# 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
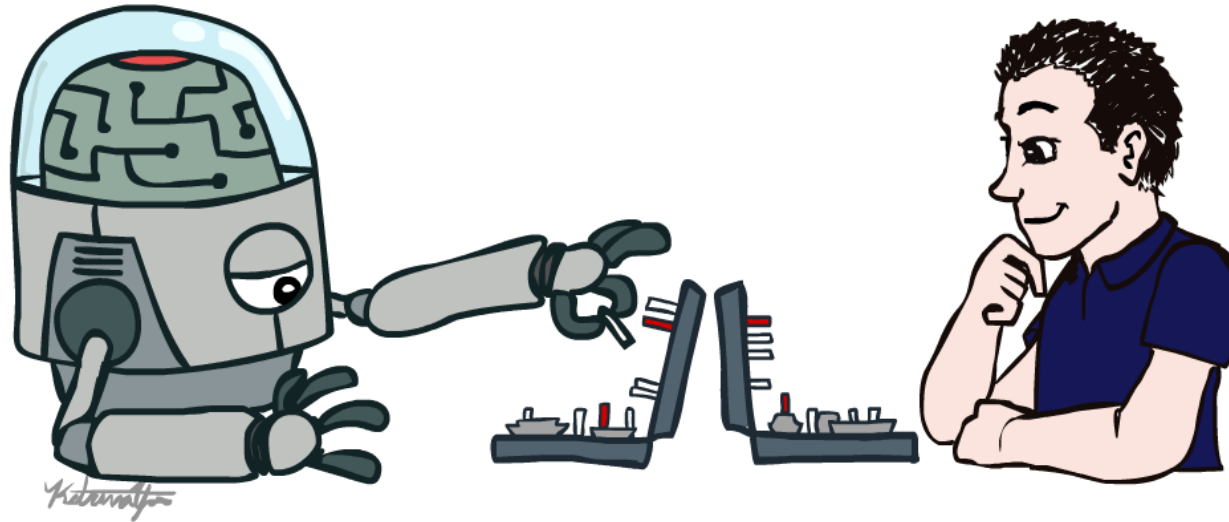
Instructor: Pat Virtue

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

Course Team

Instructor

Pat Virtue

Josep (Head TA)
jpujadas

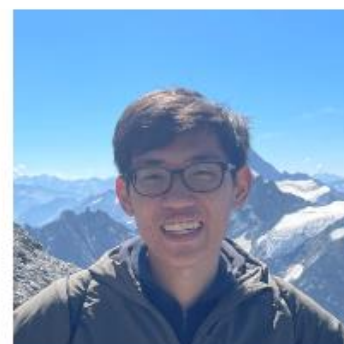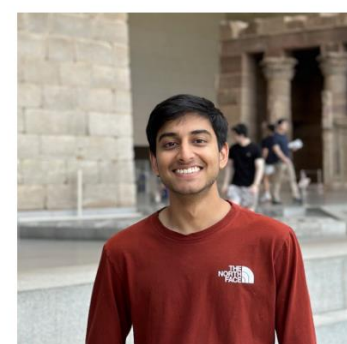## Teaching Assistants

Kate
yoonseol

Avi
aarya2

Gavin
feiyuz

Ayush
ayushg2

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

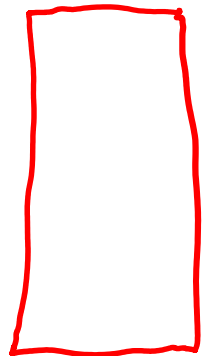## 15-281 and 10-315 (Intro ML)

- 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)
    - Probabilisted Graphical Models (Bayes Nets, HMMs)

10-301/10-601 (Intro ML)

