

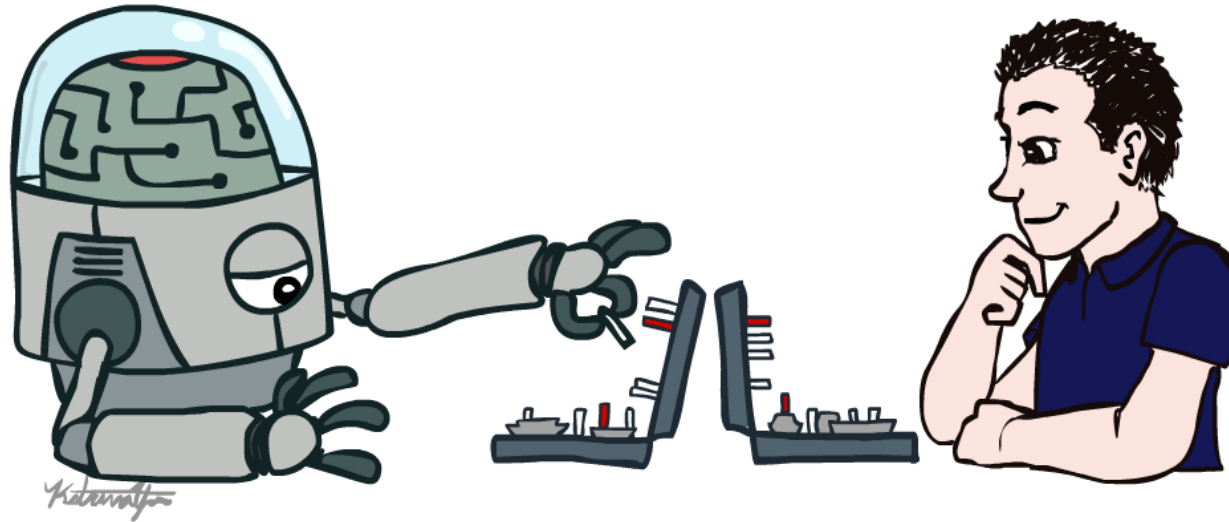
Warm-up as you walk in Candy Grab game!

1. Grab a pack of game pieces (candy/goldfish)
2. Groups of 3
3. Play the game!
 - a. Select 2 players (third play will observer)
 - b. 11 pieces on the table
 - c. Take turns taking 1 or 2 pieces
 - d. Person that takes the last piece wins!
4. Keep playing the game (rotate which 2 are playing)
5. Think about how you might implement an Agent 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

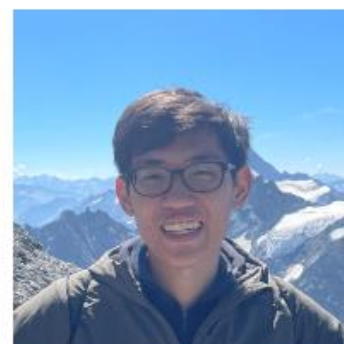
Teaching Assistants



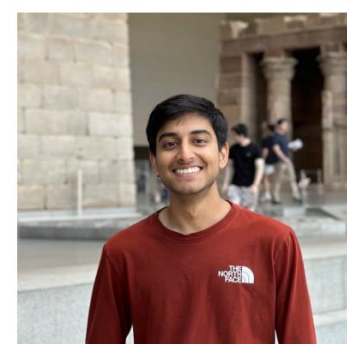
Kate
yoonseol



Avi
aarya2



Gavin
feiyuz



Ayush
ayushg2



Josep (Head TA)
jpujadas



Steven
yiy6



Shruti
shrutisr



Theo
tsurban



Ethan
ethanmac

Course Team

Students!!



(Quick) Course Information

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

Canvas: canvas.cmu.edu



Gradescope: gradescope.com



Communication: Piazza → Ed

(If Piazza/Ed doesn't work) E-mail: pvirtue@andrew.cmu.edu

AI and ML Courses

15-281 and 10-315 (Intro ML)

- Designed to go together
- Topics divided among two courses for breadth
- Two courses allows depth
- 15-281 has some machine learning topics but, notably, no neural networks (deep learning)
 - Reinforcement learning (RL)
 - Probabilistic Graphical Models (Bayes Nets, HMMs)

10-301/10-601 (Intro ML)

- Has really good ML breadth (and also decent depth) but not AI breadth

Announcements

Recitation starting this Friday

- Recommended. Materials are fair game for exams
- Choosing sections

Assignments:

