

PURDUE CS47100

INTRODUCTION TO AI

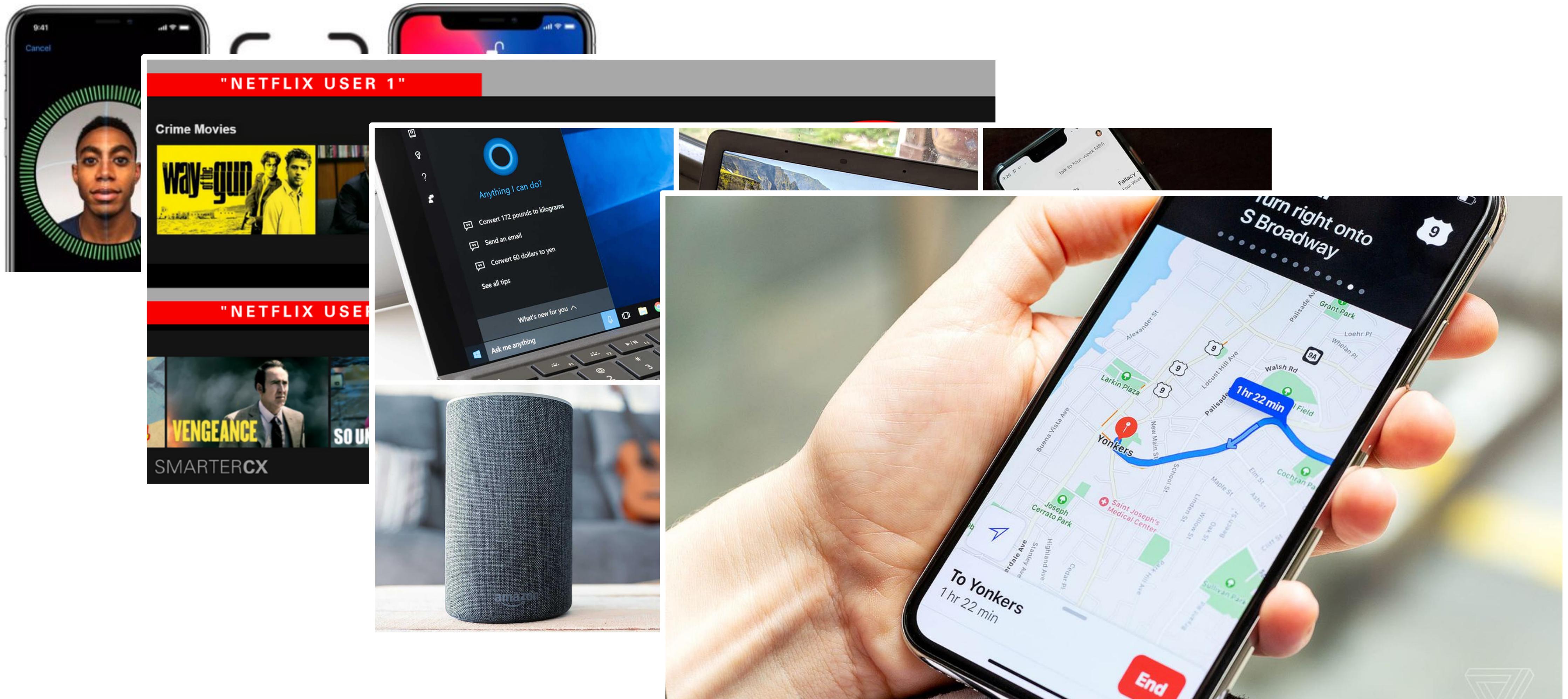
TODAY'S AGENDA

- ▶ What is AI?
- ▶ A brief history of AI
- ▶ Course overview

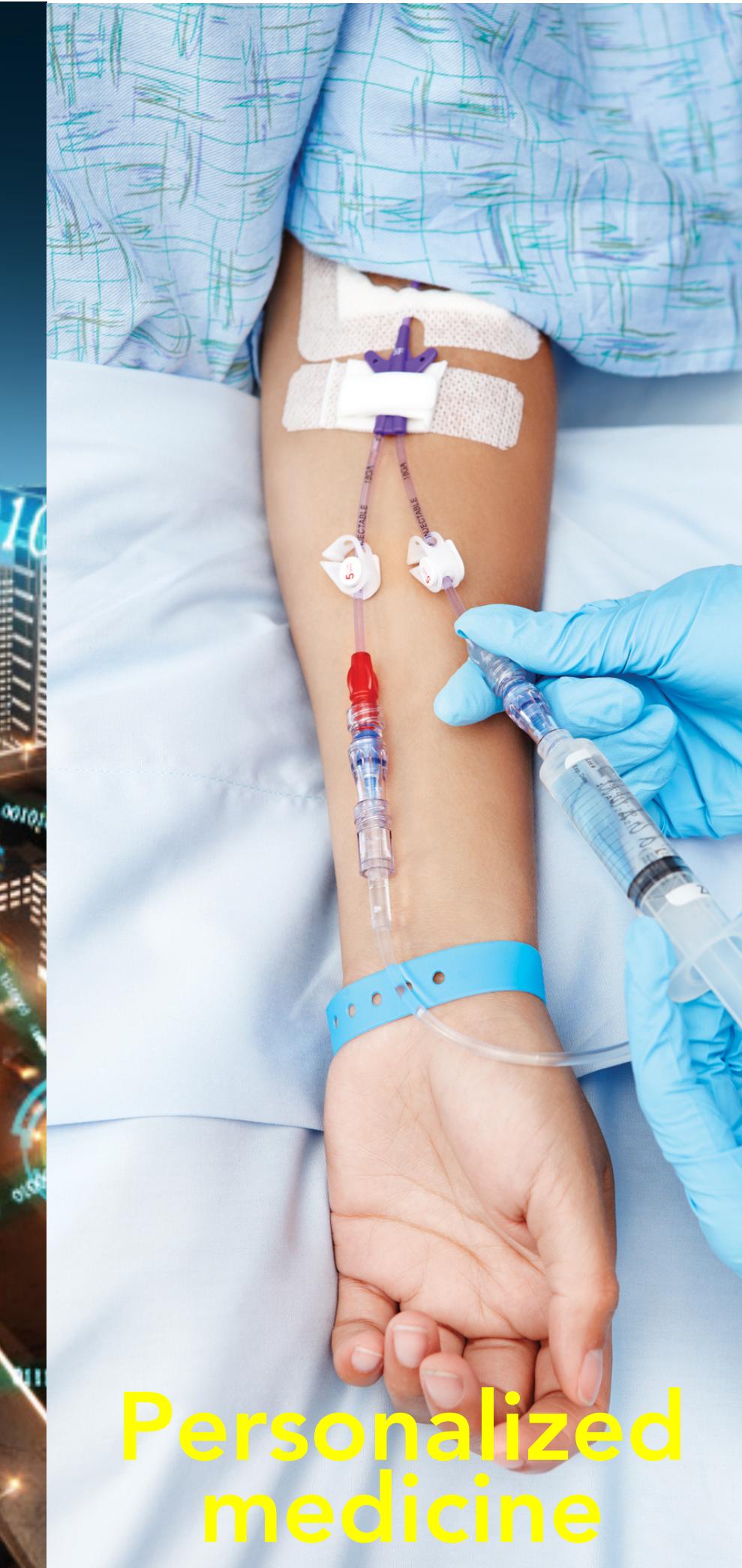
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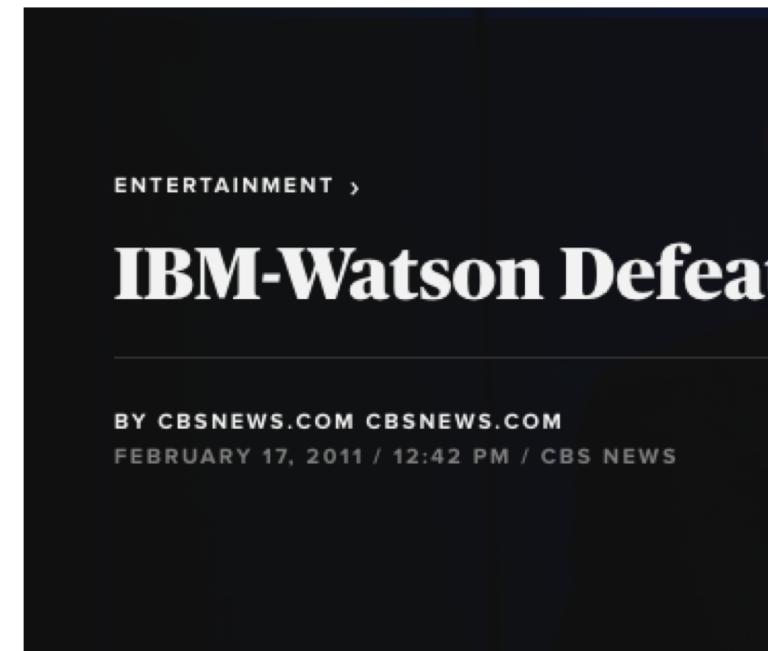
WHAT WE TALK ABOUT WHEN WE TALK ABOUT AI?



WHAT WE TALK ABOUT WHEN WE TALK ABOUT AI?