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

AI 281   10-315 ML

AI RL PGM

ML

10-301/601 ML

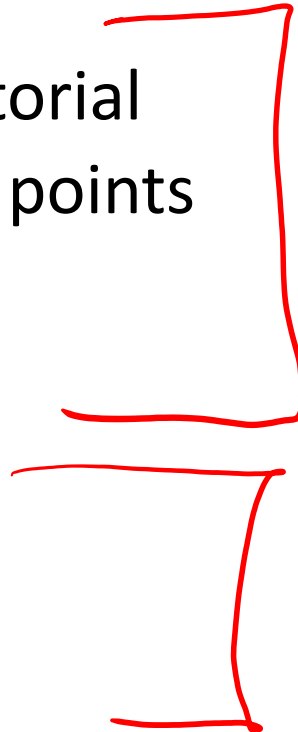11-485 DL

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)
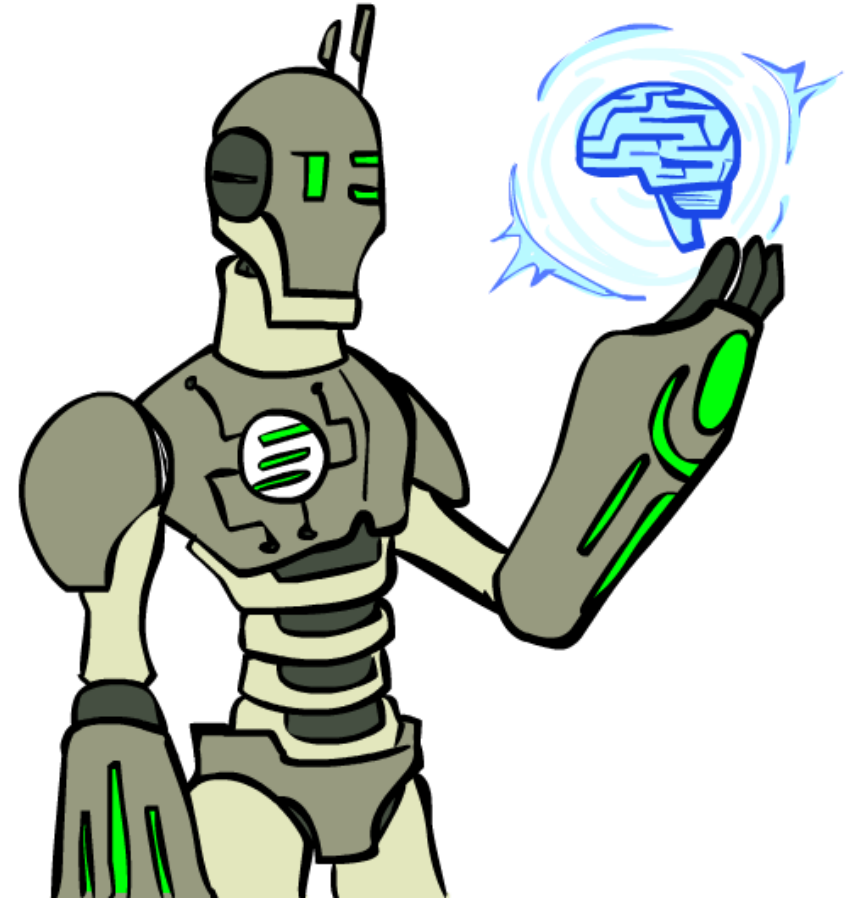   - Released Thursday
    - Due Thu 9/5, 10 pm

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

SCORE: 18

Agent

Sensors

?