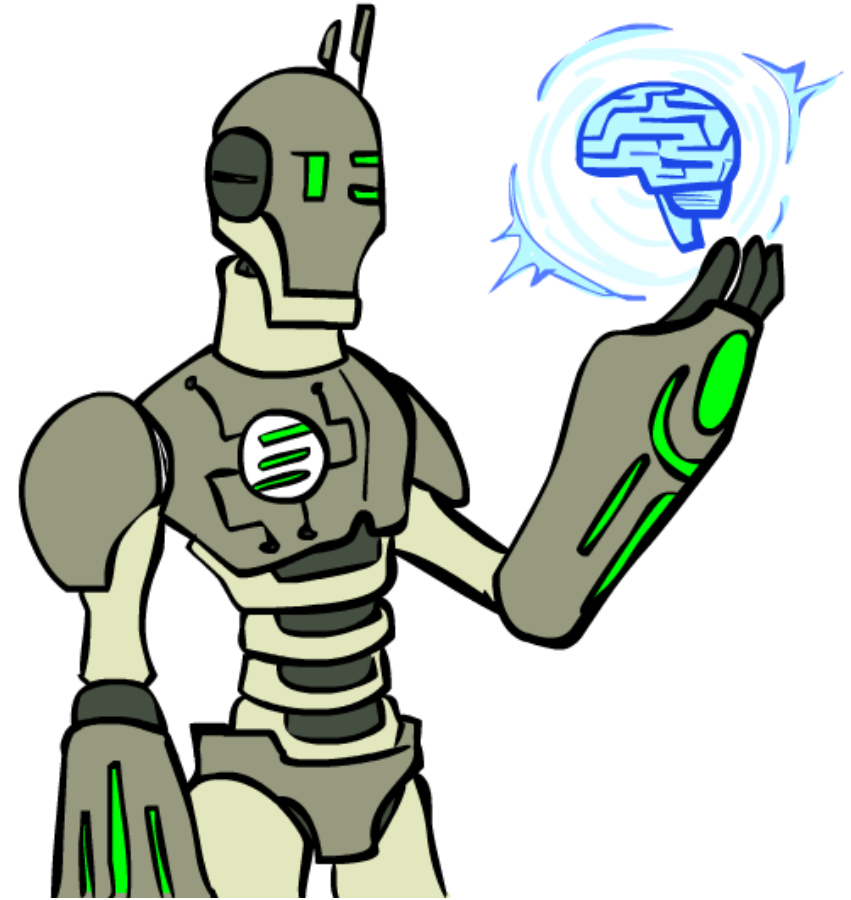
- P0: Python & Autograder Tutorial
 - Required, but worth zero points
 - Already released
 - Due Thu 9/5, 10 pm
- HW1 (online)
 - Released Thursday
 - Due Thu 9/5, 10 pm

Today

Designing Agents

What is artificial intelligence?

A brief history of AI



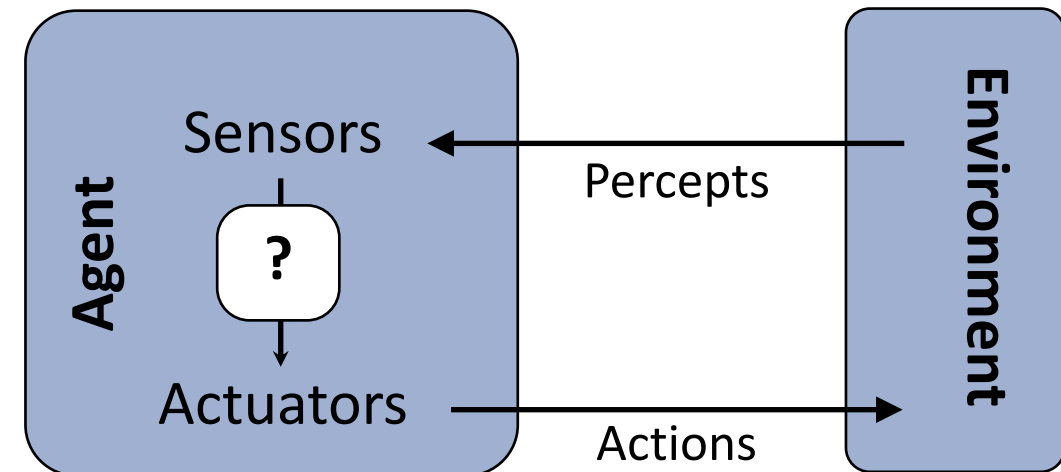
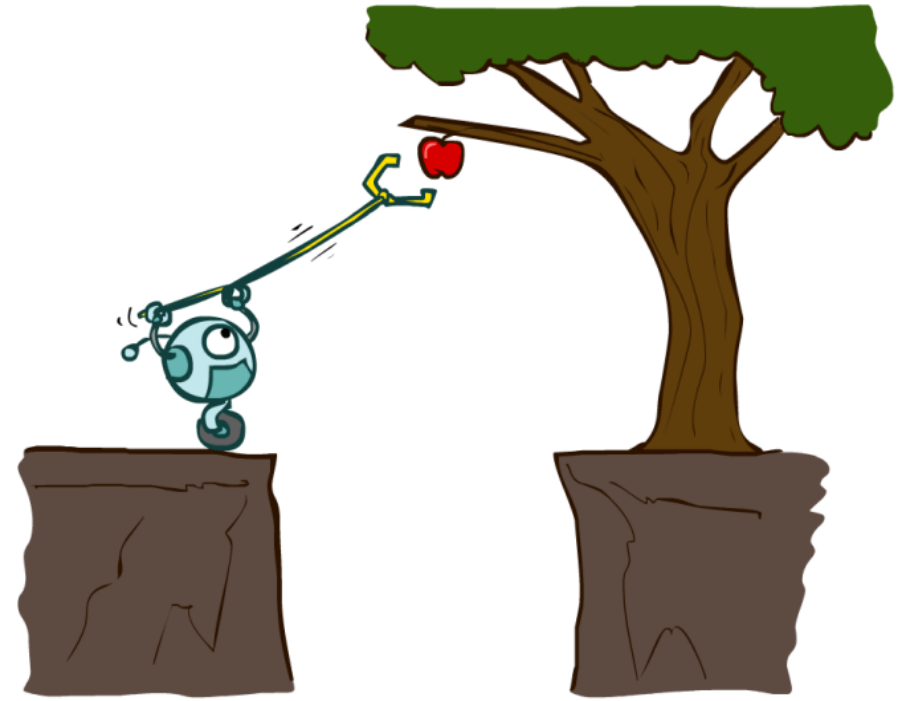
Designing Agents

