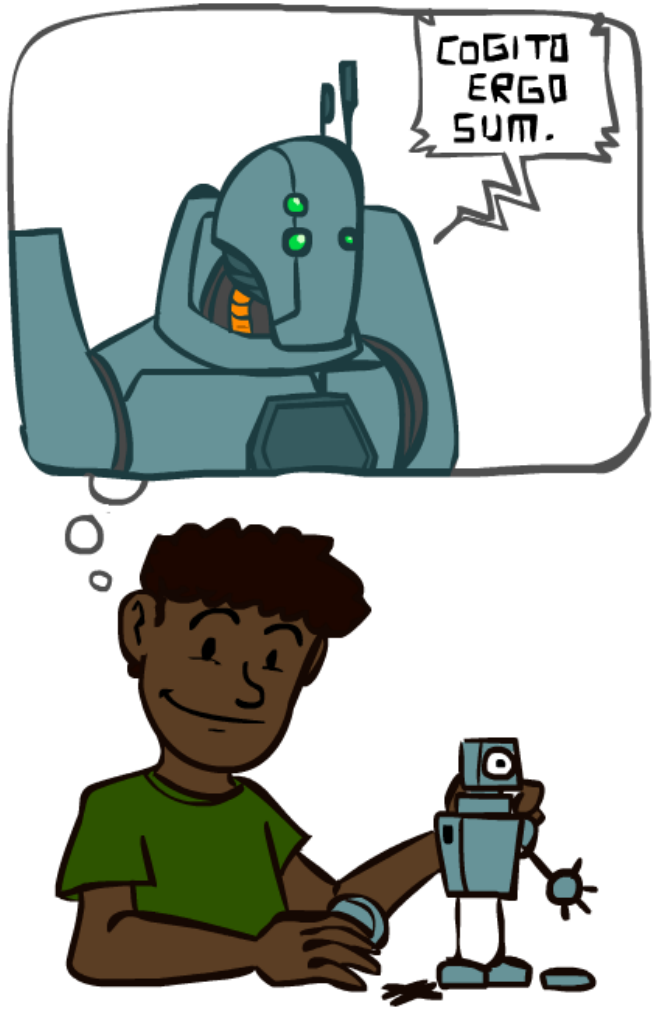
Artificial Intelligence vs Machine Learning?



Artificial Intelligence vs Machine Learning?



