

# Artificial Intelligence

CSE 120 Winter 2018

Slide credits: Pieter Abbeel, Dan Klein,  
Stuart Russell, **Pat Virtue** &  
<http://csillustrated.berkeley.edu>

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Teagan Horkan

## Candy Grab Game

- 1) Grab a pack of “game pieces” (at least 10 per pair of students)
- 2) Play the following game
  - a) 10 pieces on the table
  - b) Take turns taking either 1 or 2 pieces
  - c) Player that takes the last piece(s) wins 😊
- 3) How do humans learn to play this game?
- 4) How would a computer learn to play this game?

```
int takeTurn(int numPiecesAvailable)
```

# Administrivia

- ❖ Assignments:
  - Word Guessing due tonight (2/16)
  - Birthday Visualization due Tuesday (2/20)
  - Living Computers Report due Tuesday (2/20)
  - Portfolio Update 2 due Wednesday (2/21)
  
- ❖ Monday is Presidents Day!
  - No lecture, no office hours
  
- ❖ Justin is out of town most of next week
  - Only Tuesday office hours
  - Guest lectures on Wed & Fri

# Innovation Exploration

- ❖ Mini-research project to let you explore a computing topic *that is interesting to you*
  - Pick a recent and relevant topic
  - Think of this as your “project” for the reading & writing portion of this course
  
- ❖ **Part 1: Innovation Post (2/27)**
  - 4+ paragraphs, 550-750 words – posted to Canvas discussion board
  - Well-researched, insightful post, including 3+ citations
  - Purpose, Effects and Impacts, Technical Aspects
  
- ❖ **Part 2: Respond to Posts (3/2)**
  - Comment on 3+ other students’ posts

# Candy Grab Game

```
→ returns 1 or 2
int takeTurn(int numPiecesAvailable) {
    return ?;
}
```

starts as 10

# Candy Grab Game

- ❖ Agent 001 – always choose 1

```
int takeTurn(int numPiecesAvailable) {  
    return 1;  
}
```

```
}
```

# Candy Grab Game

- ❖ Agent 002 – always choose 2

```
int takeTurn(int numPiecesAvailable) {  
    return 2;  
}
```

```
}
```

# Candy Grab Game

- ❖ Agent 007 – whatever you think is best

```
int takeTurn(int numPiecesAvailable) {
```

```
    return ?;
```

groups of 3 are important!

use 9%3

pieces	take	pieces % 3
1	1 →	1
2	2 →	2
3	?	0
4	1 →	1
5	2 →	2
6	?	0
7	1 →	1
8	2 →	2
9	?	0
10	1 →	1

```
}
```

# Candy Grab Game

- ❖ Agent 007 – whatever you think is best

```
int takeTurn(int numPiecesAvailable) {  
    if(numPiecesAvailable%3 == 2) {  
        return 2;  
    } else {  
        return 1;  
    }  
}
```



# Candy Grab Game

- ❖ Agent 007 – whatever you think is best

```
int takeTurn(int numPiecesAvailable) {  
    return ?;  
}
```

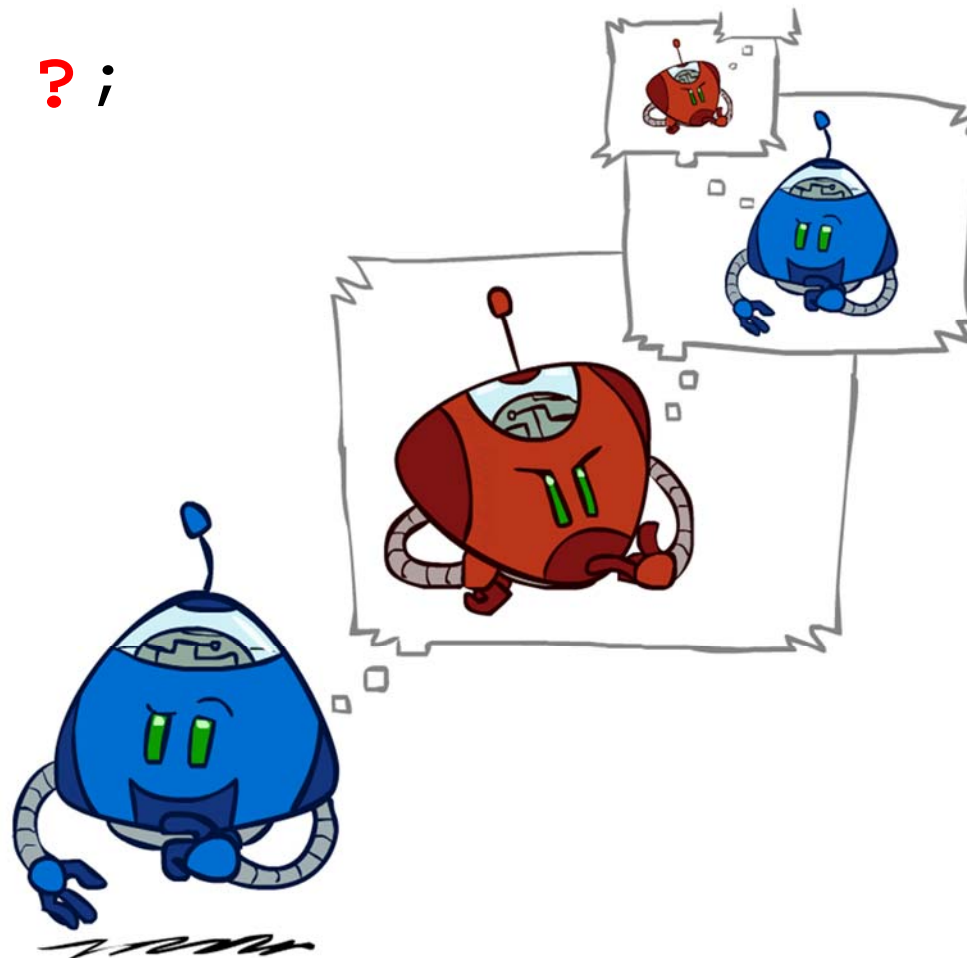
- What if we had:

```
boolean willIWin(int numPiecesAvailable,  
                boolean isMyTurn,  
                int action)
```