AI IN NEWS



TECH

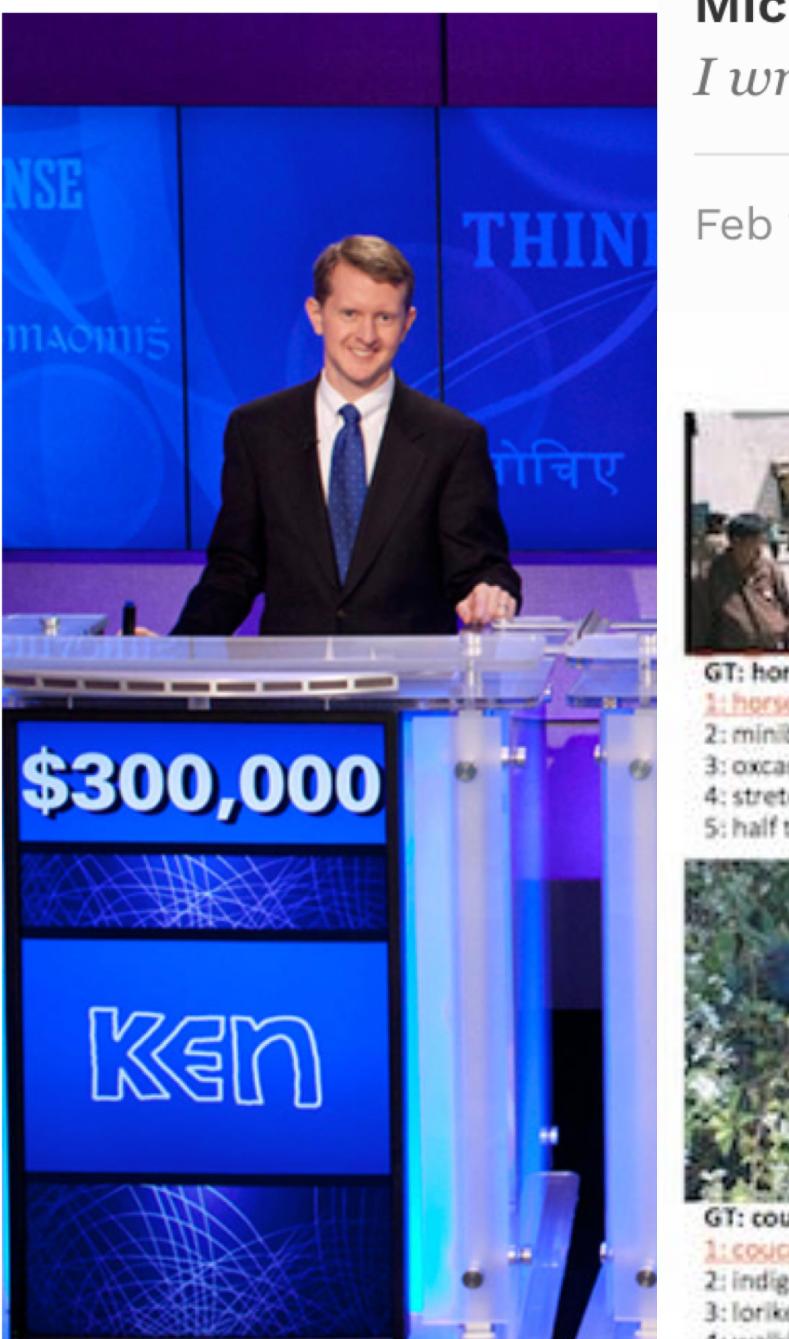
Microsoft's AlphaGo beats Project Oxford In Image Recognition Competition

12 March 2016



Michael Thomsen Former Co-Founder of Project Oxford
I write about tech, video games

Feb 19, 2015, 01:06pm EST



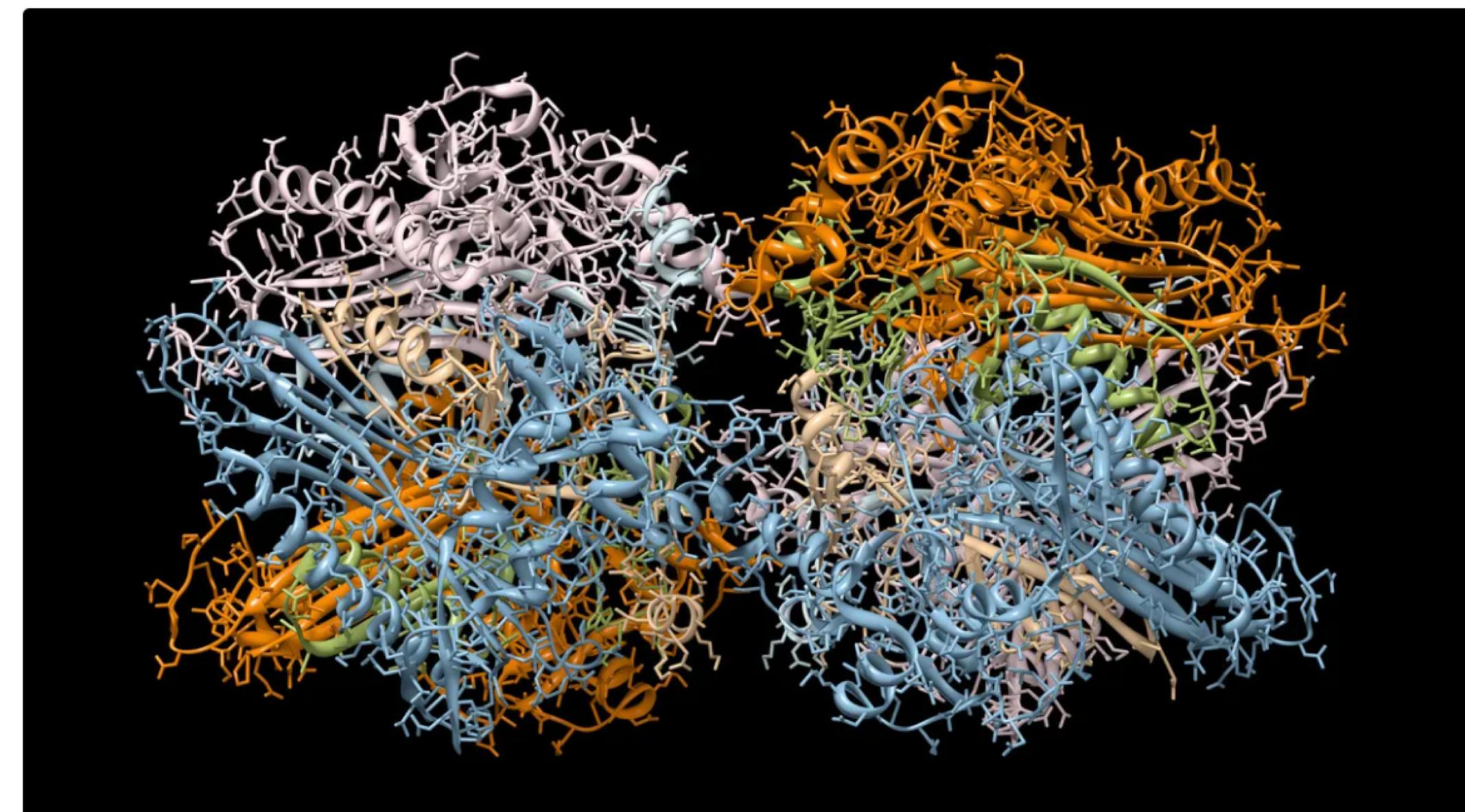
Ken Jennings, left, and Brad Rutter, right, pose with

Google's DeepMind AI Predicts 3D Structure of Nearly Every Protein Known to Science

At last, the decades-old protein folding problem may finally be put to rest.

Monisha Ravisetti
July 29, 2022 11:18 a.m. PT

7 min read



This ribbon diagram shows the 3D protein structure of an antibody. Complex? It's pretty simple for an AI.

AI IN NEWS

TECH TRANSFORMERS

Stephen Hawking says A.I. could be ‘worst event in the history of our civilization’

PUBLISHED MON, NOV 6 2017 2:10 PM EST | UPDATED MON, NOV 6 2017 3:39 PM EST

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 Arjun Kharpal
@ARJUNKHARPAL

CAREERS

U.S. Lost Over 60 Million Jobs — Now Robots, Tech And Artificial Intelligence Will Take Millions More

Jack Kelly Senior Contributor 

I write actionable interview, career and salary advice.

Follow

NEWS

World's first robot citizen 'Sophia' wants a family, baby

Posted: Nov 28, 2017 / 11:41 AM CST

Updated: Nov 28, 2017 / 10:56 AM CST



Tech

Elon Musk claims AI will overtake humans 'in less than five years'

Existential threat posed by artificial intelligence is much closer than previously predicted, billionaire warns

Anthony Cuthbertson • Monday 27 July 2020 16:49 • [1 Comments](#)

Oct 27, 2020, 11:09am EDT

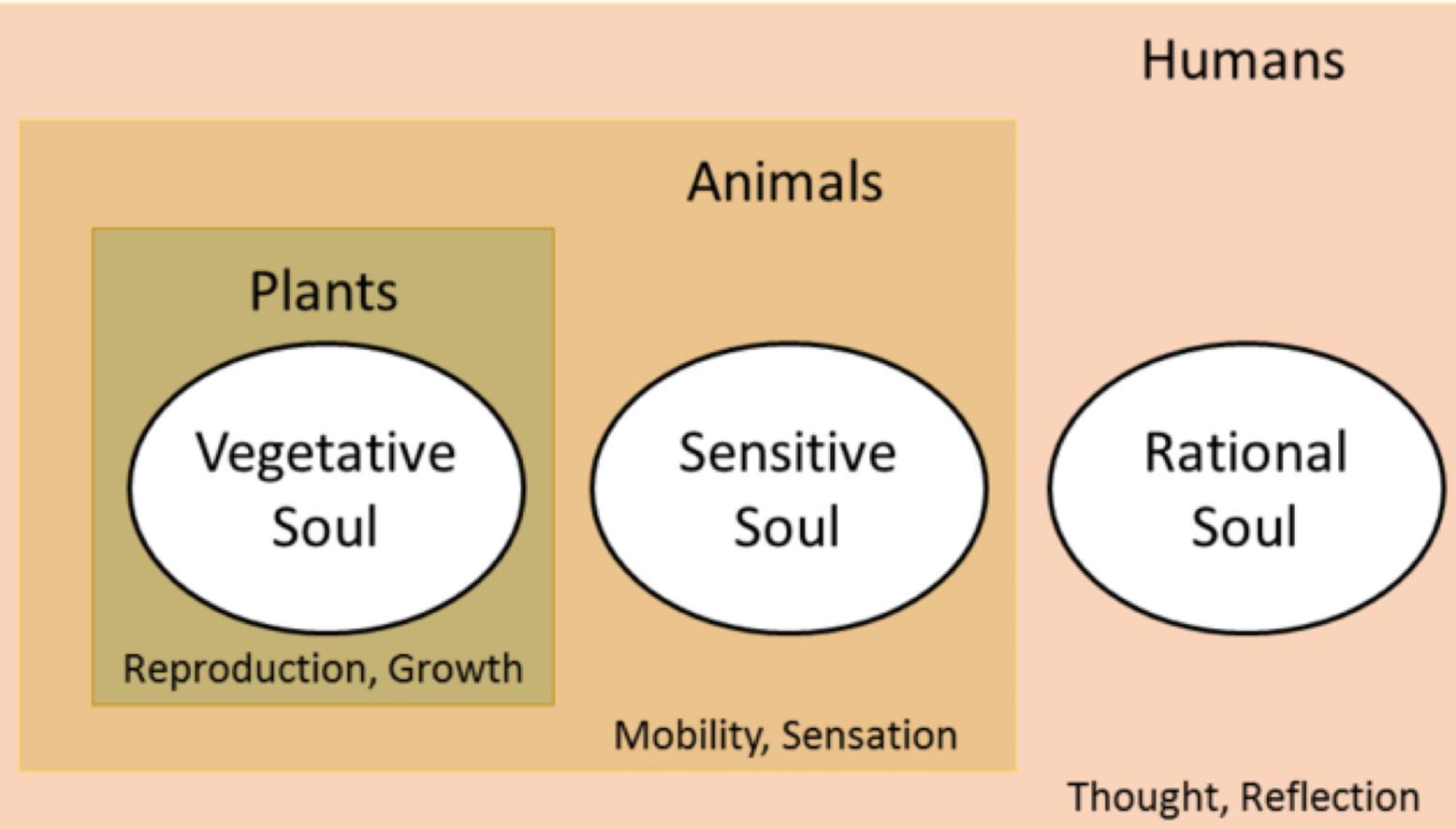


WHAT IS ARTIFICIAL INTELLIGENCE?