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

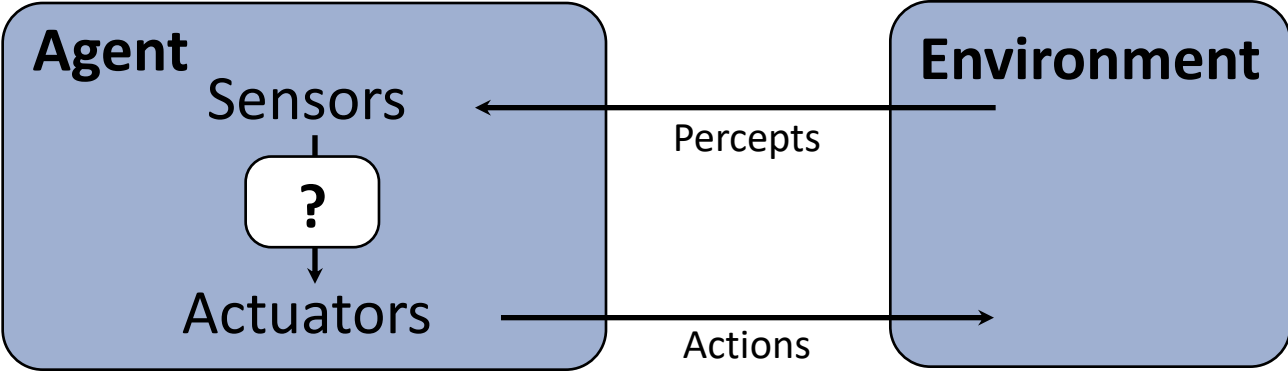
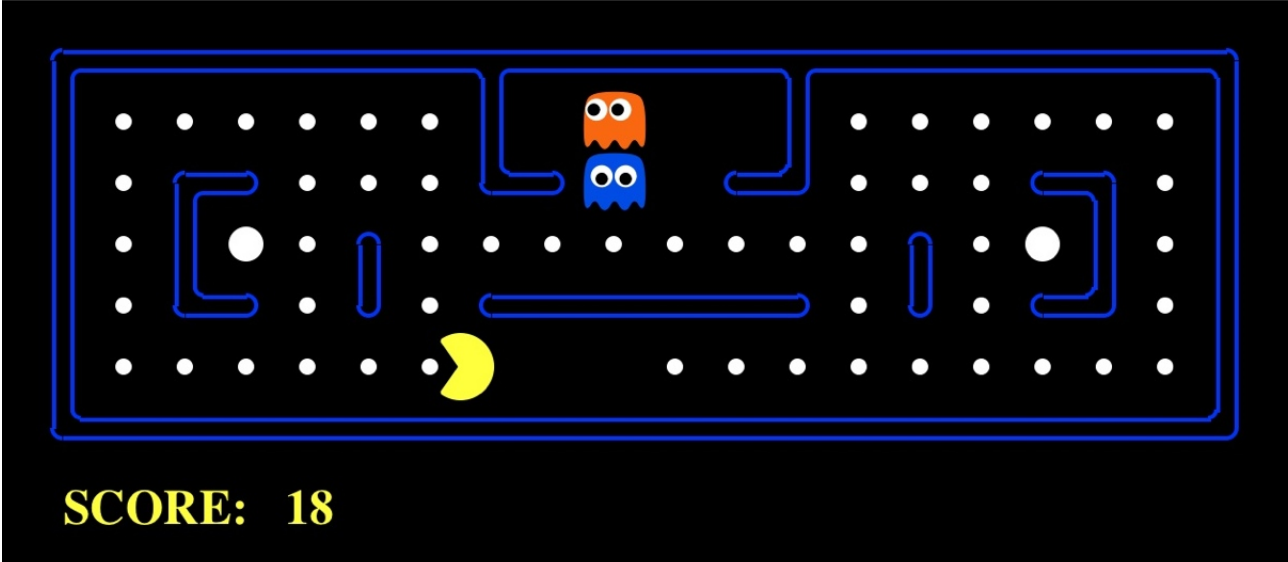
Characteristics of the **percepts**, **environment**, and **action space** dictate techniques for selecting actions

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



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 Piazza 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



MAX (X)



MIN (O)



MAX (X)