# Candy Grab Game

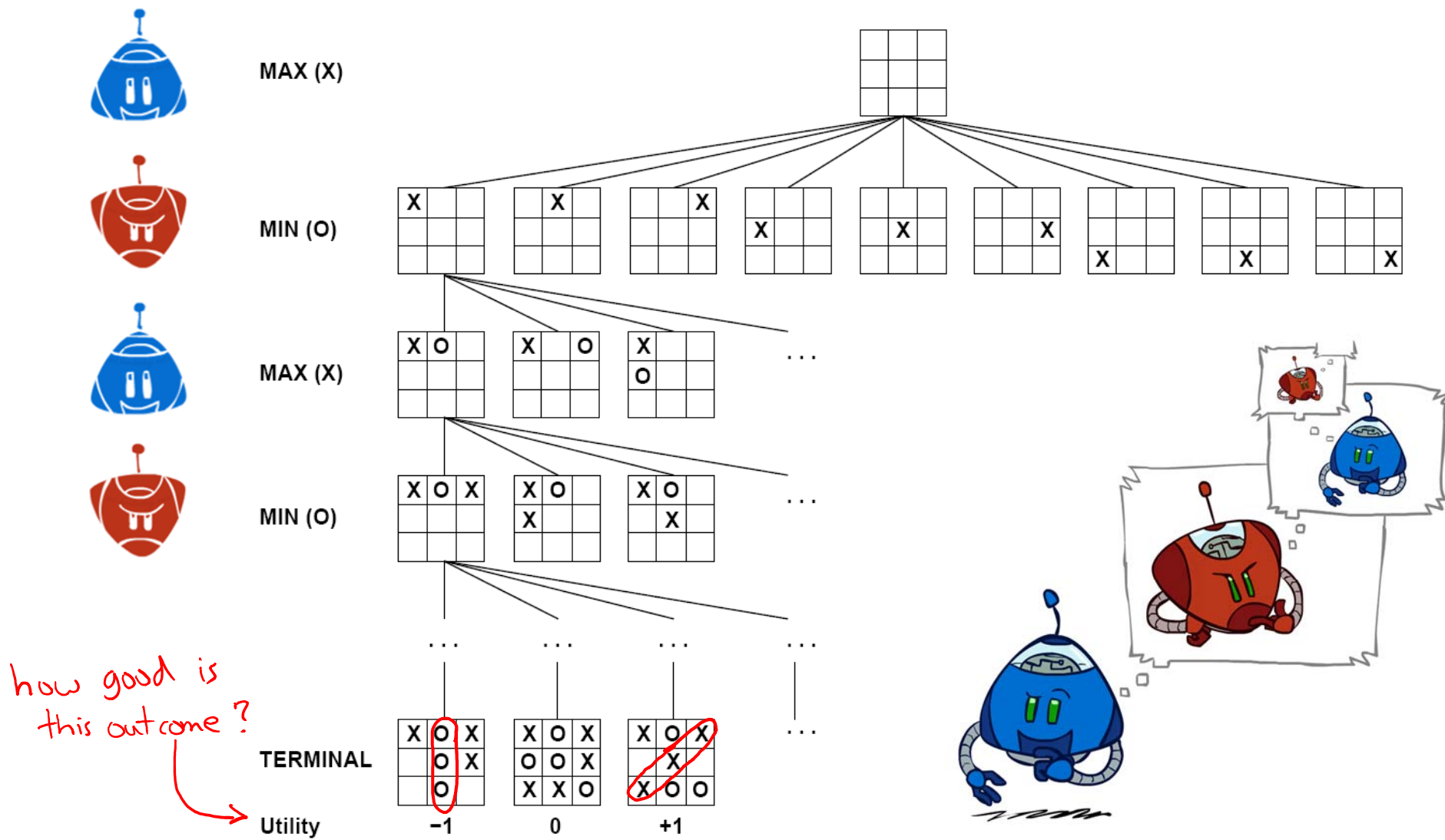
- ❖ Agent 007 – whatever you think is best

```
int takeTurn(int numPiecesAvailable) {  
    return ?;  
}
```



# How: Search & Planning

❖ I take an action... then what? ... then what?



# Candy Grab Game (Min-Max)

❖ Agent 007 – whatever you think is best

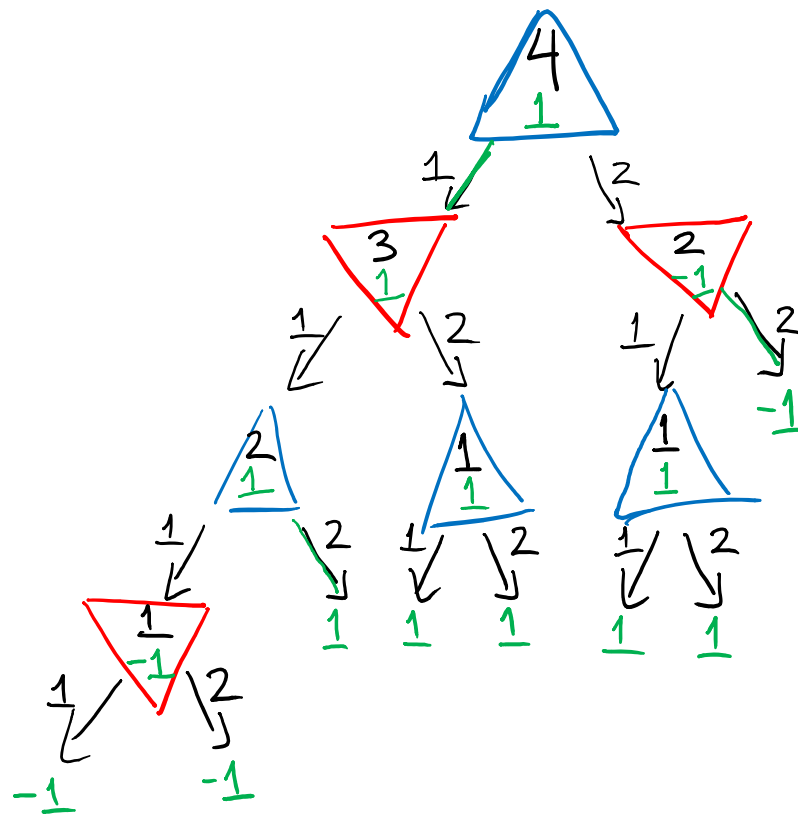
```
int takeTurn(int numPiecesAvailable)
```

△ make choice with max utility

▽ make choice with min utility

# utility of this node

(winning option is to take 1 piece.)



# Candy Grab Game (Statistical)

- ❖ Agent 007 – whatever you think is best

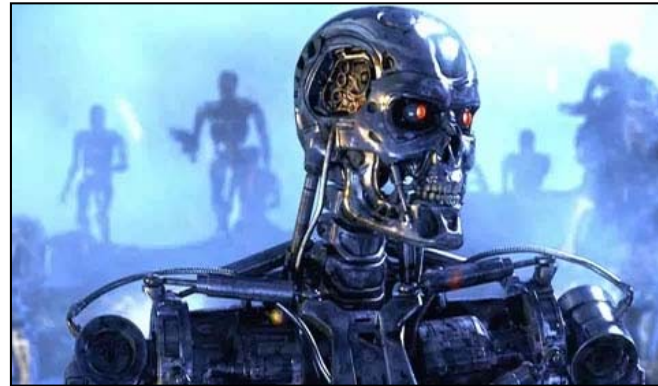
```
int takeTurn(int numPiecesAvailable)
```

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

# Outline

- ❖ **What is AI?**
- ❖ AI History
  - AI winter and the resurgence
- ❖ AI Today
  - Applications and how they work
- ❖ AI Tomorrow
  - Ethics and the singularity

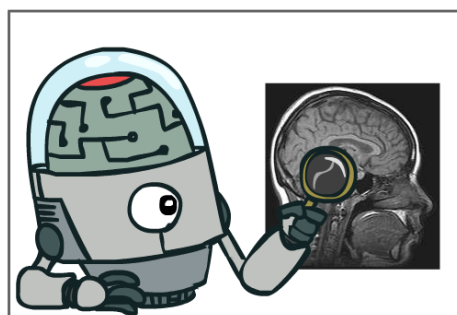
# Sci-Fi AI?



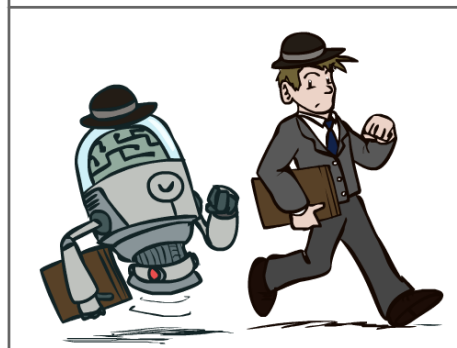
# So What is AI?