The science of making machines intelligent by making machines...



Aristotle
On the Soul
and Other Psychological Works
A new translation by Fred D. Miller, Jr.
OXFORD WORLD'S CLASSICS



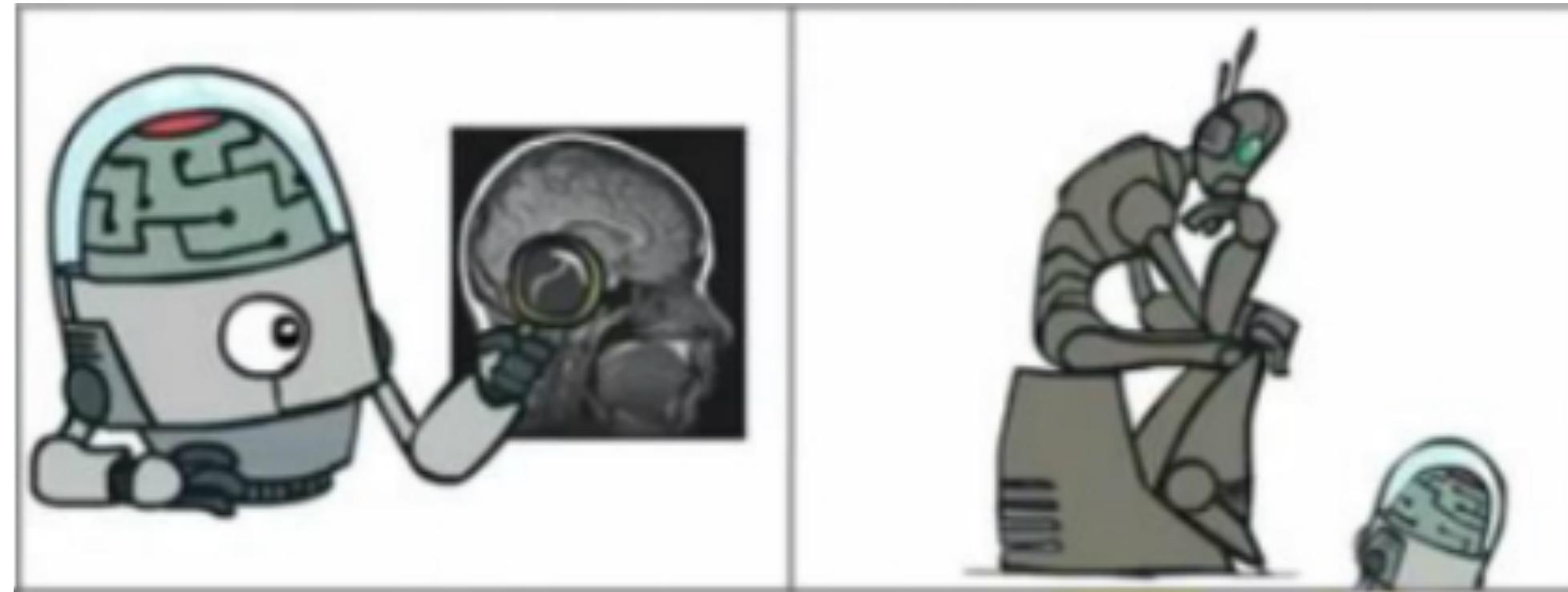
Think rationally

“The study of the computations
that make it possible to perceive,
reason, and act” (Winston 1992)

WHAT IS ARTIFICIAL INTELLIGENCE?

The science of making machines intelligent by making machines...

Think humanly



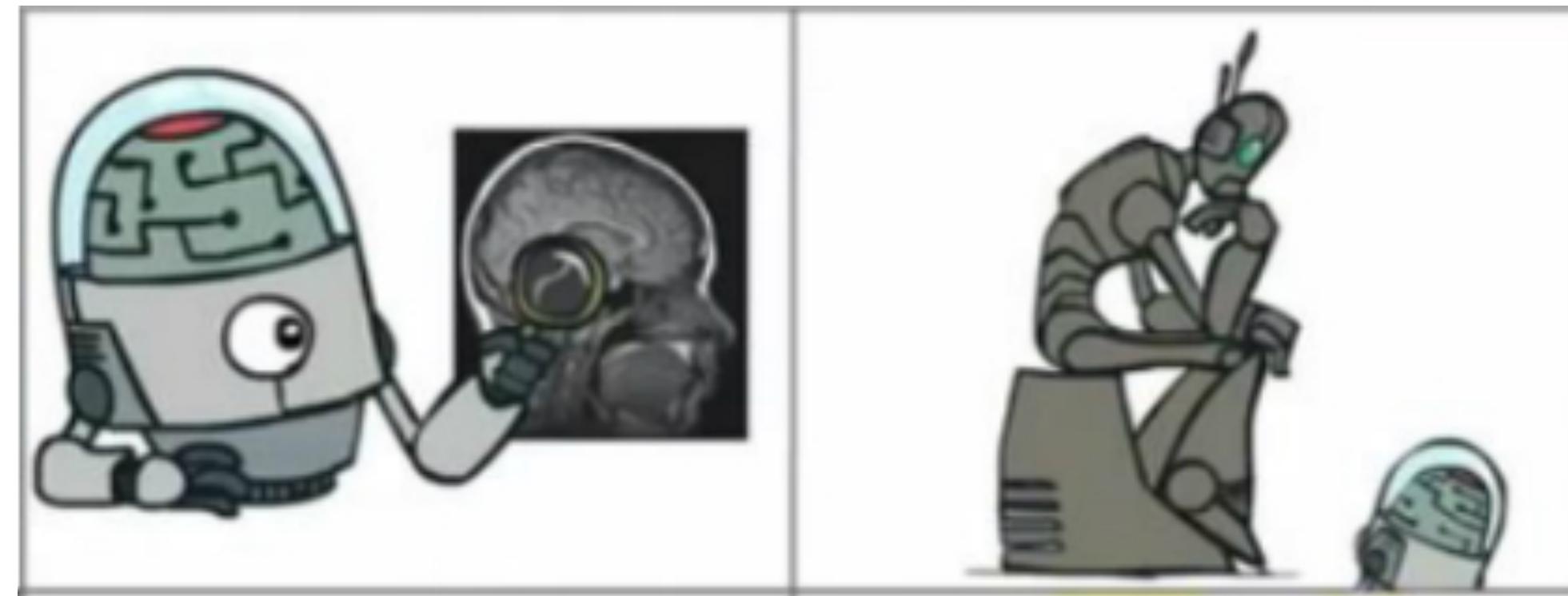
Think rationally

“The automation of activities that we associate with human thinking, activities such as decision-making, problem solving, learning ...” (Bellman, 1978)

WHAT IS ARTIFICIAL INTELLIGENCE?

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Think humanly



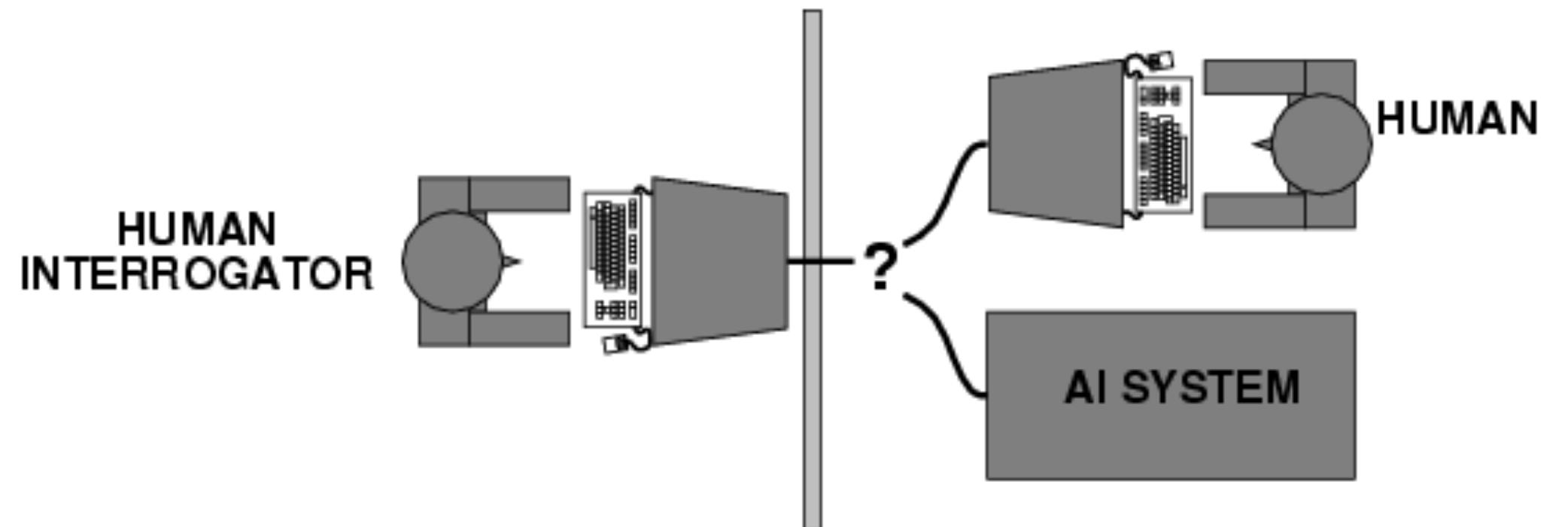
Think rationally



Act humanly

TURING TEST: INSPIRING A FIELD

- ▶ “Can machines think?” → “Can machine behave intelligently?”
- ▶ Operational test for intelligent behavior: The imitation game



- ▶ Crucially: No constraints on topics!

TURING'S PREDICTIONS

“...The original question, 'Can machines think?' I believe to be too meaningless to deserve discussion. Nevertheless I believe that at the end of the century the use of words and general educated opinion will have altered so much that **one will be able to speak of machines thinking without expecting to be contradicted ...**”

“Computing Machinery and Intelligence”, *Mind*, 1950. p. 442

“I believe that in about **fifty years' time** it will be possible to programme computers, with **a storage capacity of about 10^9** , to make them play the imitation game so well that an average interrogator will **not have more than 70 percent** chance of making the right identification after five minutes of questioning...”