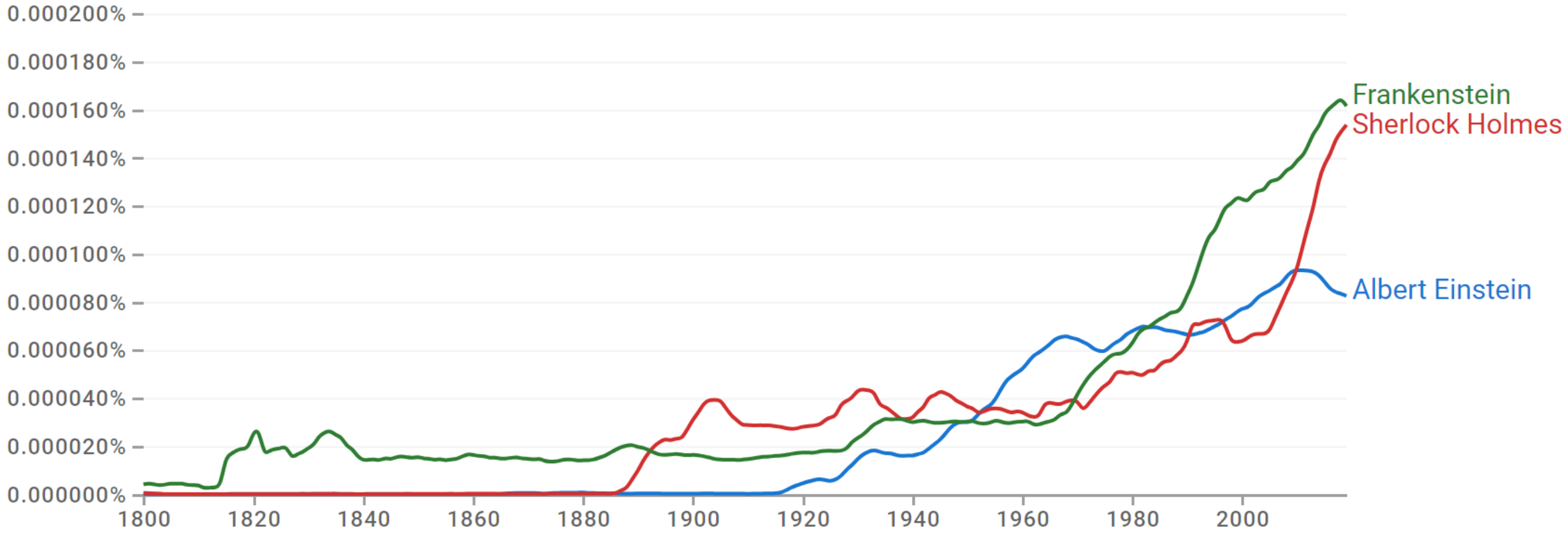
A Brief History of AI



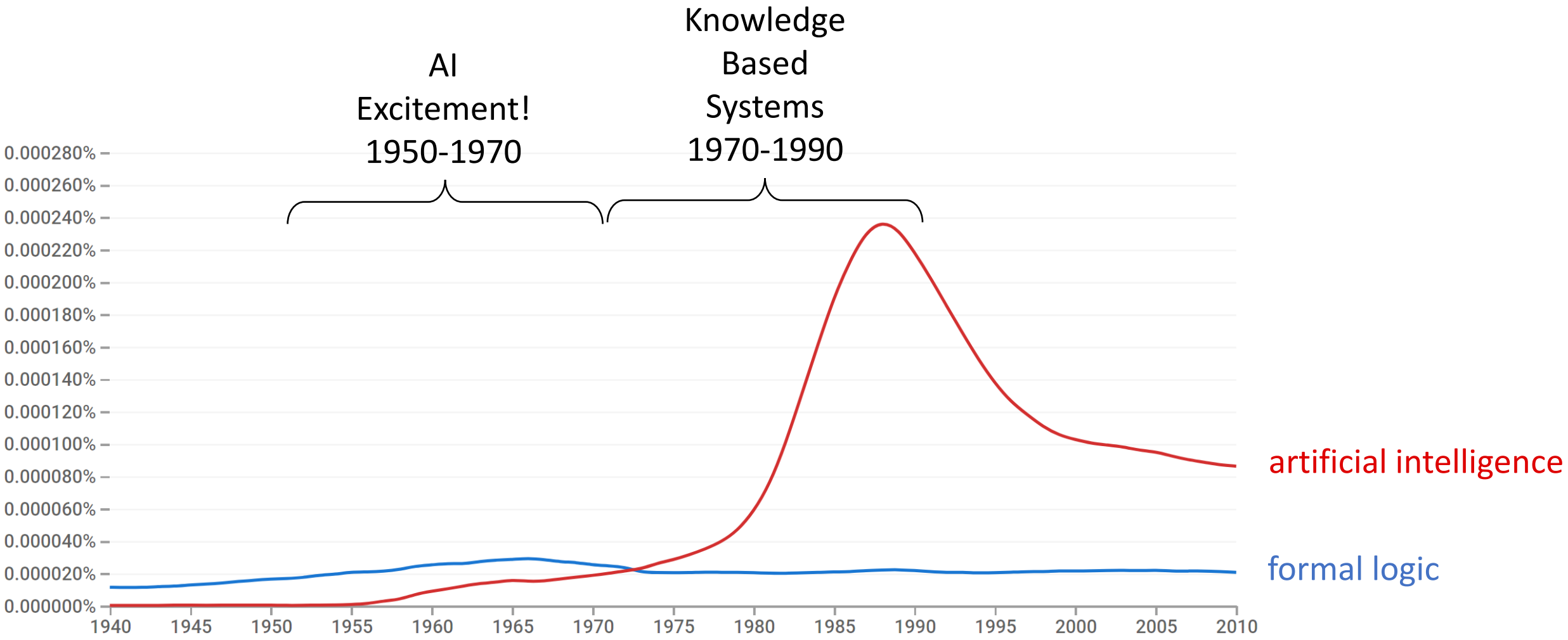
Google Books Ngram Viewer https://books.google.com/ngrams