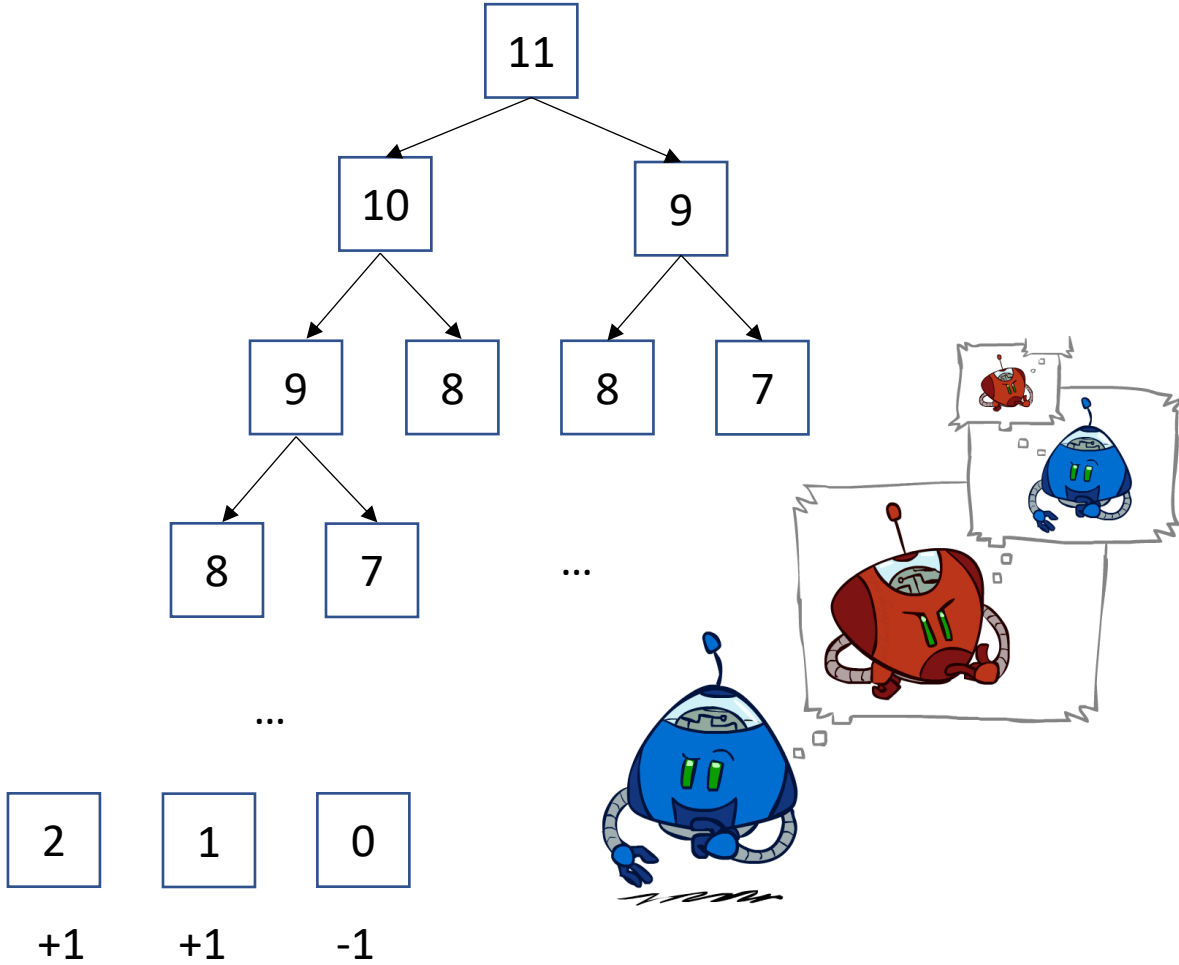


MIN (O)



TERMINAL

Utility



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

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
- B. Encode multiple of 3 pattern
- C. Keep stats on winning positions

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!

The screenshot shows the top of a web browser displaying the New Yorker website. At the top left, there is a promotional banner for the magazine with the text "READ SOMETHING THAT MEANS SOMETHING. \$1 A WEEK" and "SUBSCRIBE RENEW GIVE A GIFT NON-U.S. ORDERS". The main header features the "THE NEW YORKER" logo in a large serif font. To the right of the logo are links for "Sign in", "Link your subscription", and "TNY Store", along with social media icons for Facebook, Twitter, and Google+. Below the header is a navigation menu with categories: NEWS, CULTURE, BOOKS & FICTION, SCIENCE & TECH, BUSINESS, HUMOR, MAGAZINE, VIDEO, ARCHIVE, and SUBSCRIBE. The date "FEBRUARY 25, 2015" is displayed above the article title "ARTIFICIAL INTELLIGENCE GOES TO THE ARCADE" by "BY NICOLA TWILLEY". Social sharing buttons for Facebook, Twitter, Google+, email, and print are visible. On the right side, there is a logo for "ELEMENTS" featuring a star, a crescent moon, and a planet. The main text of the article begins with a large "A" and reads: "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". To the right of the text is a video player showing a pixelated Atari game. Below the video player is a "SIGN UP FOR NEWSLETTERS" form with an "E-mail address" input field and a "SIGN UP" button. At the bottom right, there is an "ADVERTISEMENT" placeholder.

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

What is "Artificial Intelligence"?