Does it mean machines can think if they pass the Turing test?

THE CHINESE ROOM

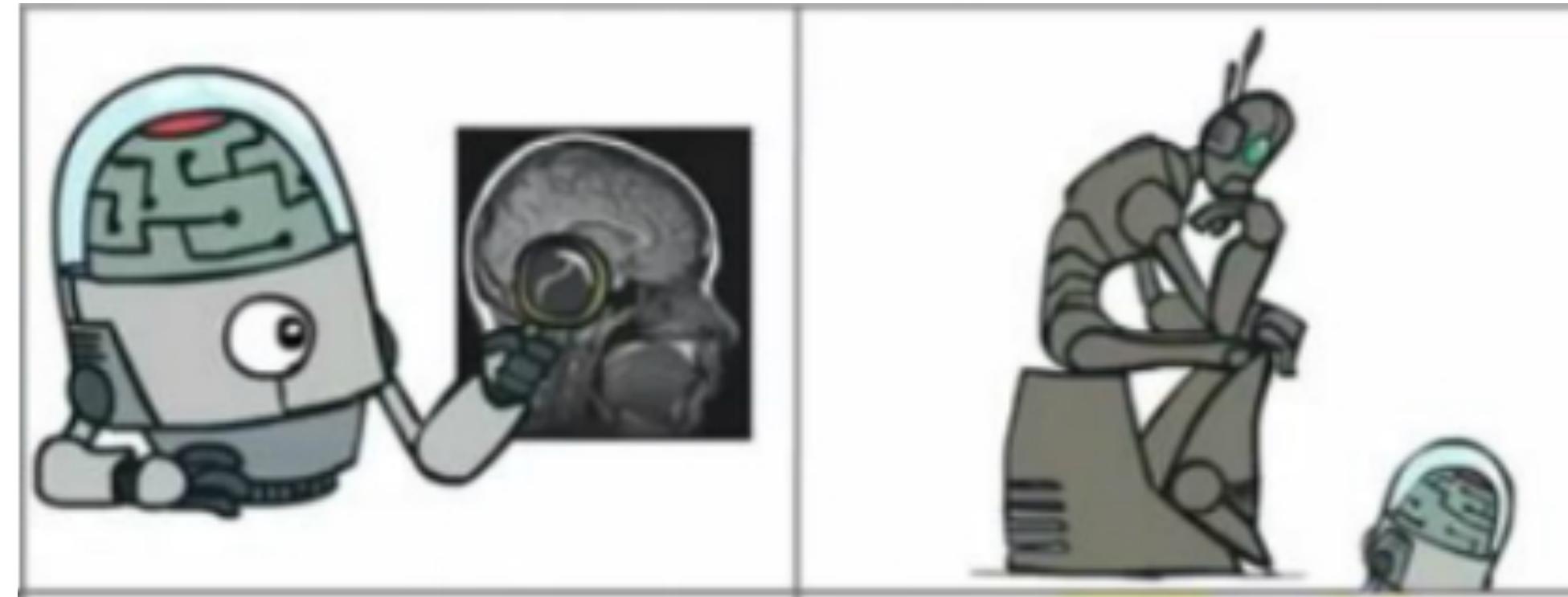


Searle, J. R. (1980). Minds, brains, and programs. *Behavioral and brain sciences*, 3(3), 417-424.

WHAT IS ARTIFICIAL INTELLIGENCE?

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Act humanly

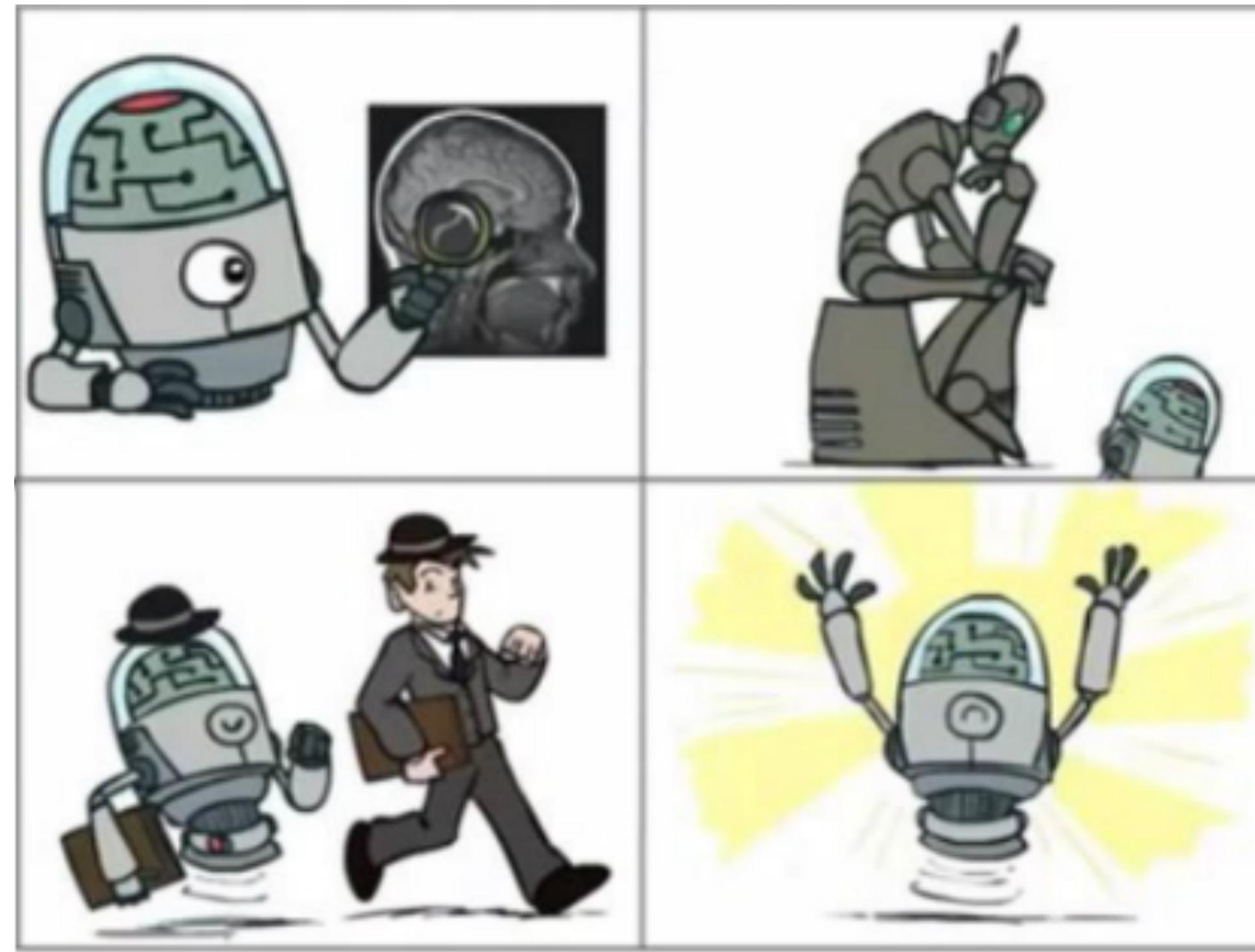


“The study of how to make computers do things at which, at the moment, people are better”
(Rich & Knight 1991)

WHAT IS ARTIFICIAL INTELLIGENCE?

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Think humanly



Think rationally

Act humanly

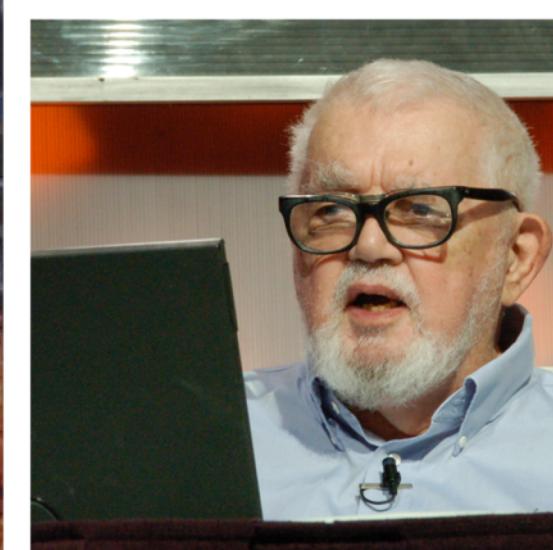
Act rationally

Construct rational agents that can perceive and act to achieve their goals, given their beliefs

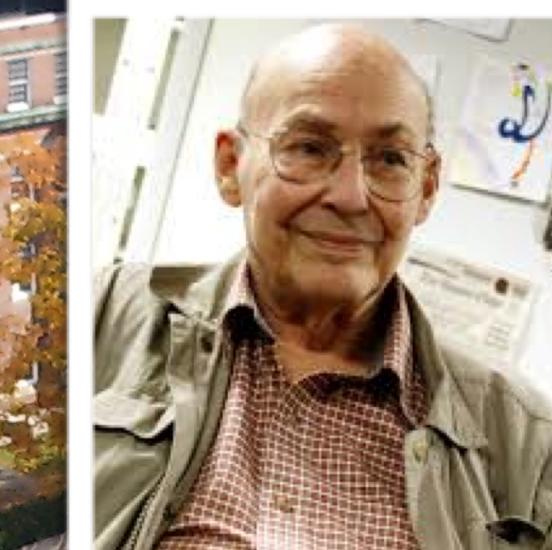
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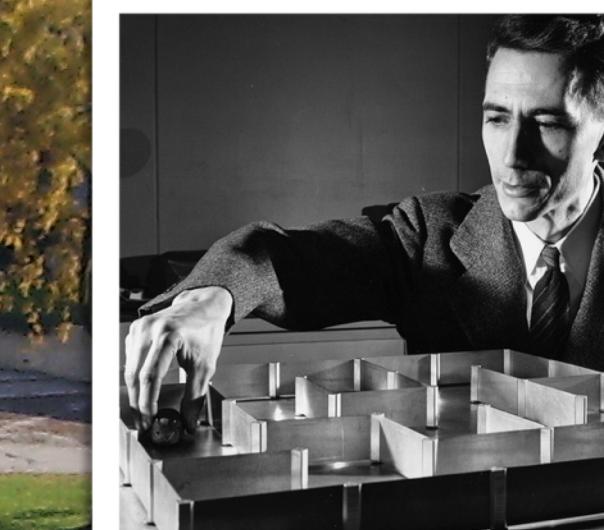
1956 DARTMOUTH SUMMER RESEARCH PROJECT THE BEGINNING OF AI RESEARCH



John McCarthy



Marvin Minsky



Claude Shannon

"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."