Albert Einstein,Sherlock Holmes,Frankenstein

1800 - 2019 English (2019) Case-Insensitive Smoothing



A Brief History of AI

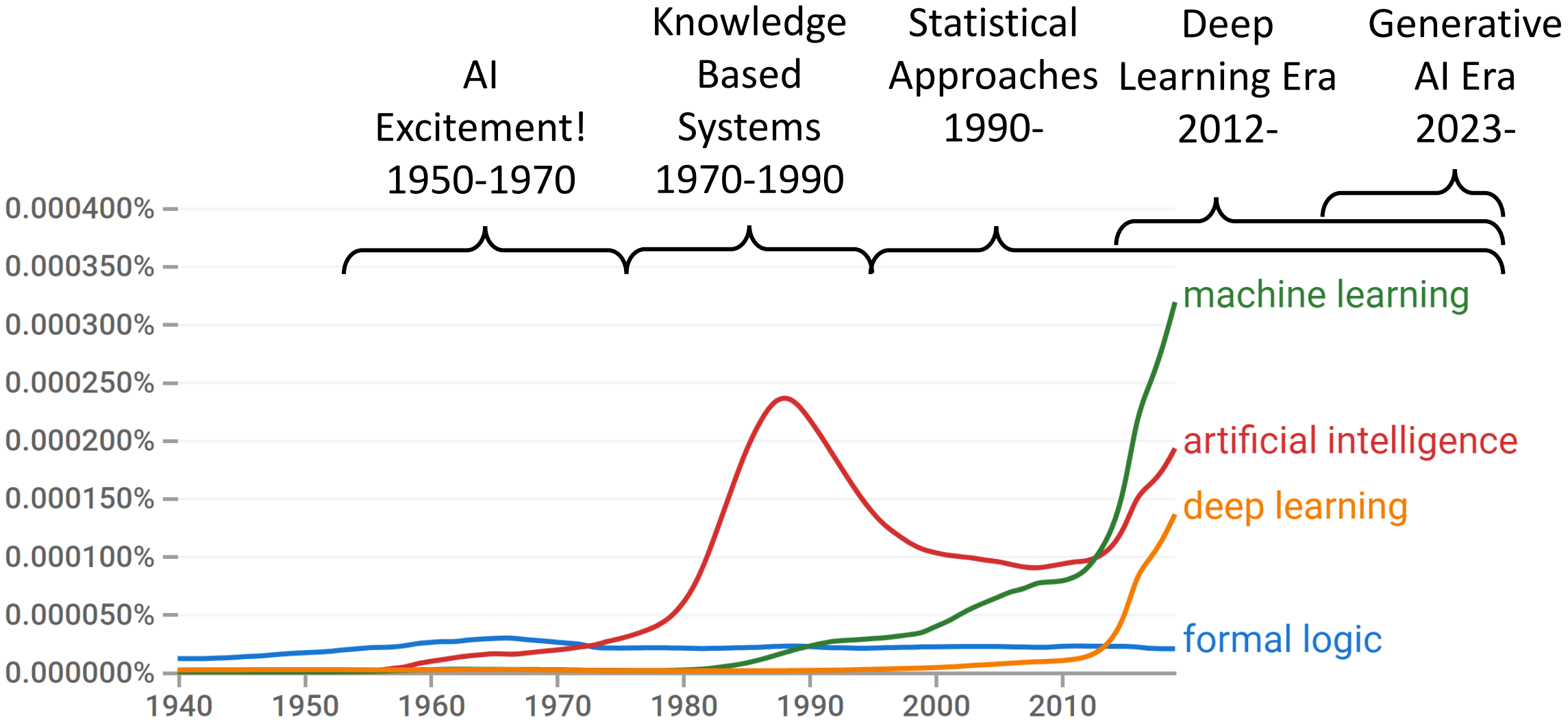


https://books.google.com/ngrams