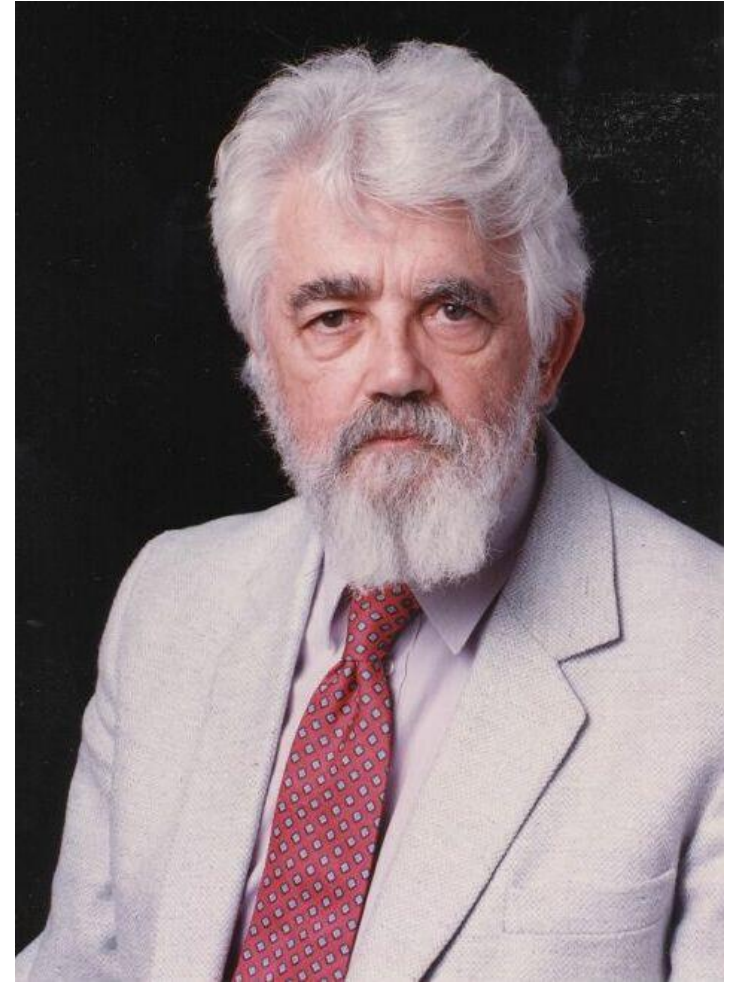
AI Definition by John McCarthy

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



What do we mean by "Artificial Intelligence"?

What do we mean by "Artificial Intelligence"?

Which of these is more intelligent?



Attributes of Intelligence

Which is more intelligent?

Robotics

- Robot that assemble cars in factory
- Robot that fold clothes



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

<https://x.com/elonmusk/status/1746964887949934958>

Intelligence and Uncertainty

Intelligence and Uncertainty

Uncertainty in robotics

- Robot that assemble cars in factory
- Robot that fold clothes



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

<https://x.com/elonmusk/status/1746964887949934958>

Intelligence and Uncertainty



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 too 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

What do we mean by an intelligent agent?

Pat's version:

An agent that performs well on tasks that involve uncertainty

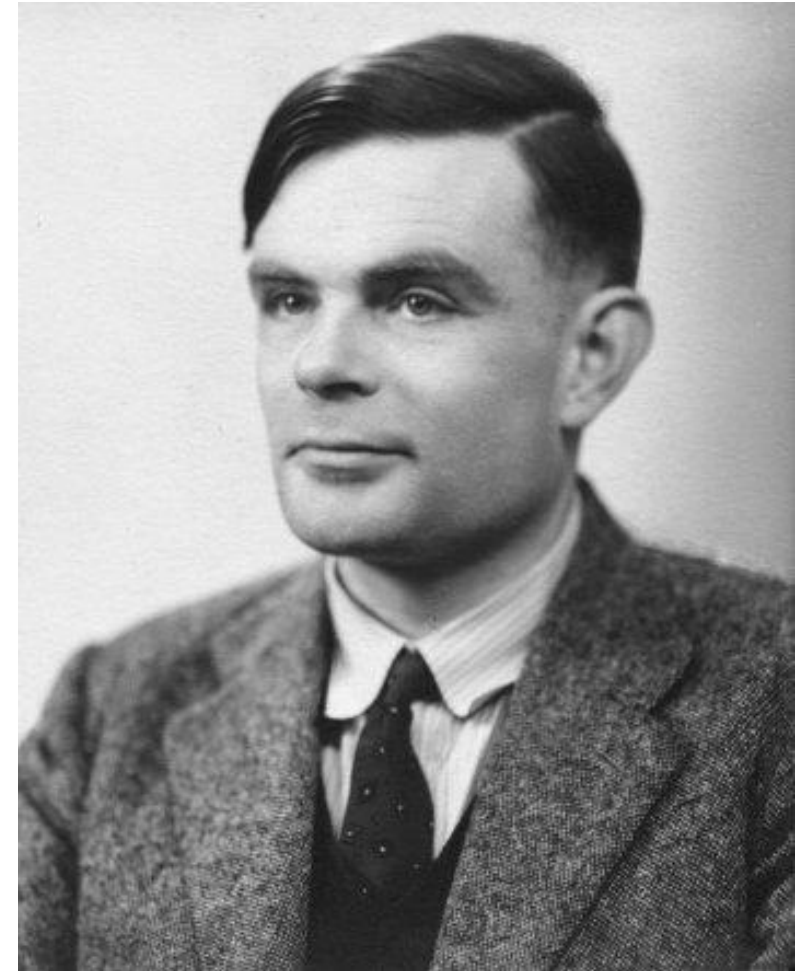
What is AI?