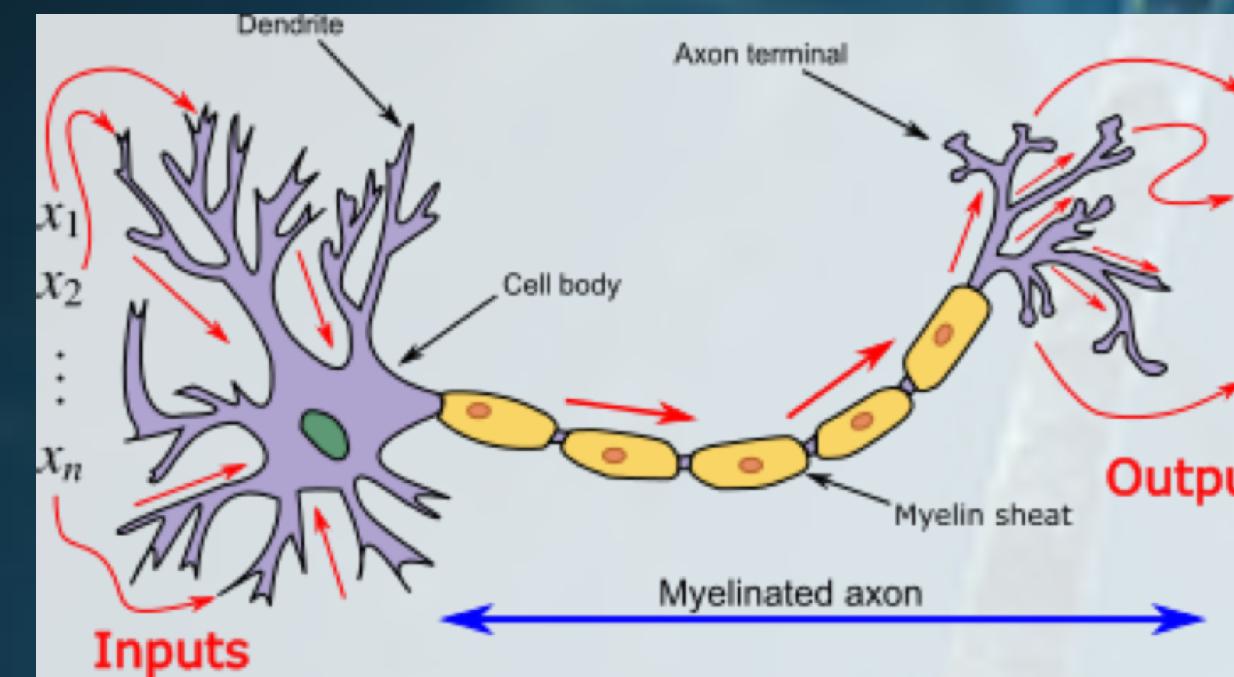
A BRIEF TIMELINE OF AI

- **1940-1950: Early days**

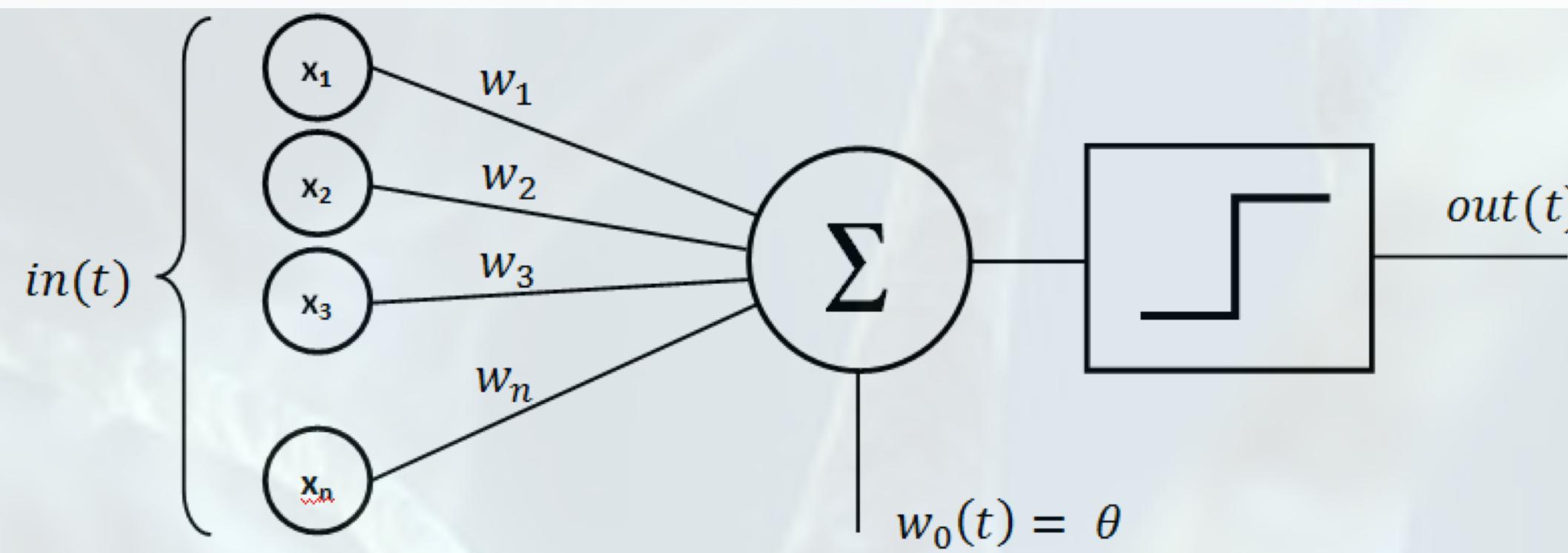
- 1943: McCulloch & Pitts: Boolean circuit model of brain
- 1950: Turing's "Computing Machinery and Intelligence"

EARLY AI RESEARCH: 1943-1965

NEURAL MODELS



Perceptrons (McCulloch and Pitts
'43; Rosenblatt '58)



$$in^0(t) = \theta$$

Perceptron: By Mayranna (Own work) [CC-BY-SA-3.0 (<http://creativecommons.org/licenses/by-sa/3.0>)], via Wikimedia Commons;

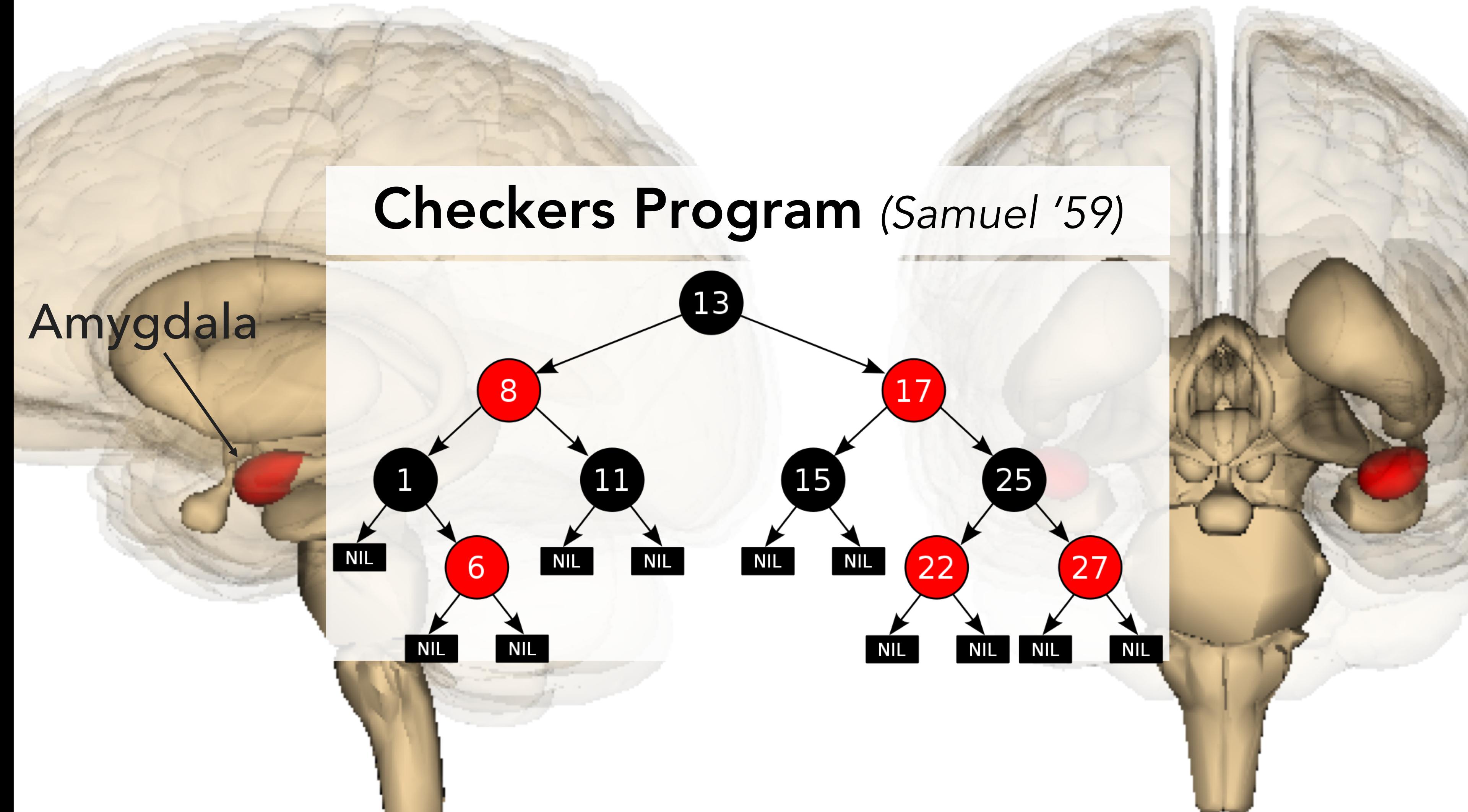
Neuron: [Scott Ingram](#), Flickr, <https://www.flickr.com/photos/scingram/100212089/>

A BRIEF TIMELINE OF AI

- **1950–70: Excitement: Look, Ma, no hands!**
 - 1956: Dartmouth meeting: “Artificial Intelligence” adopted
 - 1950s: Early AI programs: chess, checkers (RL), theorem proving
 - 1965: Robinson's complete algorithm for logical reasoning