What went wrong?

Dog	Buster
▪ Barks	✓
▪ Has Fur	✓
▪ Has four legs	✗

A Brief History of AI



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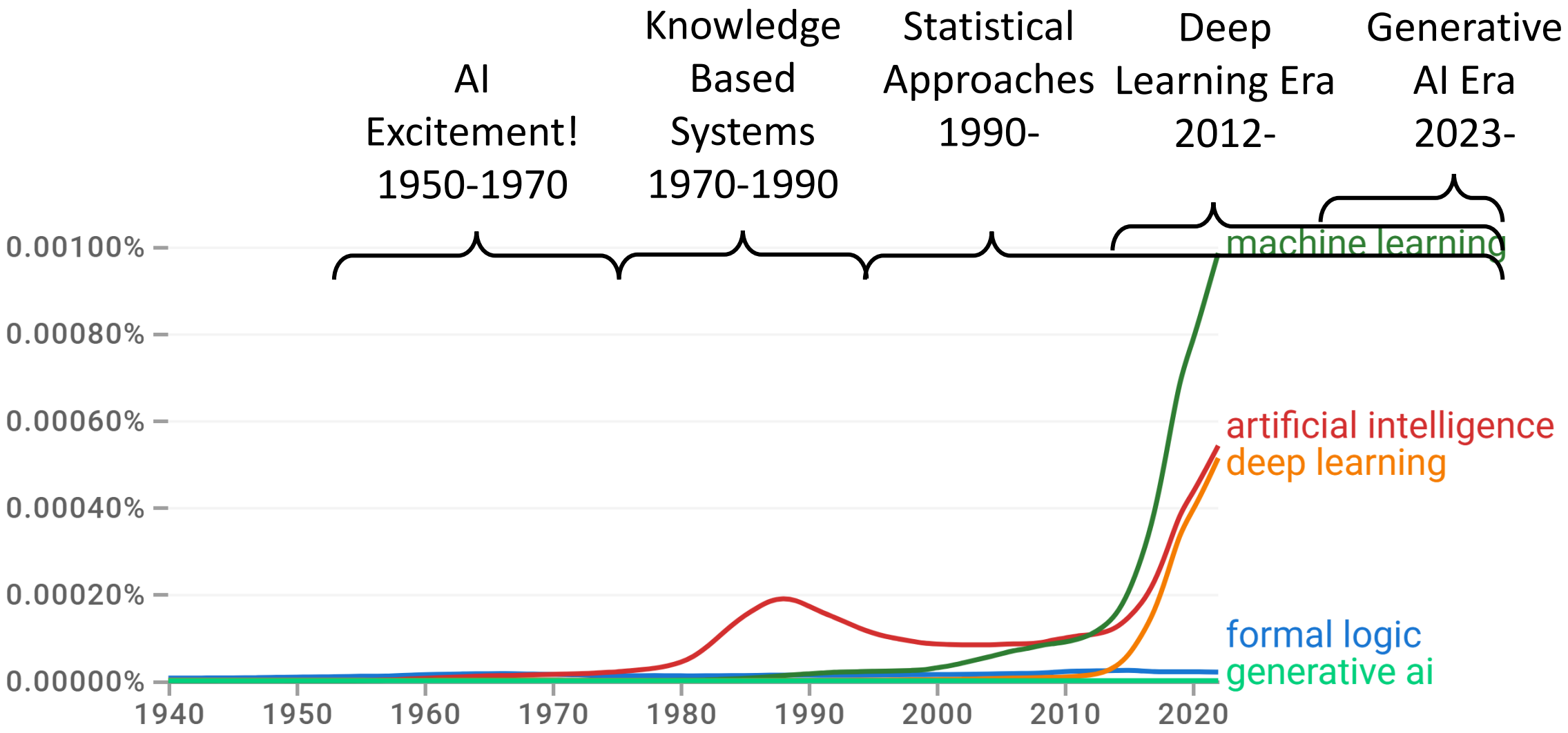
A Brief History of AI