- ❖ The science of making machines that:

Think like people



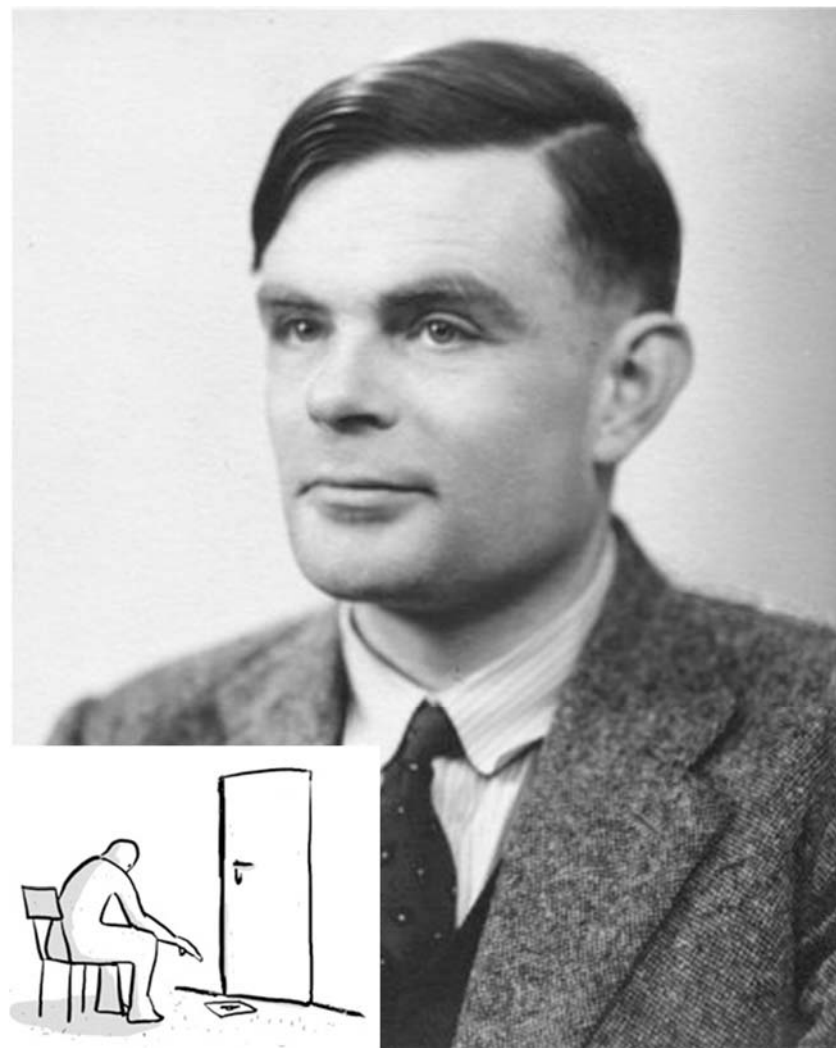
Act like people





# Turing Test for Intelligence

- ❖ 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.”

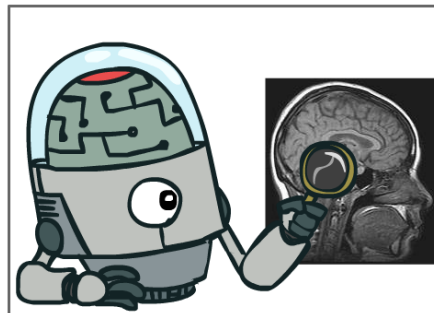


[http://en.wikipedia.org/wiki/Turing\\_test](http://en.wikipedia.org/wiki/Turing_test)

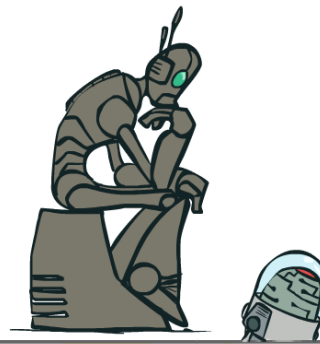
# So What is AI?

- ❖ The science of making machines that:

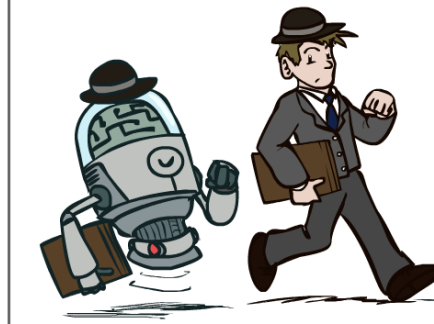
Think like people



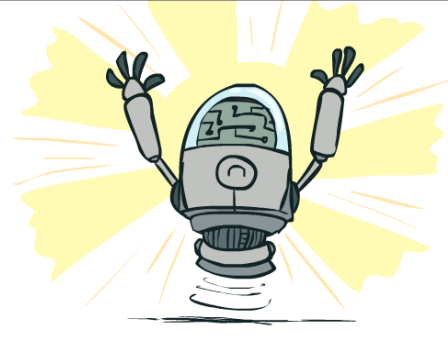
Think rationally



Act like people

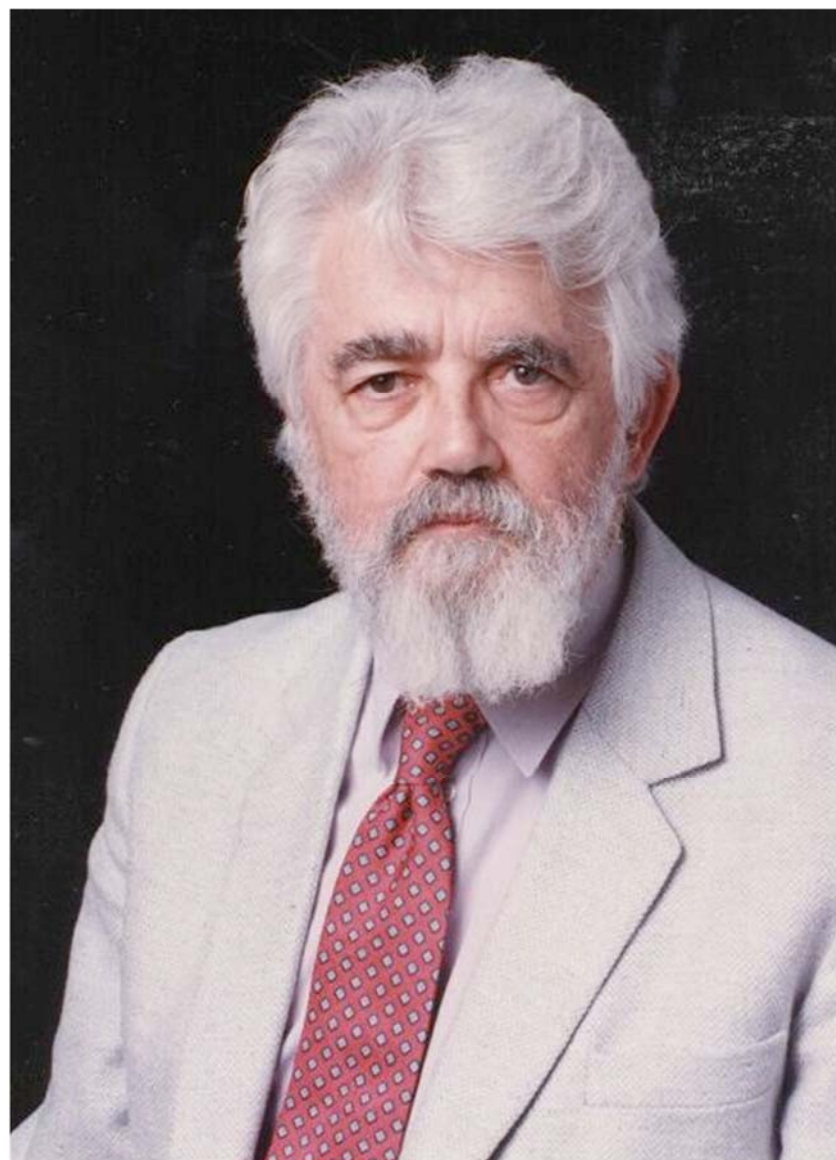


Act rationally



# AI Definition by John McCarthy

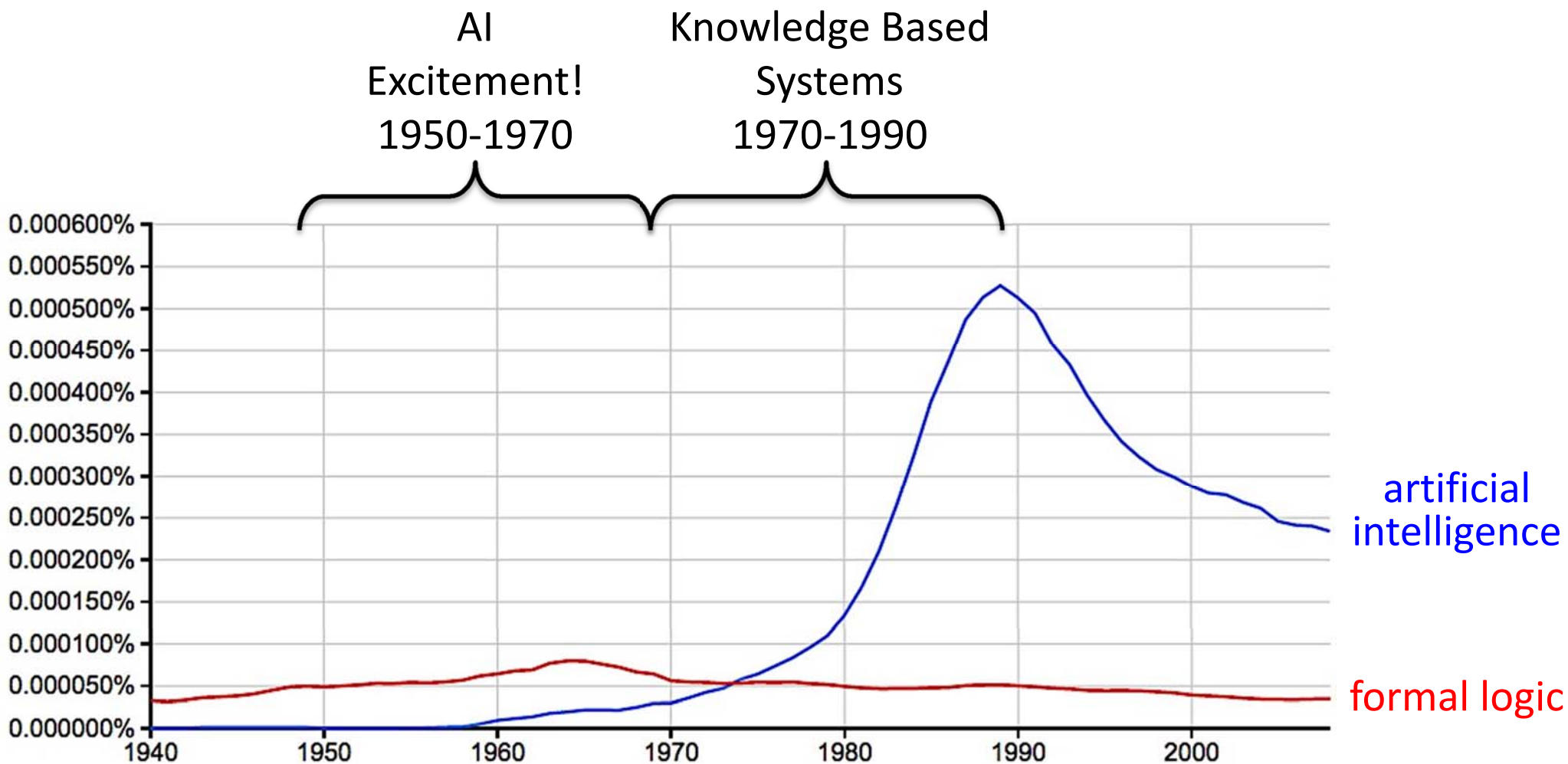
- ❖ “Getting a computer to do things which, when done by people, are said to involve intelligence”
  - Finesses the idea of whether a computer has consciousness, whether they have rights, etc.



# Outline

- ❖ What is AI?
- ❖ **AI History**
  - **AI winter and the resurgence**
- ❖ AI Today
  - Applications and how they work
- ❖ AI Tomorrow
  - Ethics and the singularity

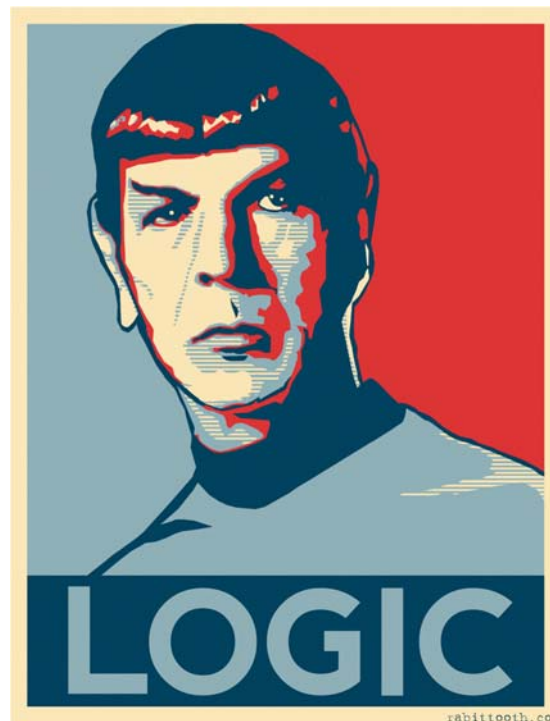
# A Brief History of AI



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

# Logic

- ❖ A formal representation of our knowledge of the world
- ❖ Use **knowledge base** and **perception** to infer new knowledge



[http://www.rabbittooth.com/gallery/spock\\_in\\_2012\\_by\\_rabbittooth.jpg](http://www.rabbittooth.com/gallery/spock_in_2012_by_rabbittooth.jpg)

# isDog(animal)

❖ *barks & fur & fourLegs*  $\Leftrightarrow$  *dog*

```
boolean isDog(Animal A) {
    if(!barks(A)) {
        return false;
    }
    if(!hasFur(A)) {
        return false;
    }
    if(!hasFourLegs(A)) {
        return false;
    }
    return true;
}
```

What's the problem?

Dog

- Barks
- Has Fur
- Has four legs

# isDog(animal)

❖ *barks & fur & fourLegs*  $\Leftrightarrow$  *dog*



What's the problem?