Actuators

Environment

Percepts
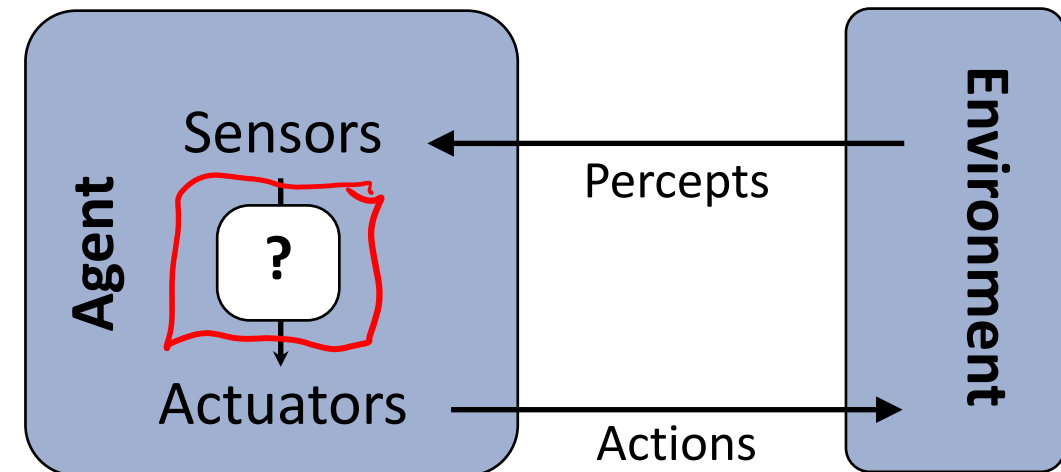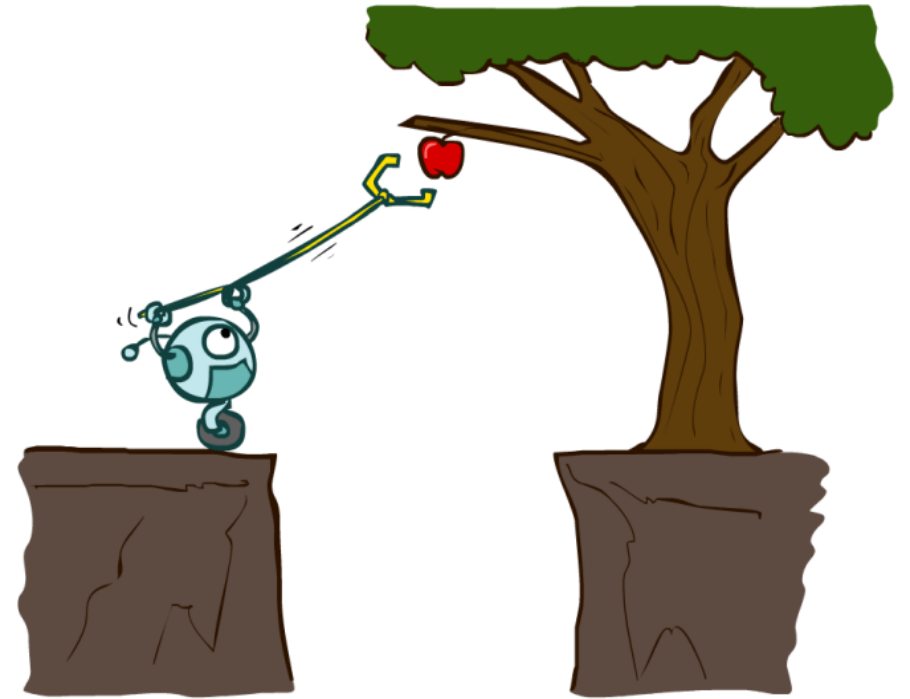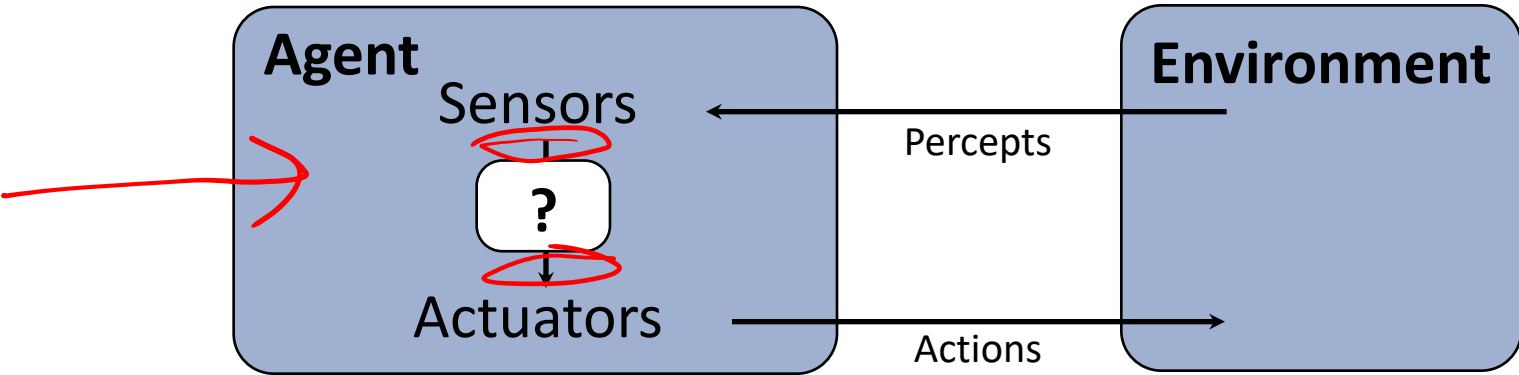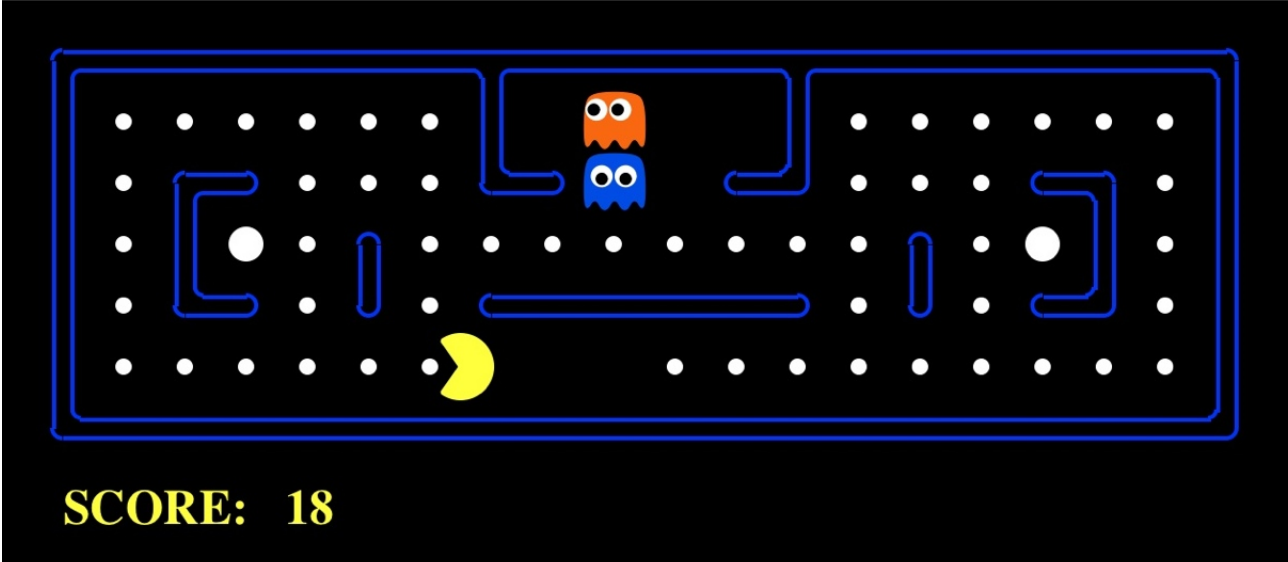
Actions