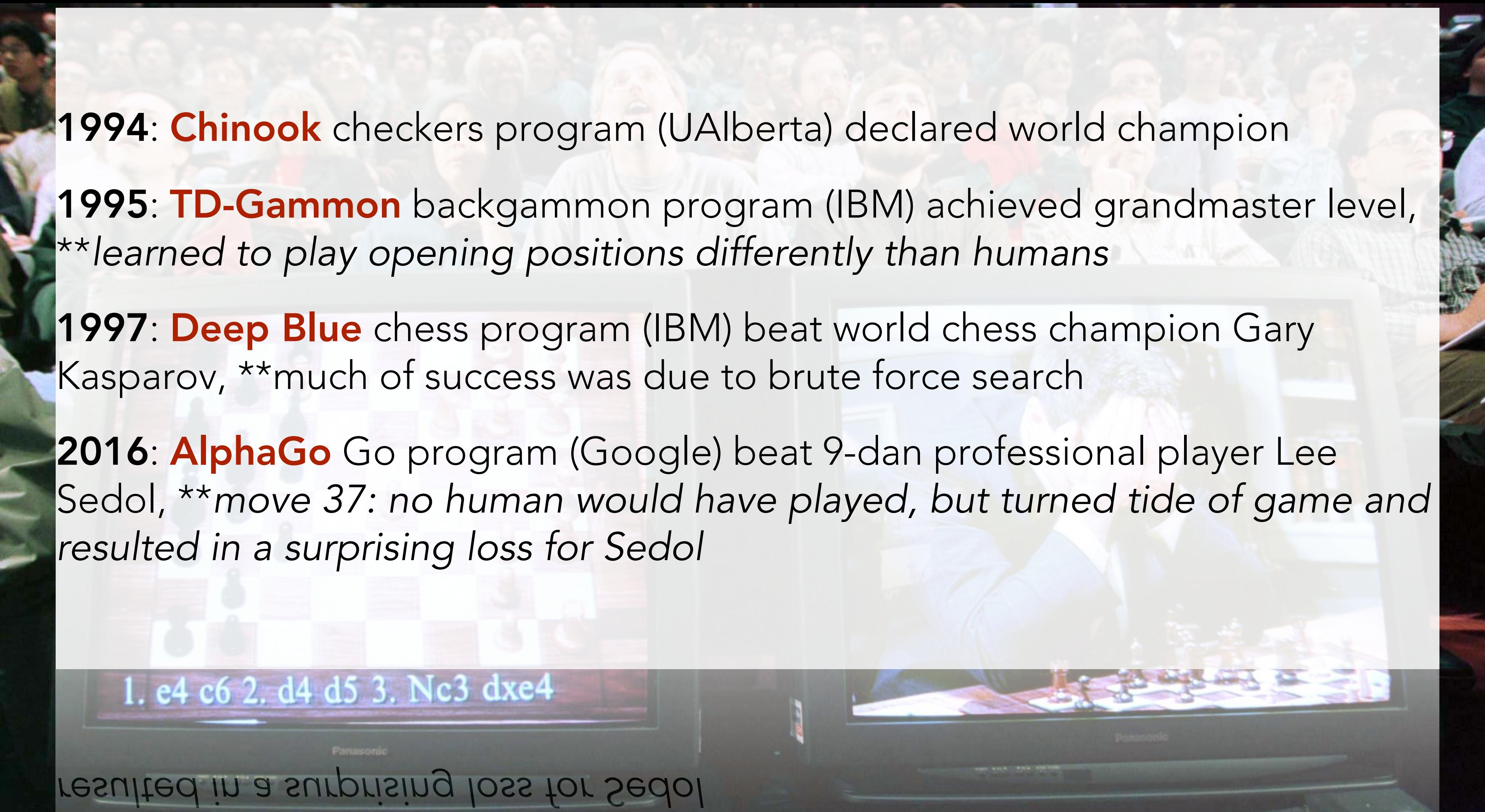
EARLY AI RESEARCH: 1950-1970

REINFORCEMENT LEARNING



Minimax tree: By Cburnett [GFDL (<http://www.gnu.org/copyleft/fdl.html>) or CC-BY-SA-3.0 (<http://creativecommons.org/licenses/by-sa/3.0/>)], via Wikimedia Commons; Brain images: Generated by Life Science Databases(LSDB). [CC-BY-SA-2.1-jp (<http://creativecommons.org/licenses/by-sa/2.1/jp/deed.en>)], via Wikimedia Commons

AI SUCCESS: GAME PLAYING



1994: **Chinook** checkers program (UAlberta) declared world champion

1995: **TD-Gammon** backgammon program (IBM) achieved grandmaster level,
**learned to play opening positions differently than humans

1997: **Deep Blue** chess program (IBM) beat world chess champion Gary Kasparov, **much of success was due to brute force search

2016: **AlphaGo** Go program (Google) beat 9-dan professional player Lee Sedol, **move 37: no human would have played, but turned tide of game and resulted in a surprising loss for Sedol

resulted in a surprising loss for Sedol

EARLY AI RESEARCH: 1950-1970

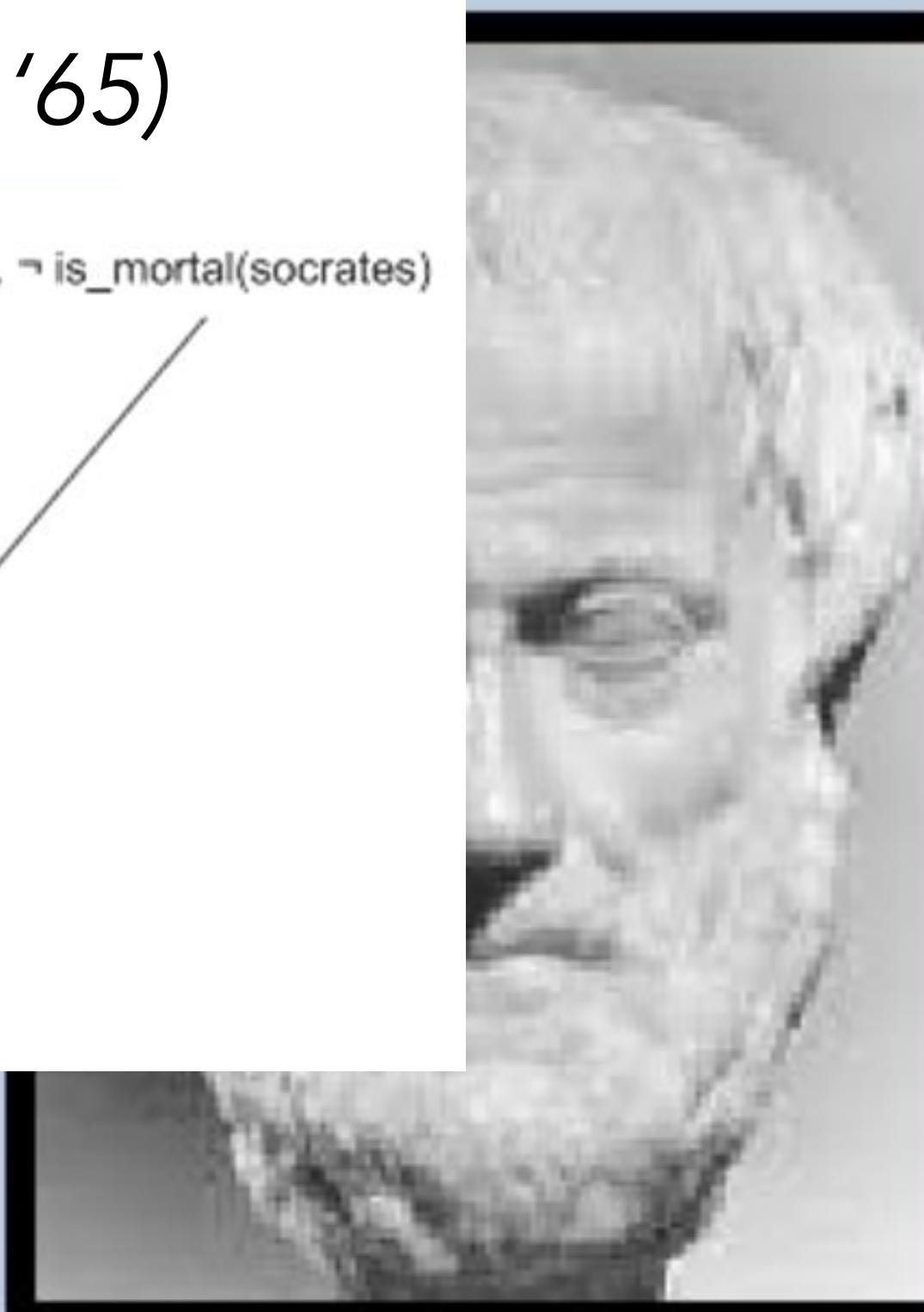
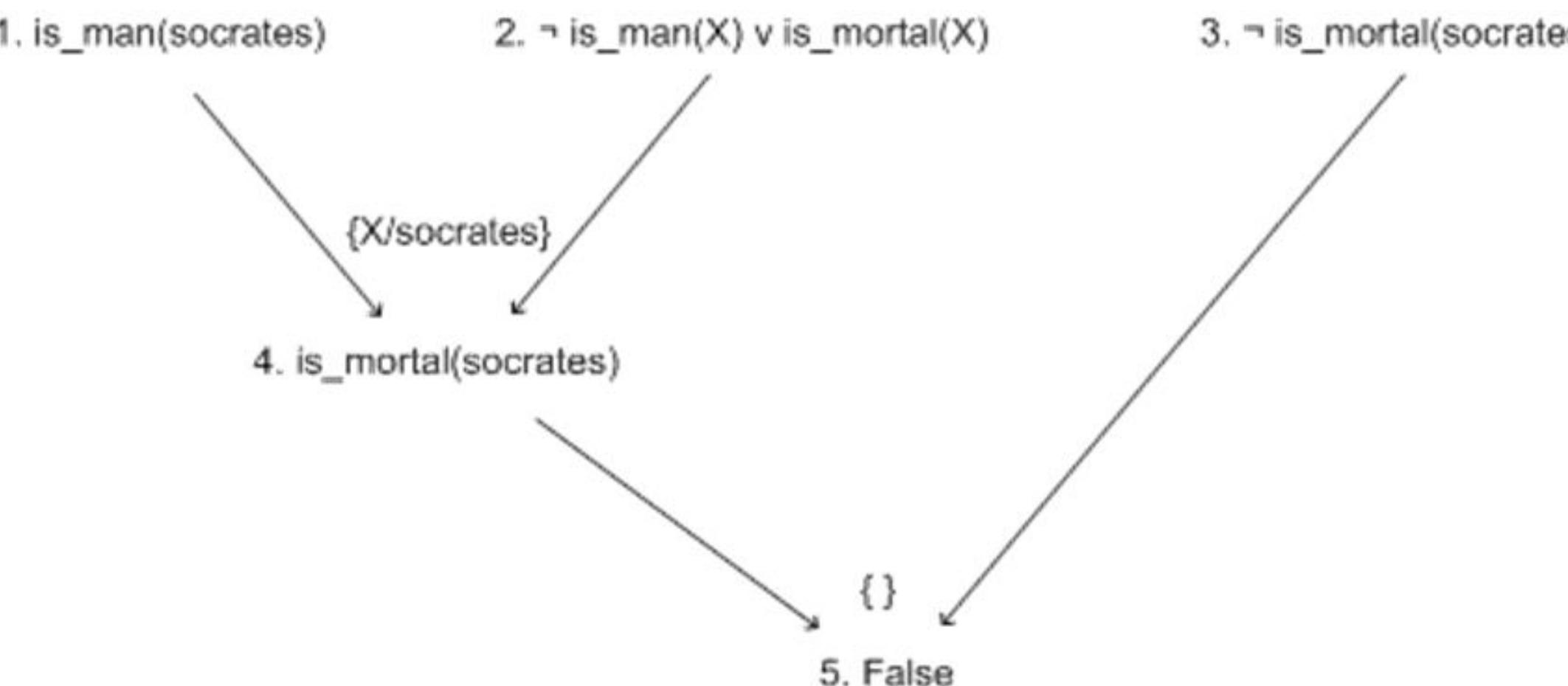
THEOREM PROVING

Premise 1
All men are mortal.