Dog

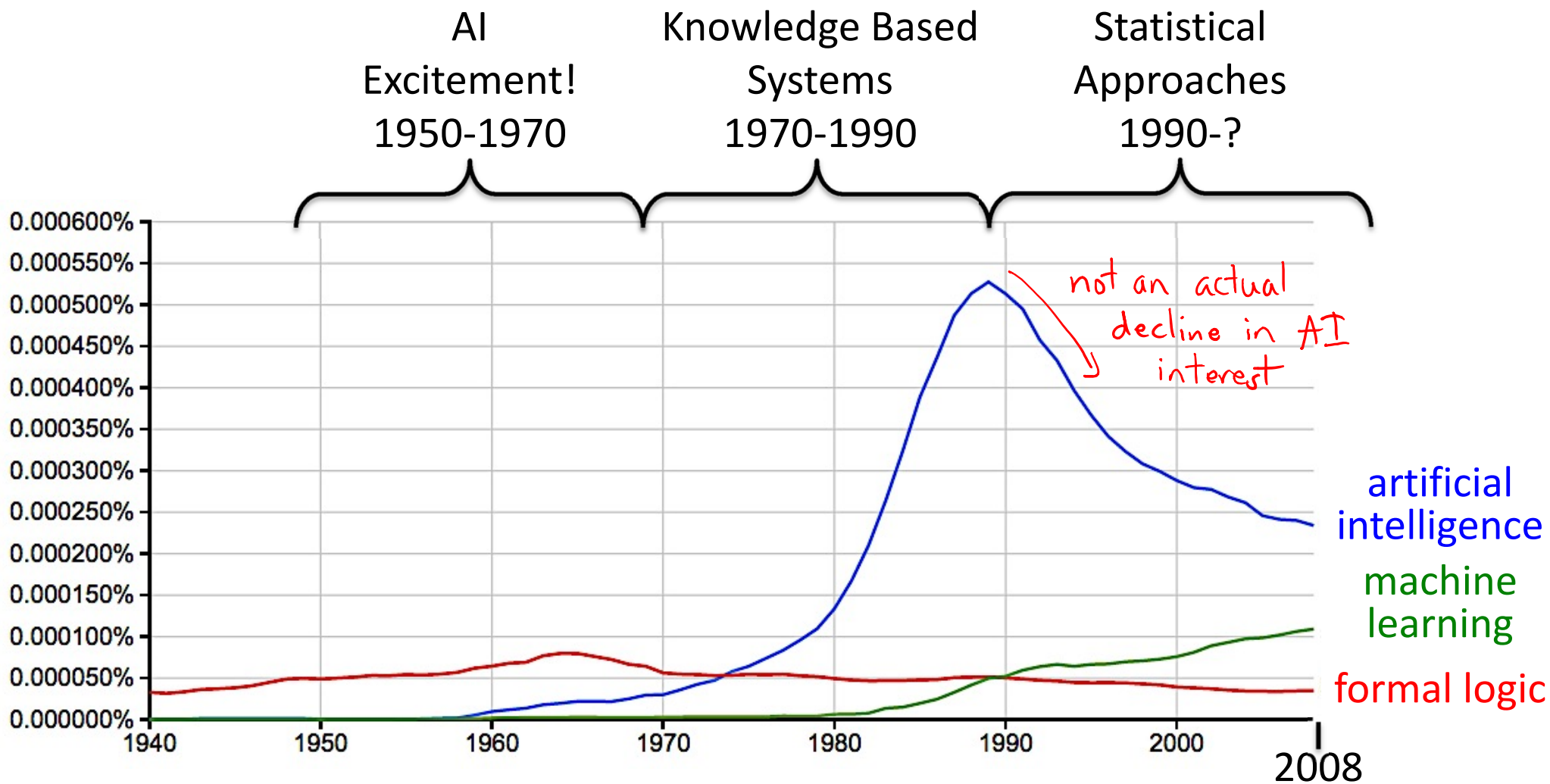
- Barks
- Has Fur
- Has four legs

Sheila





# A Brief History of AI



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

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# “Intelligent” Applications

- ❖ Discuss in pairs/groups:
  - List at least four existing applications that seem intelligent
  
- ❖ Audience responses:
  - Siri
  - CleverBot – chat bots
  - Watson – cancer research/diagnosis
  - 20 questions character guessing bot
  - Web Genie
  - Google Maps
  - Facial recognition

# Applications: Natural Language

- ❖ Speech technologies (*e.g.* Siri)
  - Automatic speech recognition (ASR)
  - Text-to-speech synthesis (TTS)
  - Dialog systems
- ❖ Language processing technologies
  - Google translation
  - Web search
  - Spam filter



# How: Probability

**Notation:**

$$P(\text{limb} | \text{artificial}, \text{audio})$$

“Probability of ‘limb’ given ‘artificial’ and audio”

- ❖ Example: speech recognition of “artificial ...”
  - Find most probable next word given “artificial” and the audio for the second word

Which second word gives the highest probability?

Break down problem

n-gram probability \* audio probability

$$P(\text{limb} | \text{artificial}, \text{audio})$$

$$P(\text{limb} | \text{artificial}) * P(\text{limb} | \text{audio})$$

$$P(\text{intelligence} | \text{artificial}, \text{audio})$$

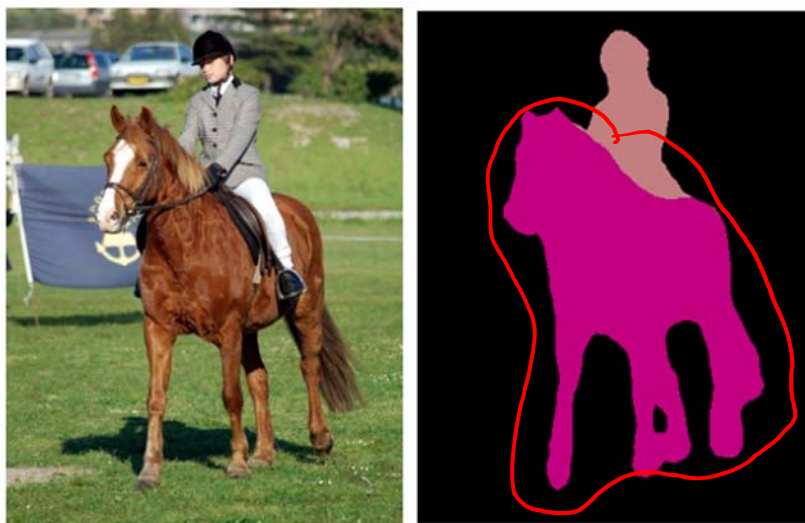
$$P(\text{intelligence} | \text{artificial}) * P(\text{intelligence} | \text{audio})$$

$$P(\text{flavoring} | \text{artificial}, \text{audio})$$

$$P(\text{flavoring} | \text{artificial}) * P(\text{flavoring} | \text{audio})$$

# Applications: Vision (Perception)

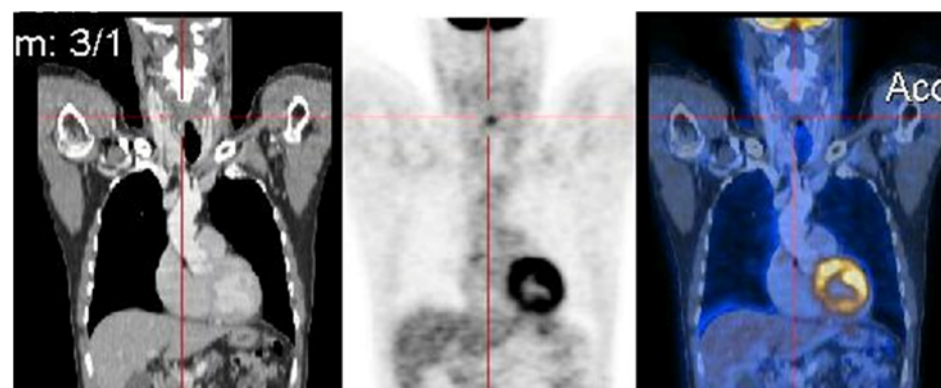
- ❖ Tasks related to understanding images/camera input