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

Nim Agent

```
class Agent

    function getAction(state)

        return action
```

numPieces, myTurn

1 or 2

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 ?
```

myTurn = T

if num == 11
ret 2

Nim Agent

end ⟶

11   0

Agent 007 – Whatever you think is best

```
function getAction( numPiecesAvailable )

    return ?
```

8   3

5   6

2   9

0   11

Nim Agent

Agent 007 – Whatever you think is best
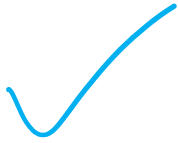
```
function getAction( numPiecesAvailable )

    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"?
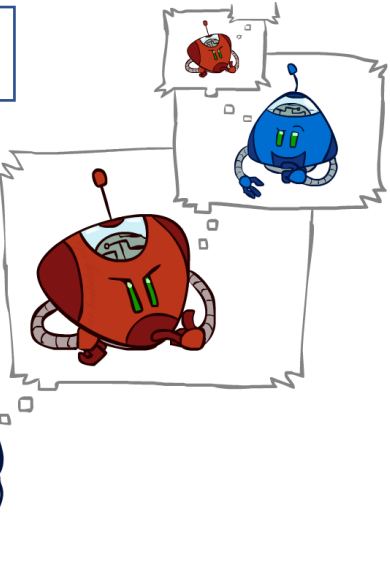
Games – Three "Intelligent" Agents

A: Search / Recursion
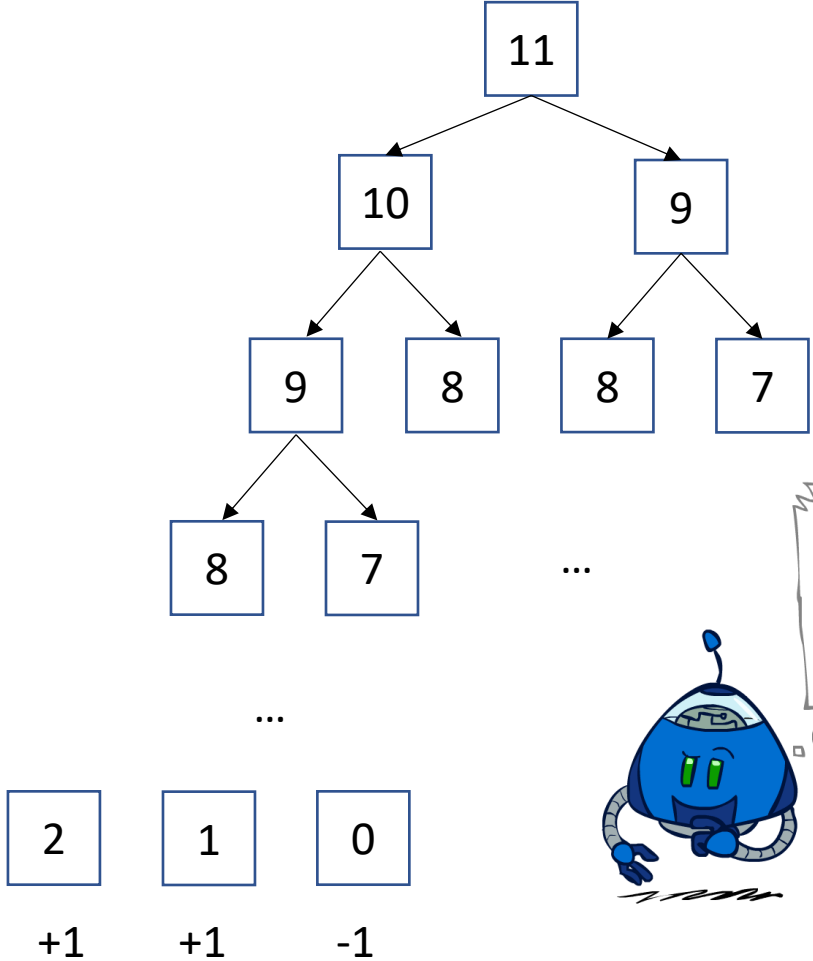
Games – Three "Intelligent" Agents

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

states	a_1	a_2
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   *16%*

B. Encode multiple of 3 pattern   *8%*

C. Keep stats on winning positions   *75%*

Games – Three "Intelligent" Agents

C: Record statistics of winning positions

RL.

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!