https://books.google.com/ngrams

A Brief History of AI

1940-1950: Early days

- 1943: McCulloch & Pitts: Boolean circuit model of brain
- 1950: Turing's “Computing Machinery and Intelligence”

1950—70: Excitement: Look, Ma, no hands!

- 1950s: Early AI programs, including Samuel's checkers program, Newell & Simon's Logic Theorist, Gelernter's Geometry Engine
- 1956: Dartmouth meeting: “Artificial Intelligence” adopted

1970—90: Knowledge-based approaches

- 1969—79: Early development of knowledge-based systems
- 1980—88: Expert systems industry booms
- 1988—93: Expert systems industry busts: “AI Winter”

1990—: Statistical approaches

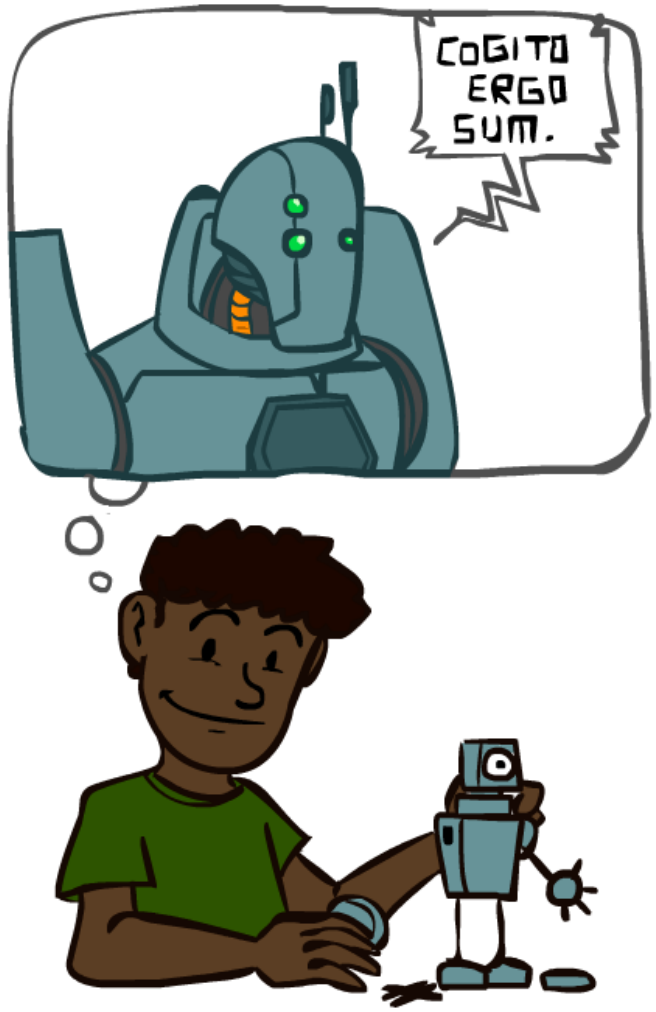
- Resurgence of probability, focus on uncertainty
- General increase in technical depth
- Agents and learning systems… “AI Spring”?

2012—: Deep learning

- 2012: ImageNet & AlexNet

2023—: Generative AI

- 2023: ChatGPT



Images: ai.berkeley.edu