Segmentation



Pedestrian Detection



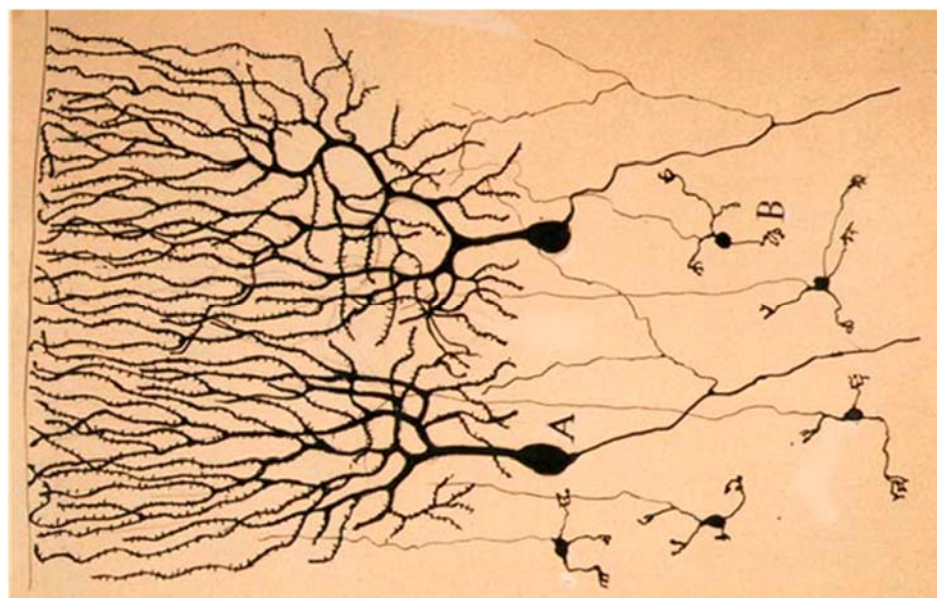
Alignment/Registration

Long, Shelhamer, Darrell. arXiv preprint arXiv:1411.4038 (2014).

[https://en.wikipedia.org/wiki/Medical\\_image\\_computing#/media/File:CT-PET.jpg](https://en.wikipedia.org/wiki/Medical_image_computing#/media/File:CT-PET.jpg)

# How: Neural Networks

Input  
Signal



Output  
Signal



DOG



CAT



TREE



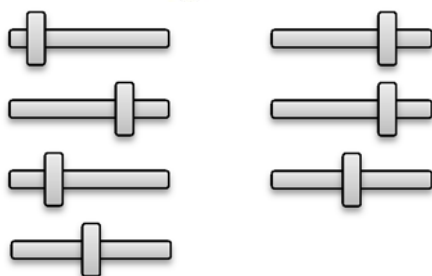
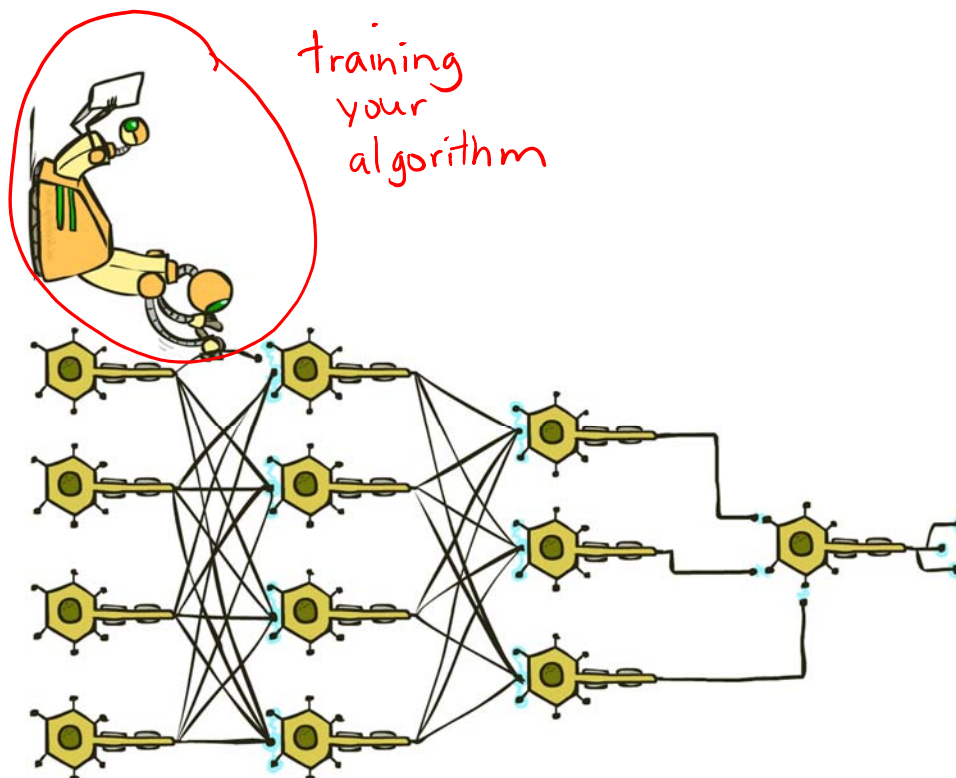
CAR