Premise 2
Socrates is a man.

Conclusion:
Therefore, Socrates is mortal.

Resolution (Robinson '65)



A BRIEF TIMELINE OF AI

- **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– 2012: Statistical approaches + subfield expertise**
 - Resurgence of probability, focus on uncertainty
 - Agents and learning systems... “AI Spring”?
- **2012– __: Excitement: Look, Ma, no hands again?**
 - Big data, big compute, deep learning
 - AI used in many industries

TODAY'S AI: KEYWORDS AT AAAI 2023

- Machine Learning
- Computer Vision
- Data Mining & Knowledge Management
- Speech & Natural Language Processing
- Multiagent Systems
- Knowledge Representation and Reasoning
- Humans and AI
- Philosophy and Ethics of AI
- Planning, Routing, and Scheduling
- Constraint Satisfaction and Optimization
- Search and Optimization
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- Intelligent Robotics
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A LONG WAY TO GO...

- We've made great progress in AI over the last 60+ years...
- But we've also notoriously underestimated the difficulty of the problem...

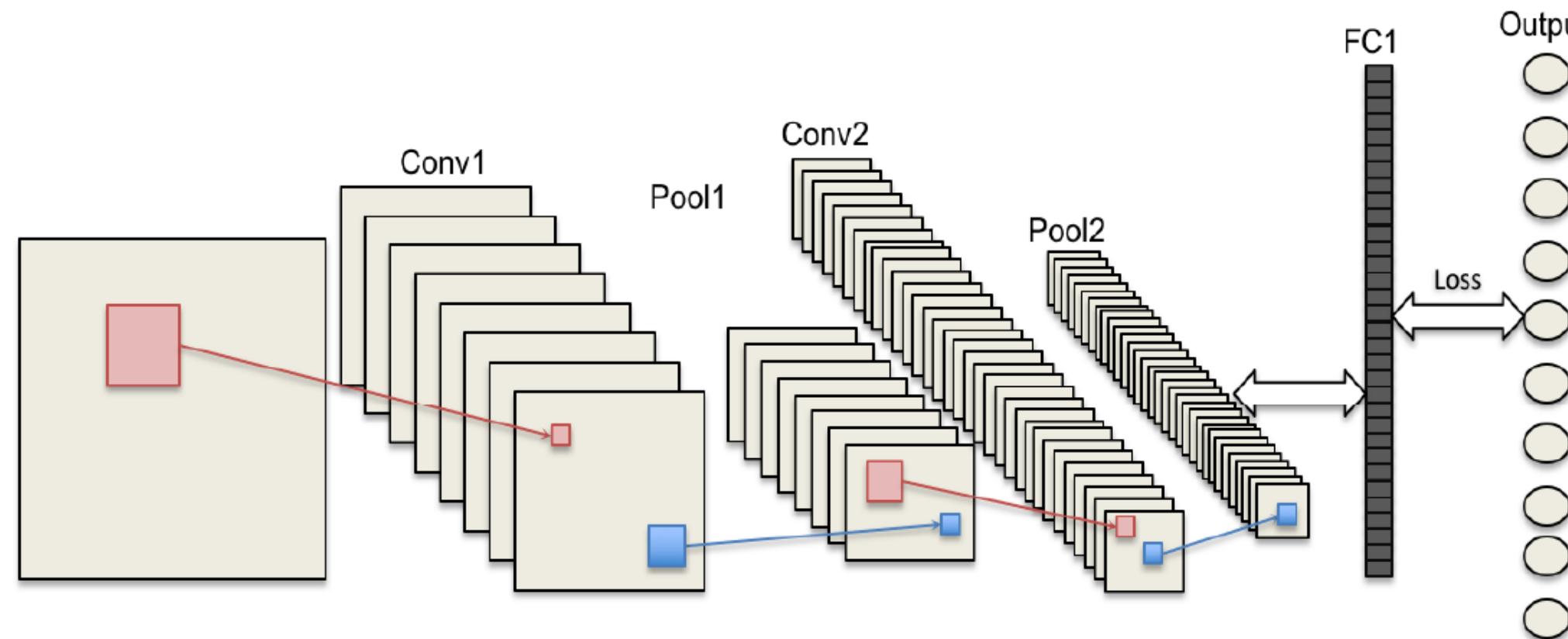
THE STORY OF COMPUTER VISION

- In 1966, Seymour Papert (from the same MIT AI group as McCarthy and Minsky) told his graduate students to “solve” computer vision as a **summer project**...because unlike many other problems in AI, vision was tractable and “easy” to encode
- 50 years later, we are still working on it...

COMPUTERS ACHIEVE SUPER HUMAN PERFORMANCE IN IMAGE CLASSIFICATION, RECENTLY...



ImageNet Dataset: sample images from ILSVRC 2012



Convolutional neural net example

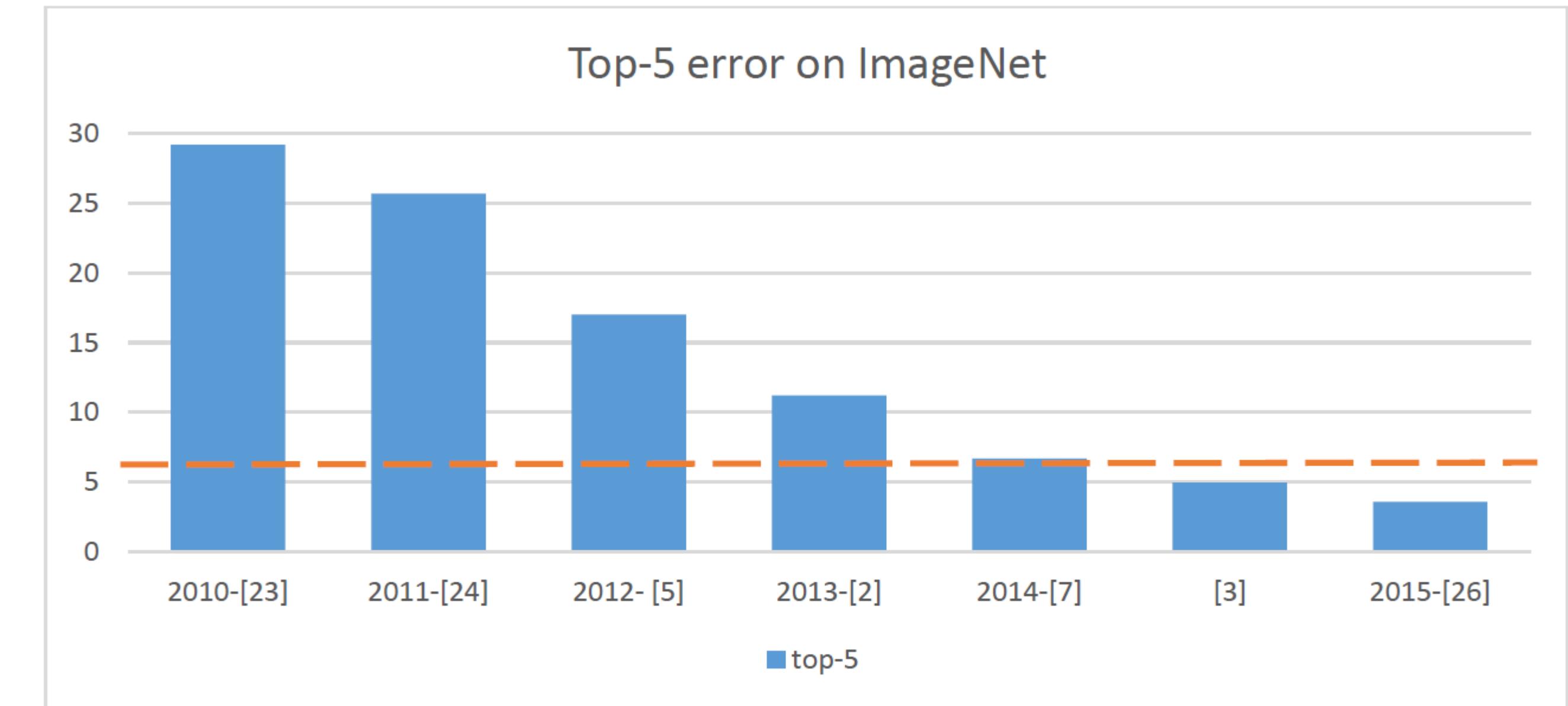
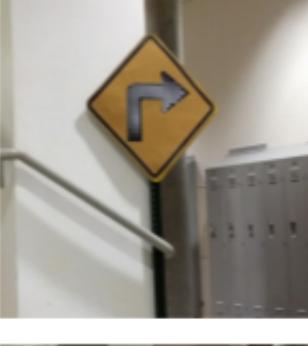
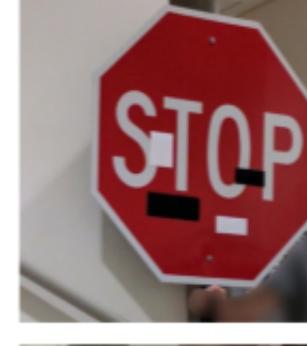
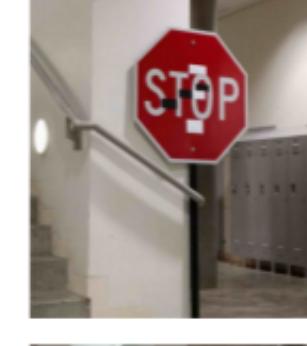
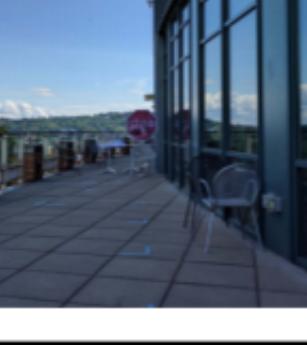
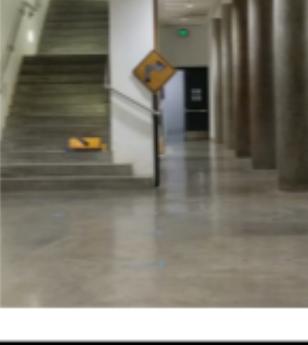
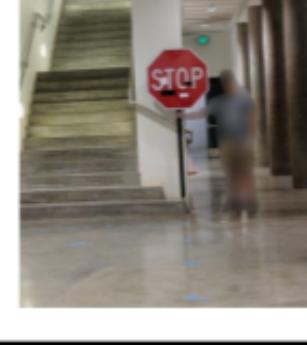


Fig 19. Shows the progress of classification performance (top-5 error %) on Imagenet dataset over past few years. Dashed line indicates Human performance (5.1%).