The science of making machines that:

Turing Test

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

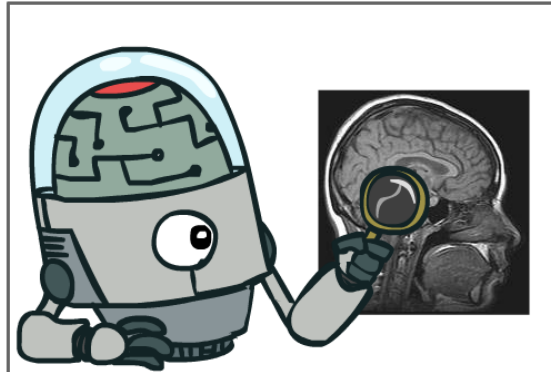
“A human judge engages in a natural language conversation with one human and one machine, each of which tries to appear human. If judge can’t tell, machine passes the Turing test”



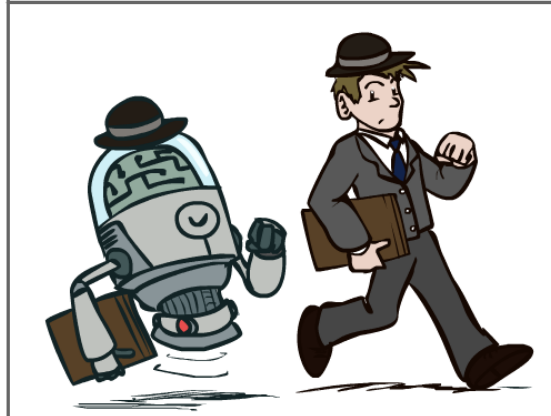
What is AI?

The science of making machines that:

Think like people



Act like people

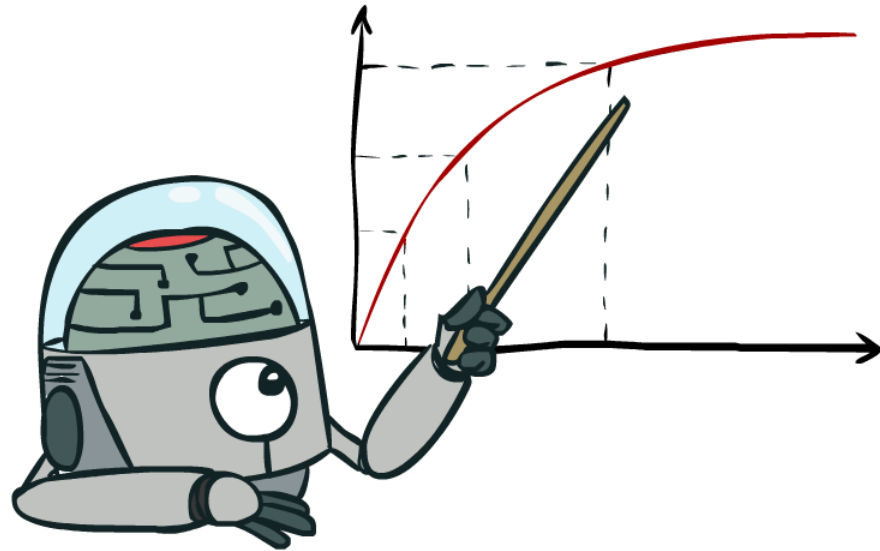


Rational Decisions

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

- Rational: maximally achieving pre-defined goals
- Rationality only concerns 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

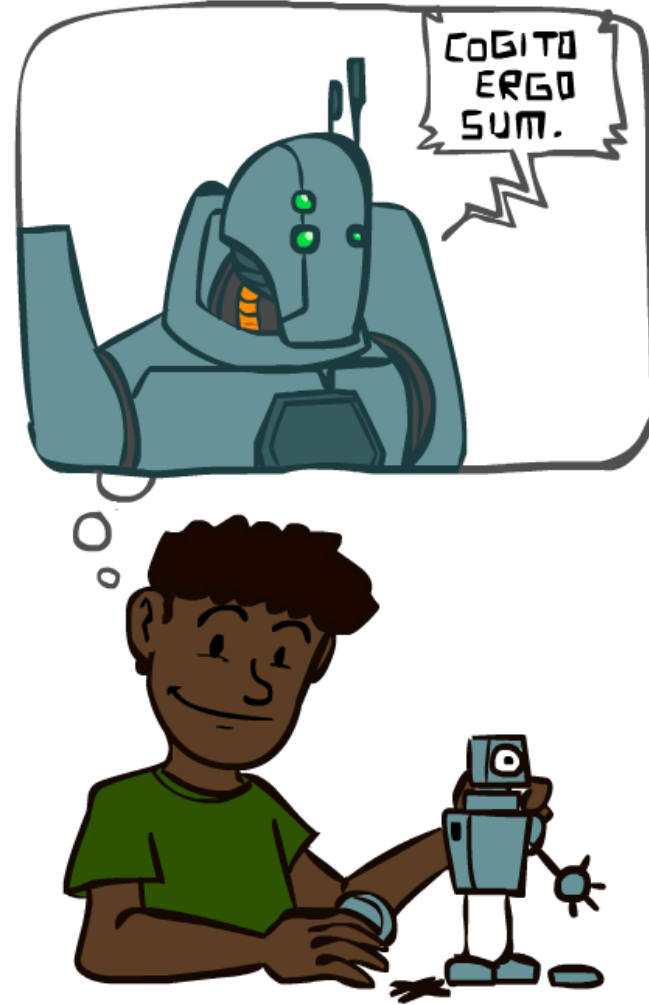


What About the Brain?