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

http://www-formal.stanford.edu/jmc/whatisai/whatisai.html
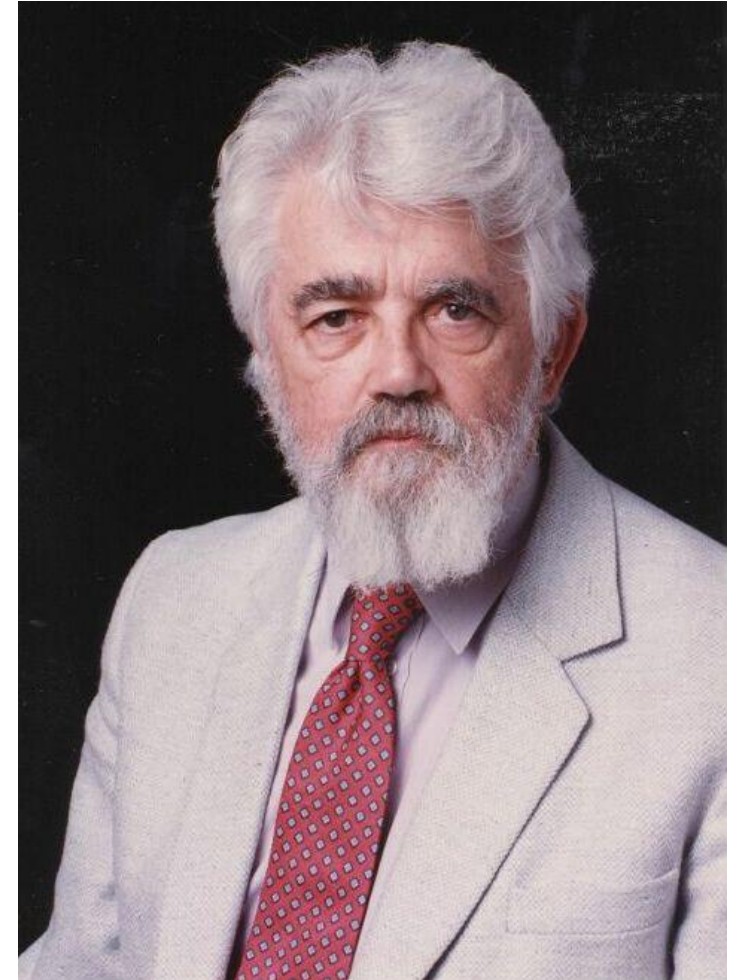
What do we mean by "Artificial Intelligence"?

What do we mean by "Artificial Intelligence"?

Which of these is more intelligent?

Attributes of Intelligence

making decision
adapt / new env
sensing (data)
analyzing (use data to make dec.)
learn
memory
creative
uncertainty

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

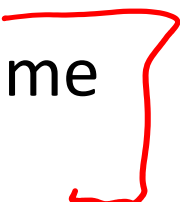# Intelligence and Uncertainty

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 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

What do we mean by an intelligent agent?

Pat's version:

An agent that preforms well on tasks that involve uncertainty

What is AI?

The science of making machines that:

Turing Test

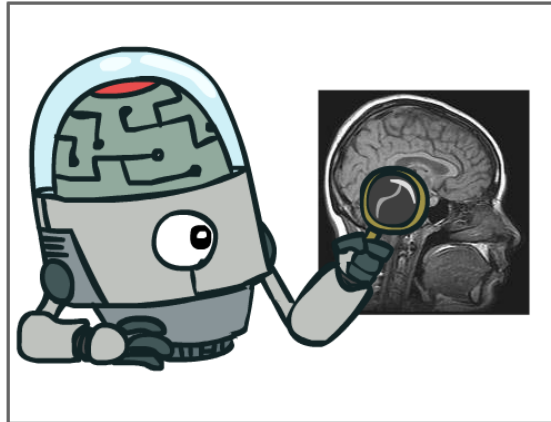In 1950, Turing defined a test of whether a machine could "think"

"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"
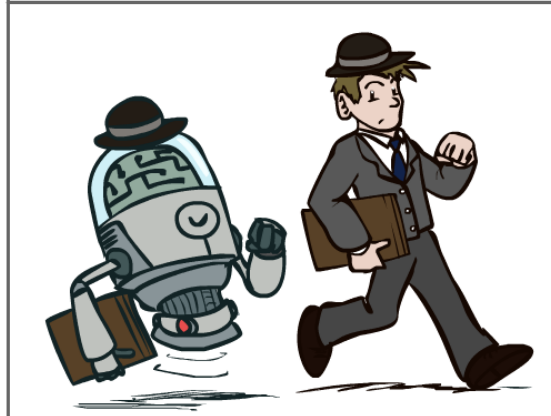