SKY

# How: Neural Networks

Input  
Signal



Output  
Signal



DOG



CAT



TREE



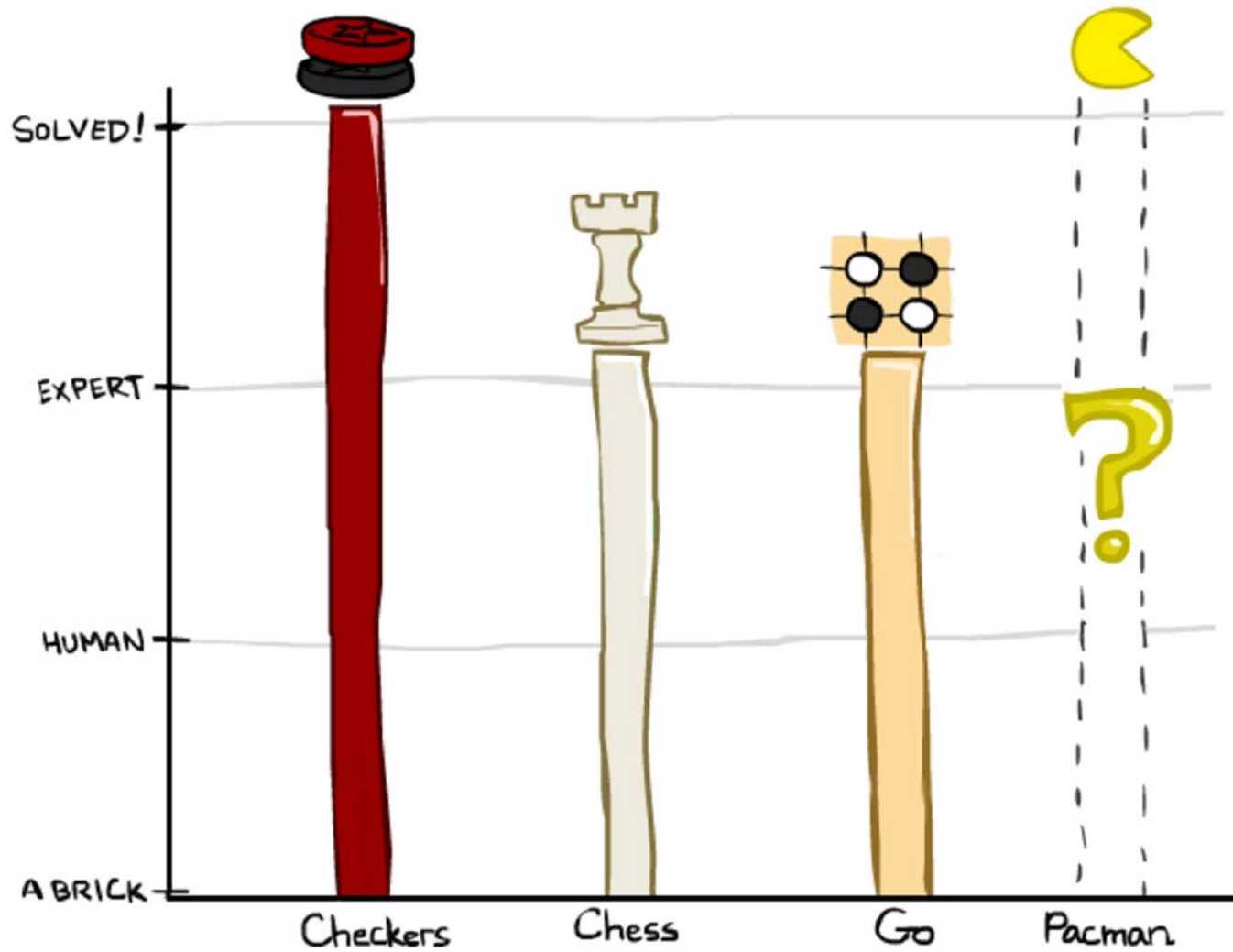
CAR



SKY

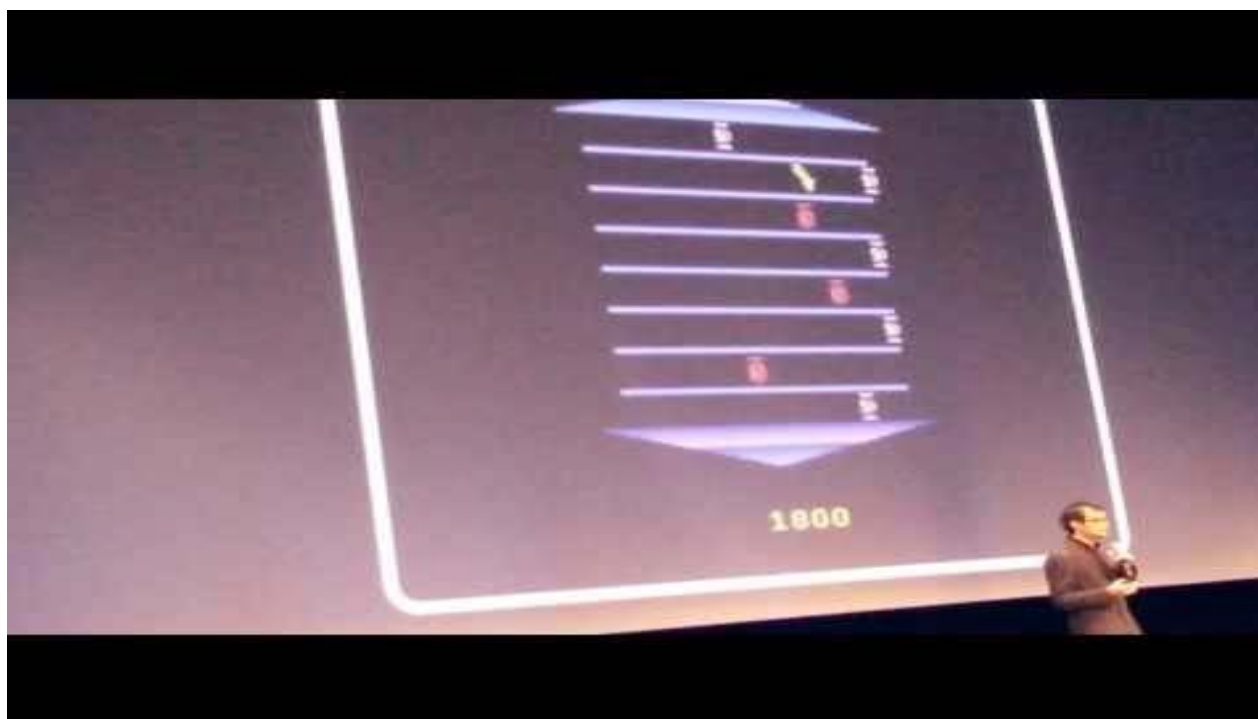


# Applications: Games



# AI Games in the News

- ❖ “DeepMind artificial intelligence @ FDOT14”
  - First Day of Tomorrow technology conference (April 2014)
  - <https://www.youtube.com/watch?v=EfGD2qveGdQ>



- ❖ Additional training footage:
  - <https://www.youtube.com/watch?v=cjpElotvwFY>

# How: Search & Planning

❖ I take an action... then what? ... then what?



MAX (X)



MIN (O)



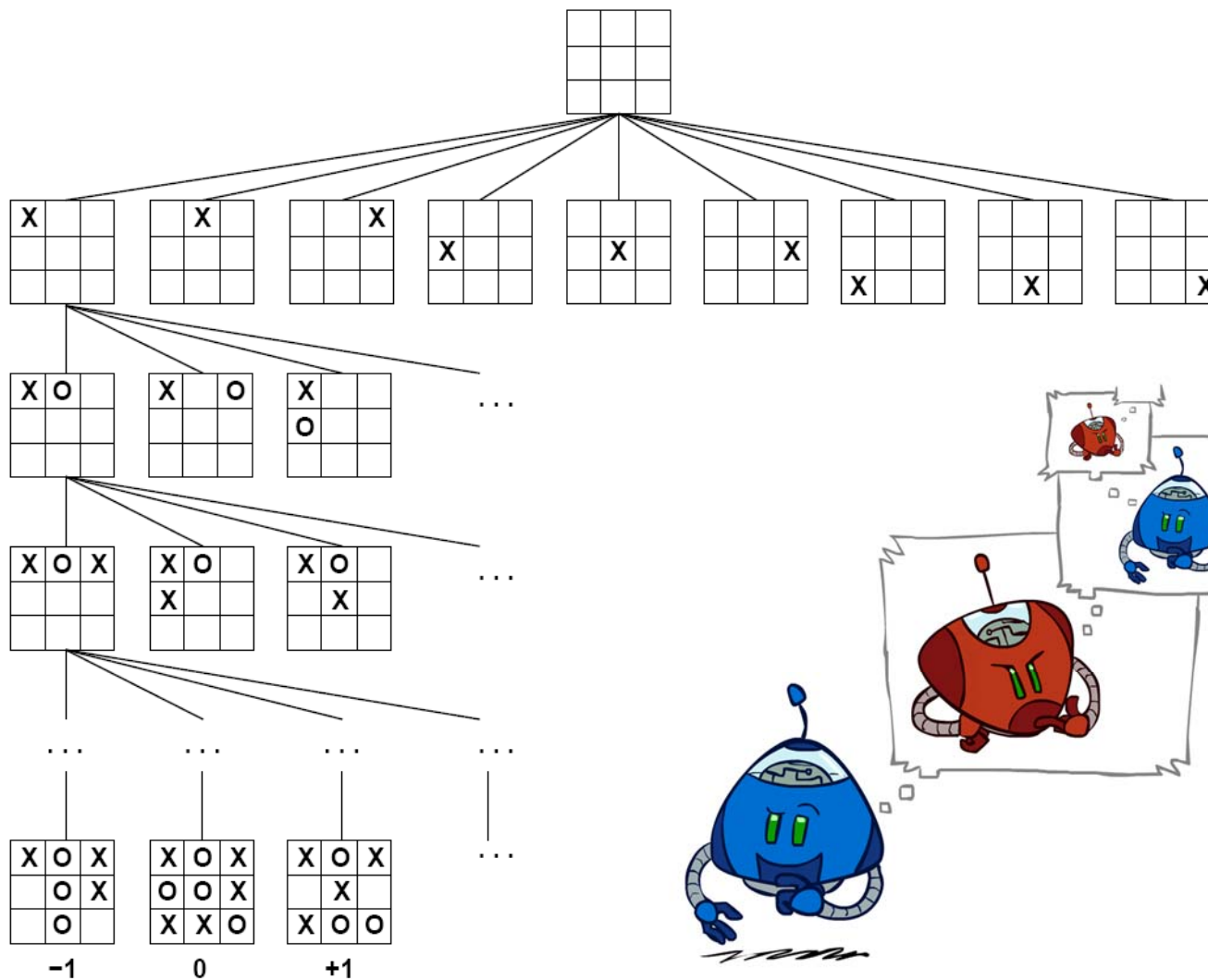
MAX (X)