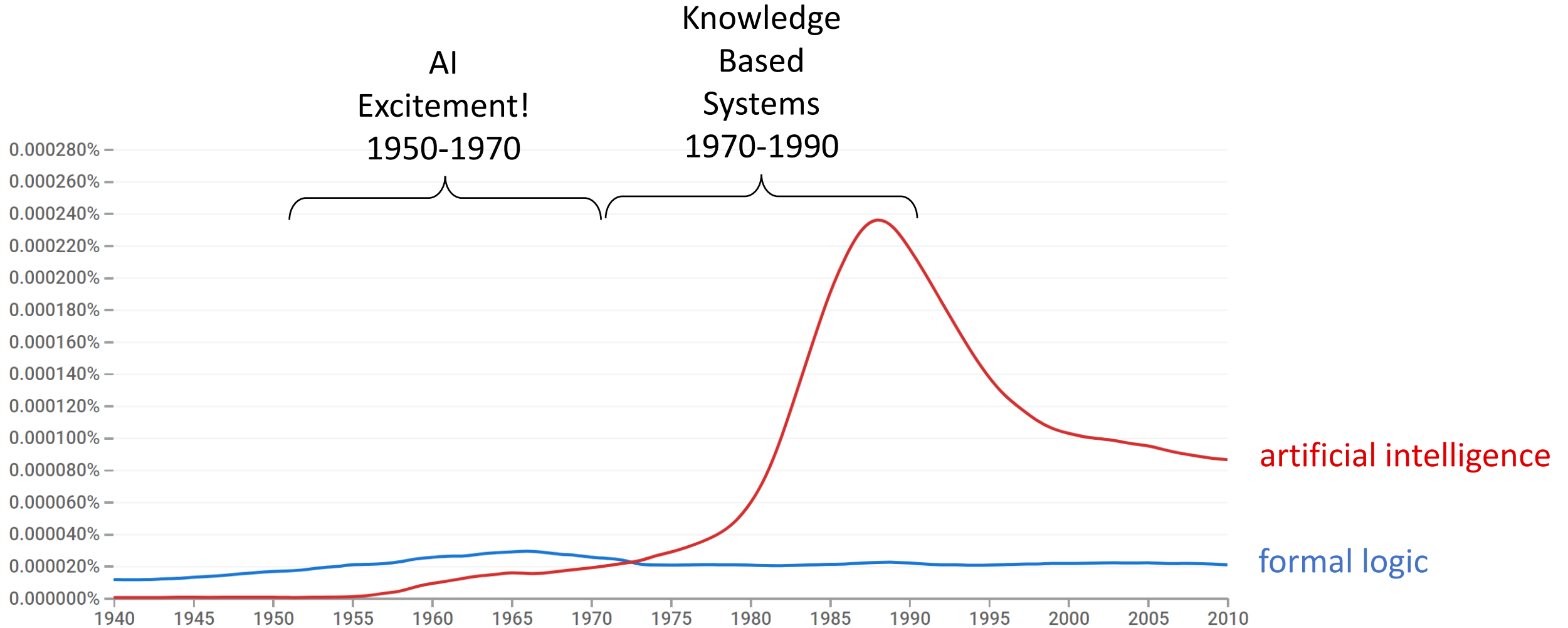
- Brains (human minds) are very good at making rational decisions, but not perfect
- Brains aren't as modular as software, so hard to reverse engineer!
- “Brains are to intelligence as wings are to flight”
- Lessons learned from the brain: memory and simulation are key to decision making



A Brief History of AI



A Brief History of AI



<https://books.google.com/ngrams>

What went wrong?