en.wikipedia.org/wiki/Turing_test
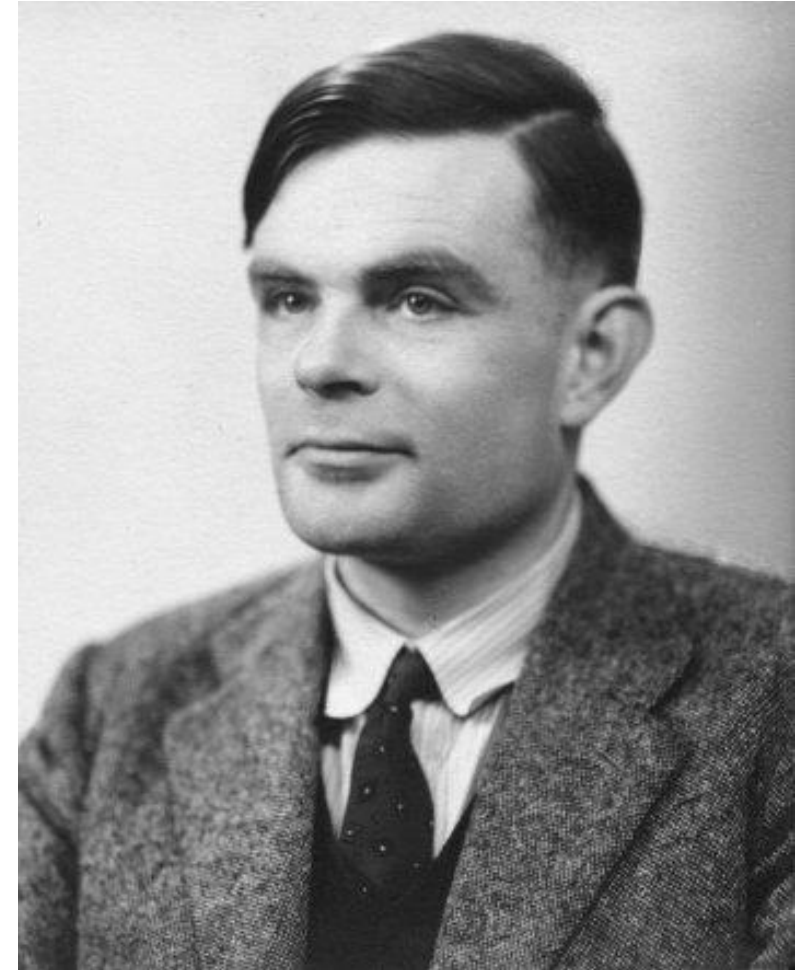
What is AI?

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**