MIN (O)

TERMINAL

Utility



# Applications: Robotics

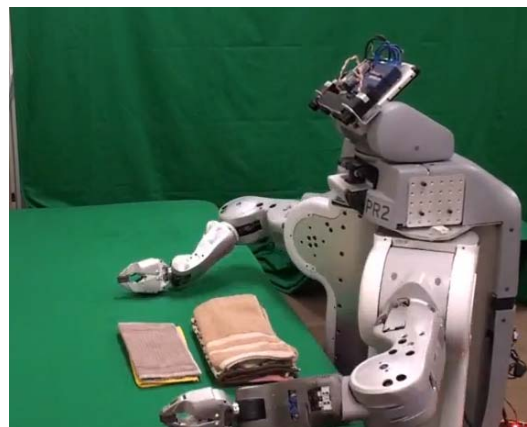
- ❖ For many, the coolest and scariest part of AI
- ❖ Combines fields of AI/CS
  - Speech recognition
  - Synthetic voice
  - Machine vision
  - Planning
  - HCI



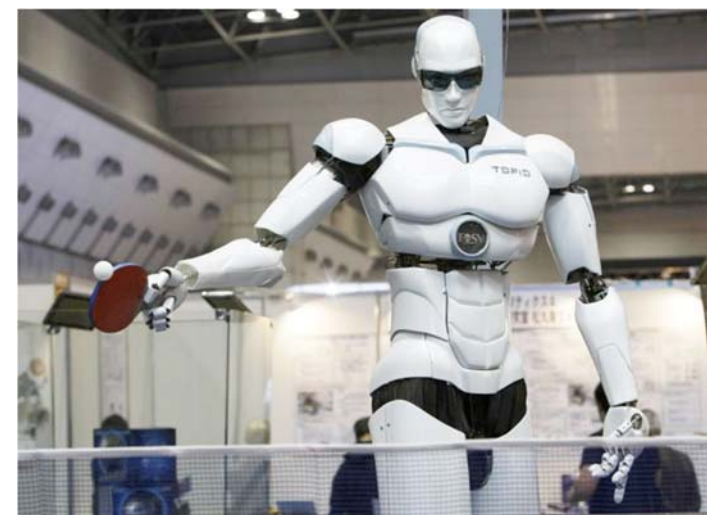
Surgical robots



Autonomous helicopter



Towel-folding!



TOPIO, the ping-pong playing robot

# Applications: Robotics

- ❖ Video: Robot opening doors – Boston Dynamics
  - <https://www.youtube.com/watch?v=fUyU3IKzoio>



- ❖ Video: Robot Preschool – UC Berkeley
  - <http://www.bloomberg.com/features/2015-preschool-for-robots/>

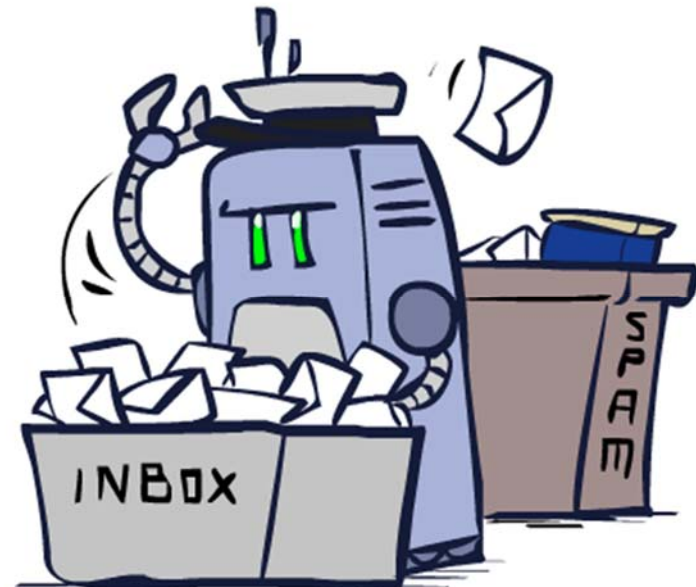
# Applications: Driving



Image: <https://www.google.com/selfdrivingcar/how/>

# Applications: Much, Much More

- Scheduling, *e.g.* airline routing, military
- Route planning, *e.g.* Google maps
- Medical diagnosis
- Web search engines
- Spam classifiers
- Automated help desks
- Fraud detection
- Product recommendations
- ... Lots more!



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# What's In a Training Set?

❖ Just like humans, machines can only learn what they are taught (or can read about on their own)

■ Biased training set = biased behavior

★ <https://techcrunch.com/2016/12/10/5-unexpected-sources-of-bias-in-artificial-intelligence/>

❖ Examples:

■ In March 2016, Microsoft released AI Twitter bot Tay

• <http://www.complex.com/life/2016/03/microsoft-racist-ai>

■ Software used to predict future criminals is biased against African Americans

• <https://www.propublica.org/article/machine-bias-risk-assessments-in-criminal-sentencing>

# AI: What Should We Worry About?

## ❖ AI Ethics: Immediate concerns

### Jobs



### Liability



### Weapons



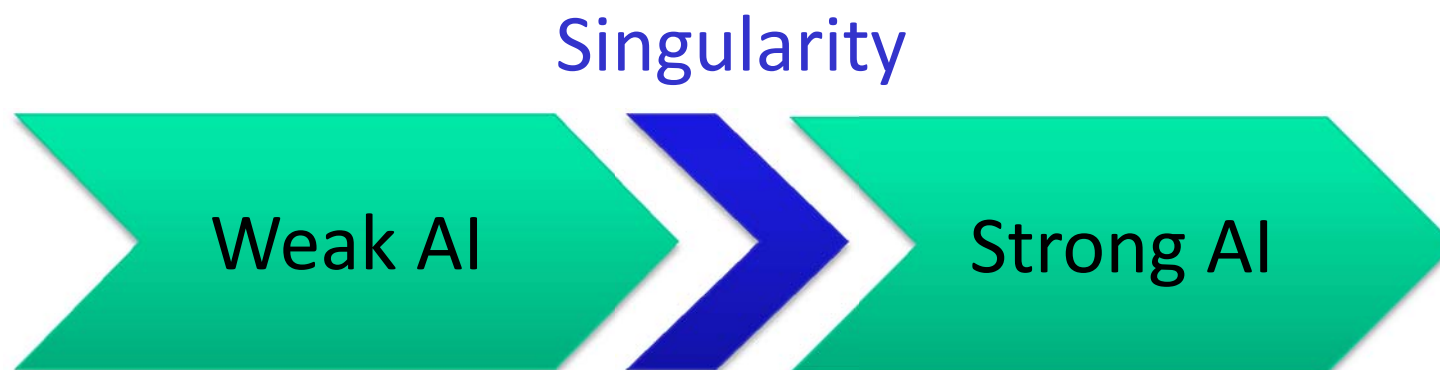
Images:

<http://ot.to/>

<https://electrek.co/2016/09/25/tesla-model-s-crashes-into-gym-driver-claims-autonomous-acceleration-tesla>

<http://futureoflife.org/2016/09/20/podcast-what-is-nuclear-risk/>

# AI: Superintelligence



- Narrow AI
  - Limited number of applications
- Artificial General Intelligence
  - Recursive self-improvement
  - Beyond human control