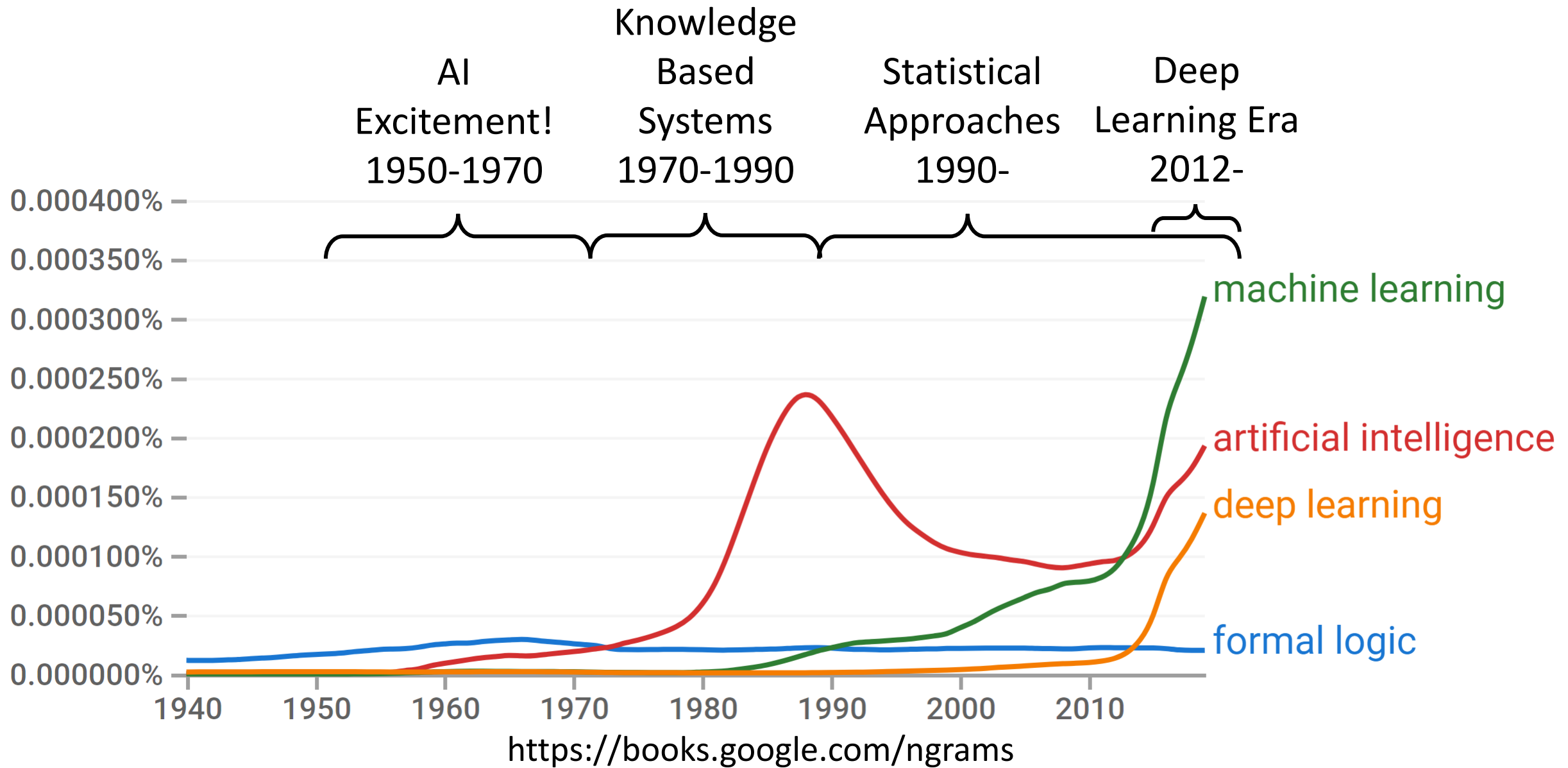
Dog

- Barks
- Has Fur
- Has four legs

Buster



A Brief History of AI



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"

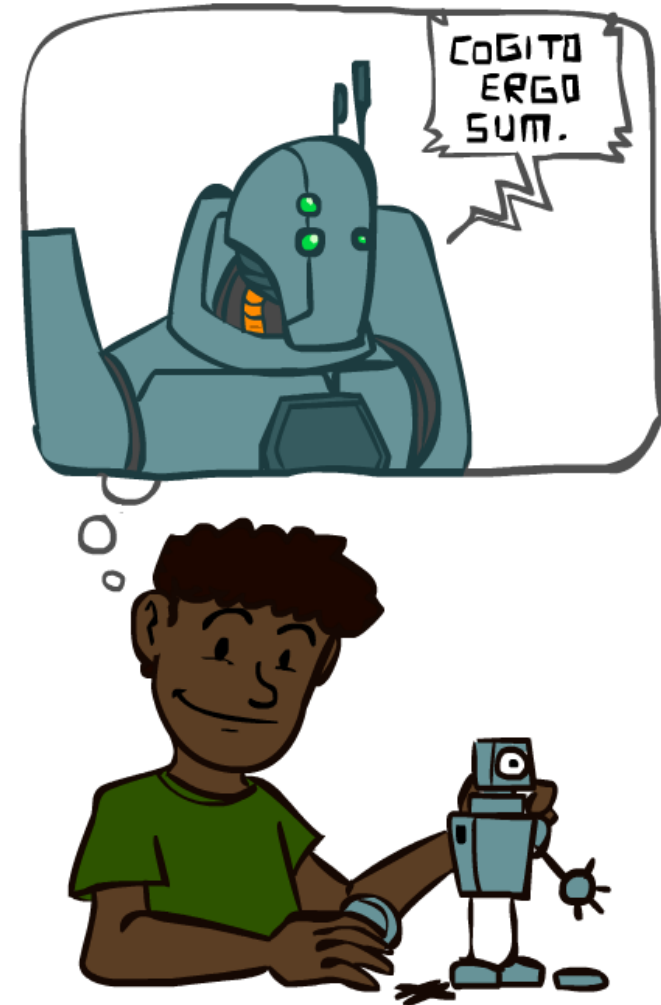
1990—: Statistical approaches

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

2012—: Deep learning

- 2012: ImageNet & AlexNet

Images: ai.berkeley.edu



Artificial Intelligence vs Machine Learning?