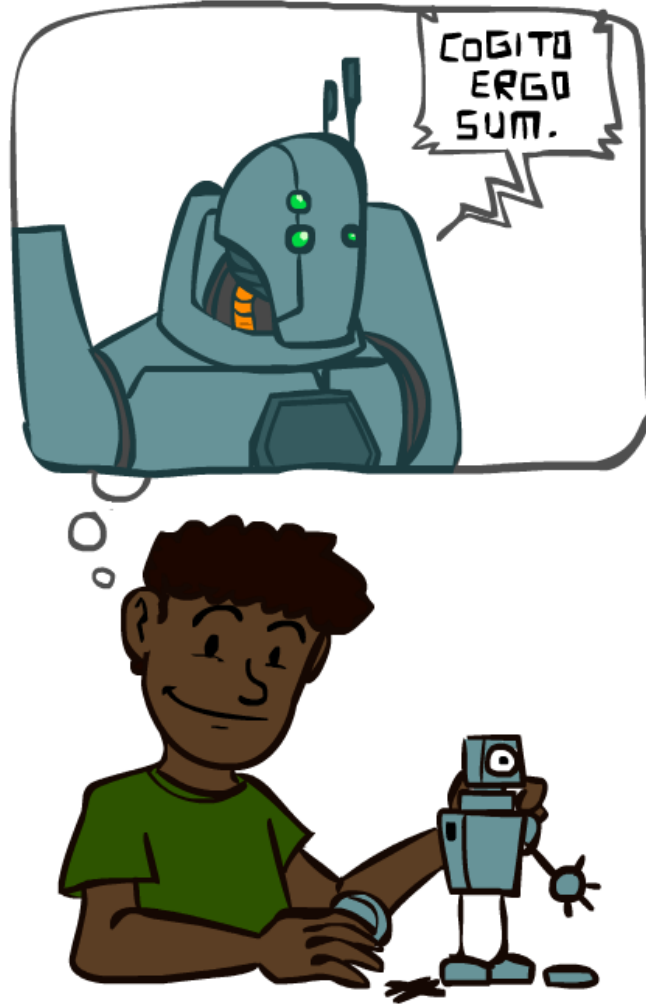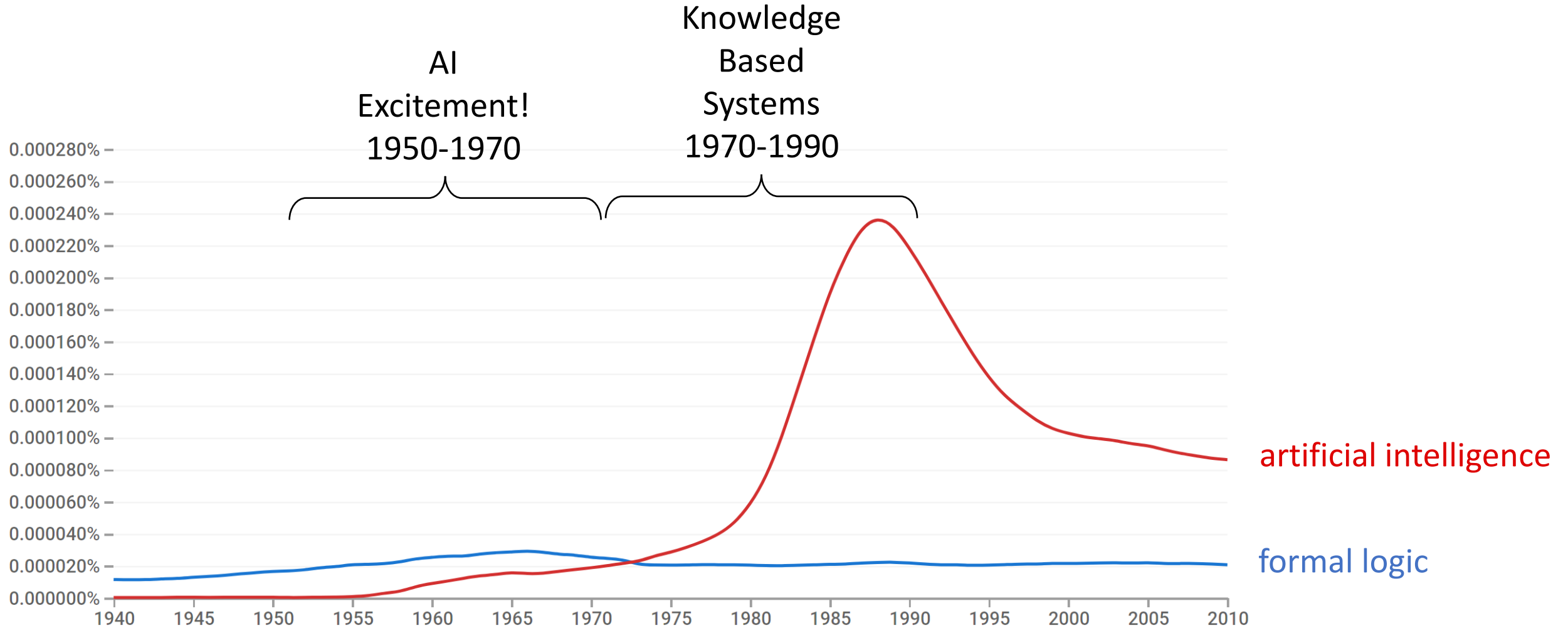# Maximize Your Expected Utility
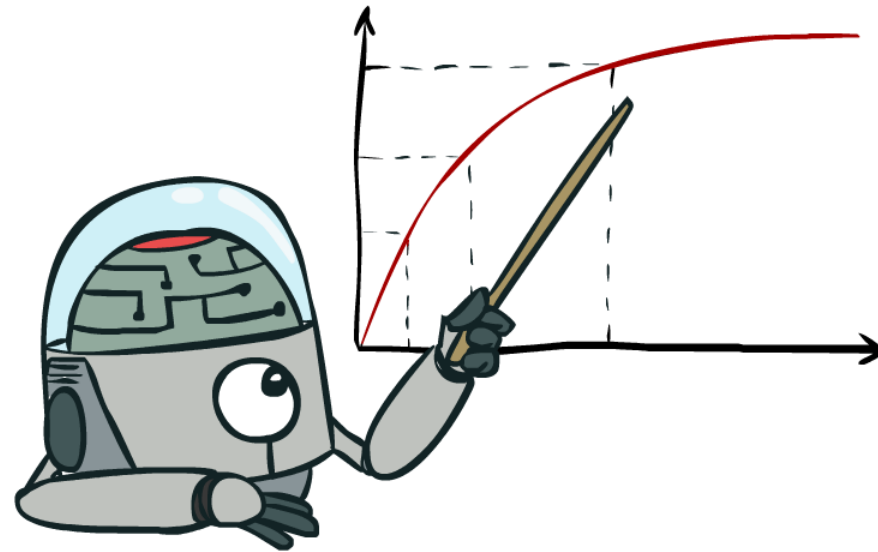
What About the Brain?

- 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

AI
Excitement!
1950-1970

Knowledge
Based
Systems
1970-1990

0.000280% –
0.000260% –
0.000240% –
0.000220% –
0.000200% –
0.000180% –
0.000160% –
0.000140% –
0.000120% –
0.000100% –
0.000080% –
0.000060% –
0.000040% –
0.000020% –
0.000000% –

1940 1945 1950 1955 1960 1965 1970 1975 1980 1985 1990 1995 2000 2005 2010

artificial intelligence

formal logic

https://books.google.com/ngrams

What went wrong?

Dog   Buster
- Barks   ✔
- Has Fur   ✔
- Has four legs   ✘

A Brief History of AI

https://books.google.com/ngrams
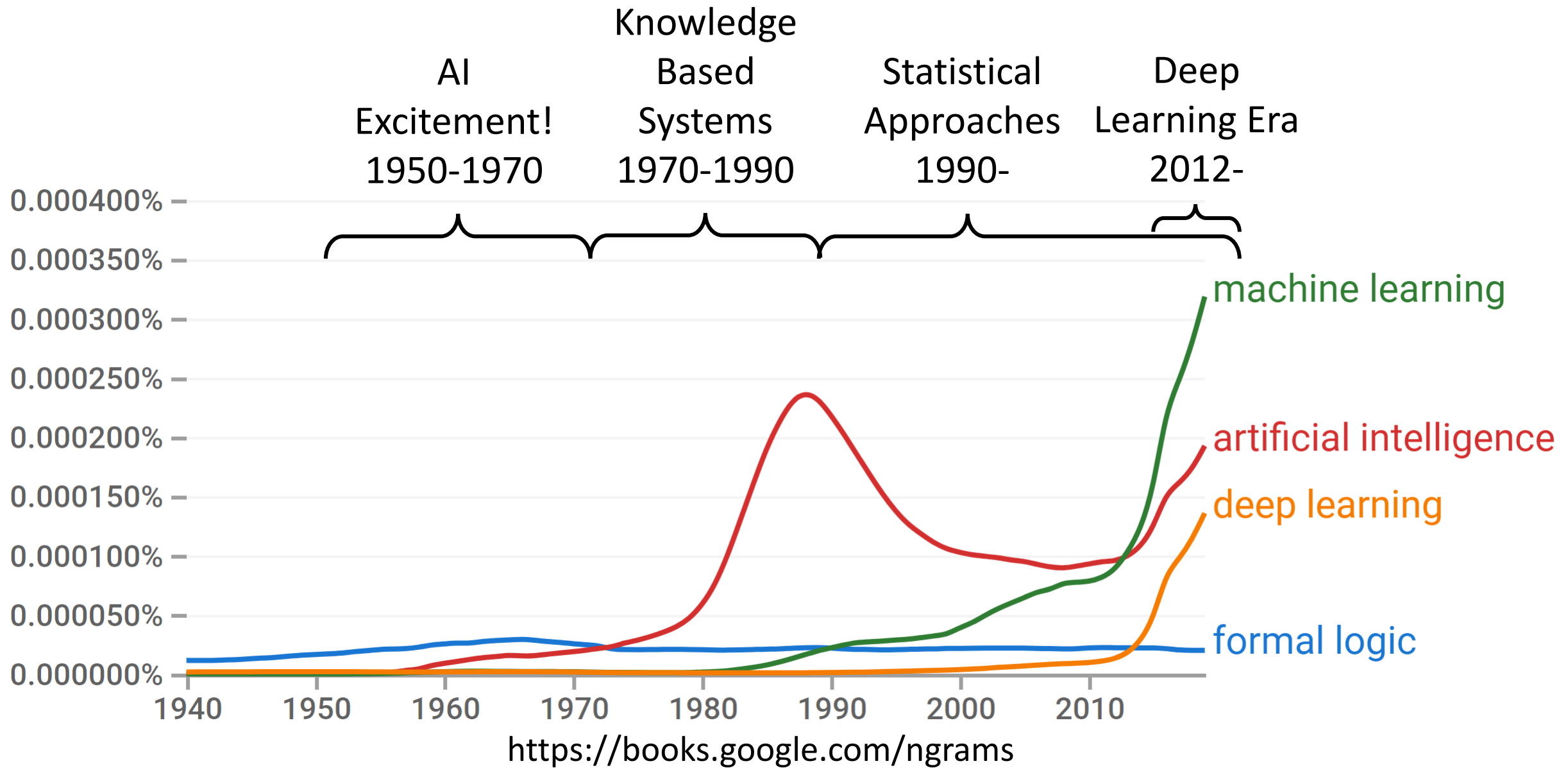
A Brief History of AI

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
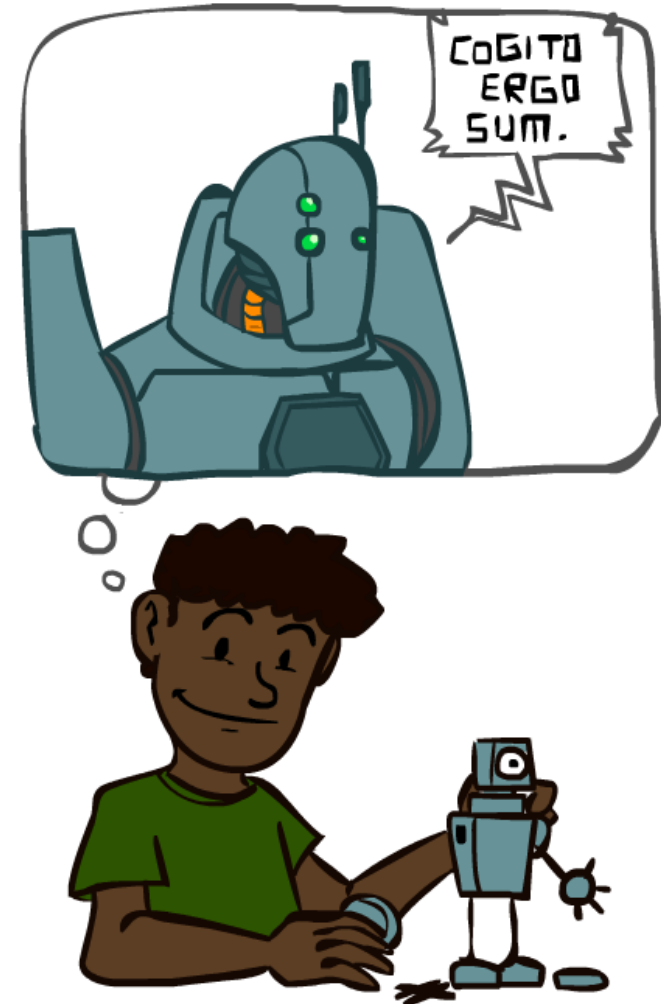- 1988—93: Expert systems industry busts: "AI Winter"

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

Images: ai.berkeley.edu

Artificial Intelligence vs Machine Learning?