Source: Ph.D. thesis, Dr. [Sumanth Chennupati](#)

BUT THERE ARE STILL MANY UNSOLVED PROBLEMS...

Distance/Angle	Subtle Poster	Subtle Poster Right Turn	Camouflage Graffiti	Camouflage Art (LISA-CNN)	Camouflage Art (GTSRB-CNN)
5' 0°					
5' 15°					
10' 0°					
10' 30°					
40' 0°					
Targeted-Attack Success	100%	73.33%	66.67%	100%	80%



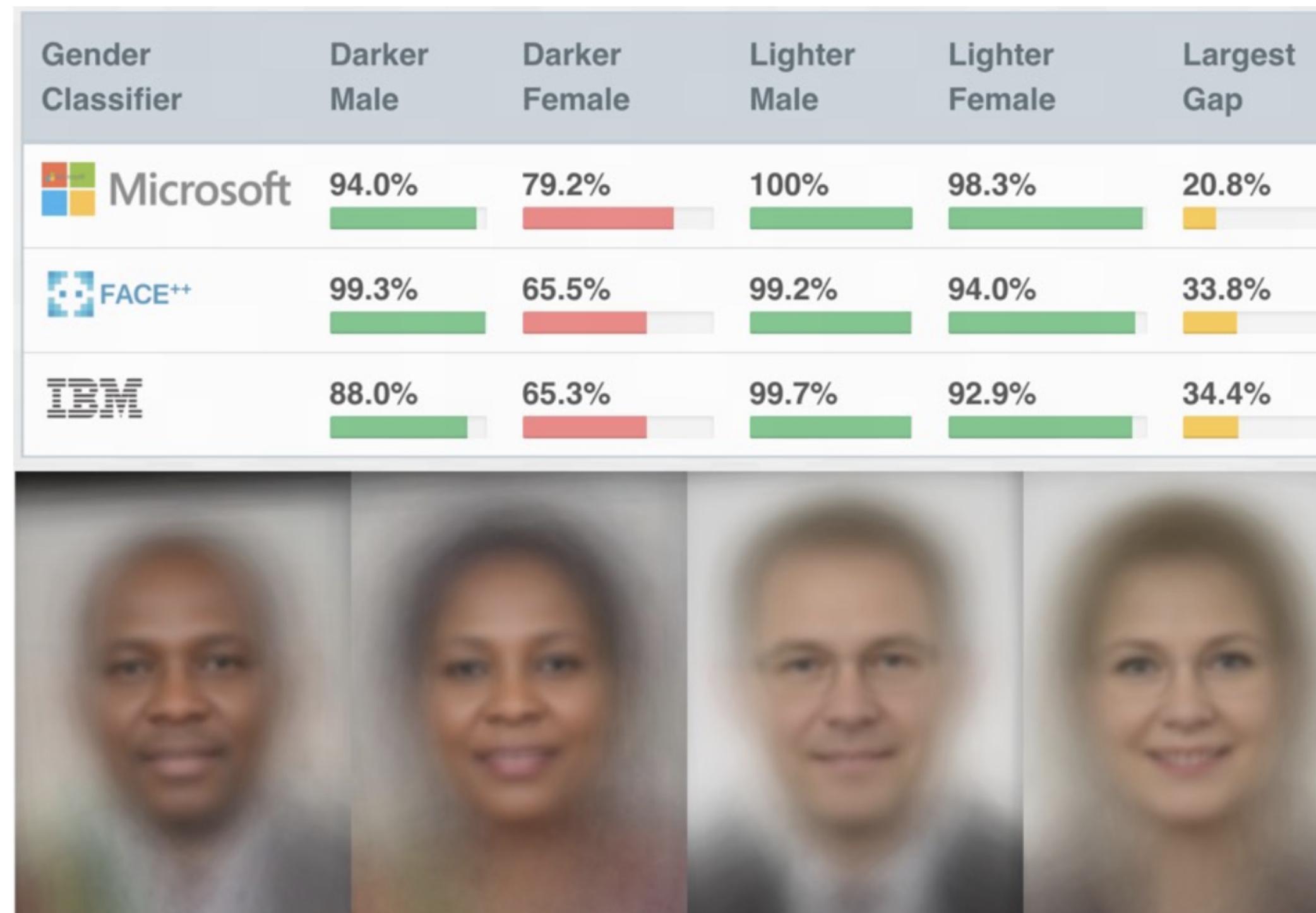
Neural network
thinks they are
“speed limit 45”.

Robust Physical-World Attacks
on Deep Learning Visual
Classification, CVPR 2018

BUT THERE ARE STILL MANY UNSOLVED PROBLEMS...

Facial Recognition Is Accurate, if You're a White Guy

By [Steve Lohr](#)



Gender shades: Intersectional accuracy disparities in commercial gender classification. FAT 2018

BUT THERE ARE STILL MANY UNSOLVED PROBLEMS...

A very accurate wolf detector!



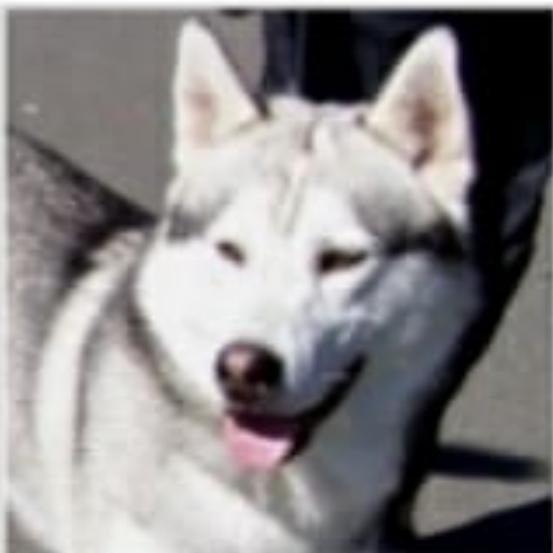
Predicted: **wolf**
True: **wolf**



Predicted: **husky**
True: **husky**



Predicted: **wolf**
True: **wolf**



Predicted: **husky**
True: **husky**

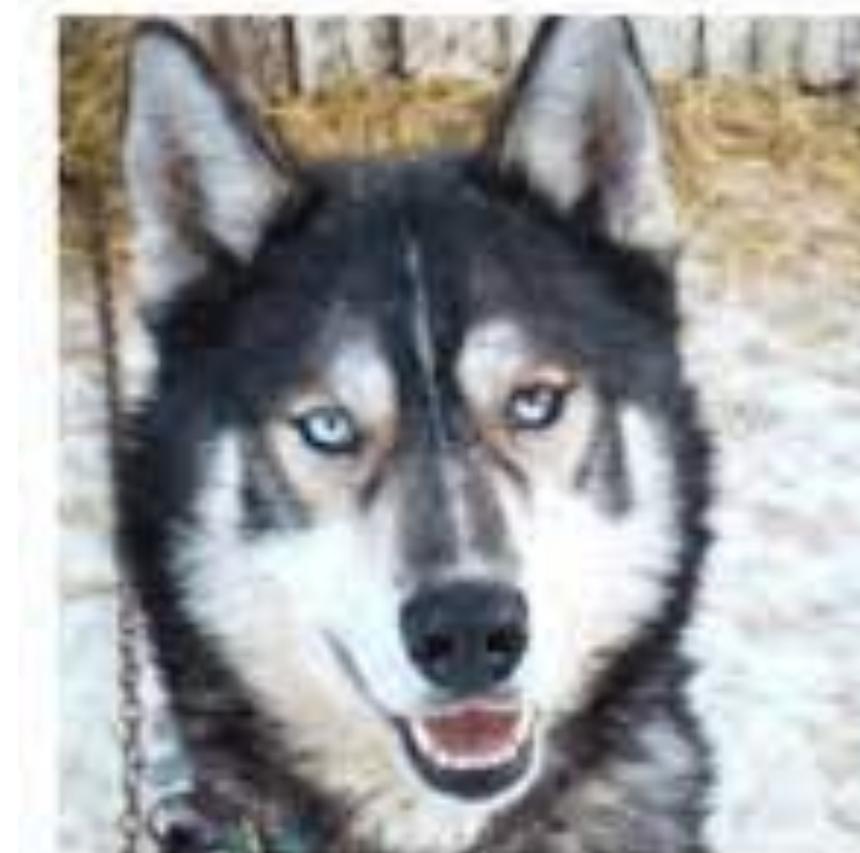


Predicted: **wolf**
True: **wolf**



Predicted: **wolf**
True: **husky**

Or really...a snow detector?



" Why should I trust you?" Explaining the predictions of any classifier. KDD 2016

TODAY'S AGENDA

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- ▶ A brief history of AI
- ▶ **Course overview**

LOGISTICS

- ▶ Time: Tues / Thurs 5:30 - 6:45 pm, LILY G126.
- ▶ Course website: <http://mingyin.org/CS471/Fall2022/index.html>
- ▶ In-class learning & video recording
- ▶ Instructor: Ming Yin (mingyin@purdue.edu)
 - ▶ Office hours: Thursdays 4:30 - 5:30 pm via Zoom (drop me an email so that I expect you to attend the virtual office hour)
 - ▶ Zoom link for office hour:
<https://us02web.zoom.us/j/89544887971?pwd=aGVQd2pnOVo3WVBsaVFwMmxaa3hqdz09> (passcode: cs471)

LOGISTICS

- ▶ Teaching assistants and office hours:



Jiaxin Du

Thu 3-4pm



Jinzhao Li

Fri 10-11am



Zhuoyan Li

Wed 10-11am



Mir Imtiaz Mostafiz

Fri 11am-noon



Xinru Wang

Tue 10-11am

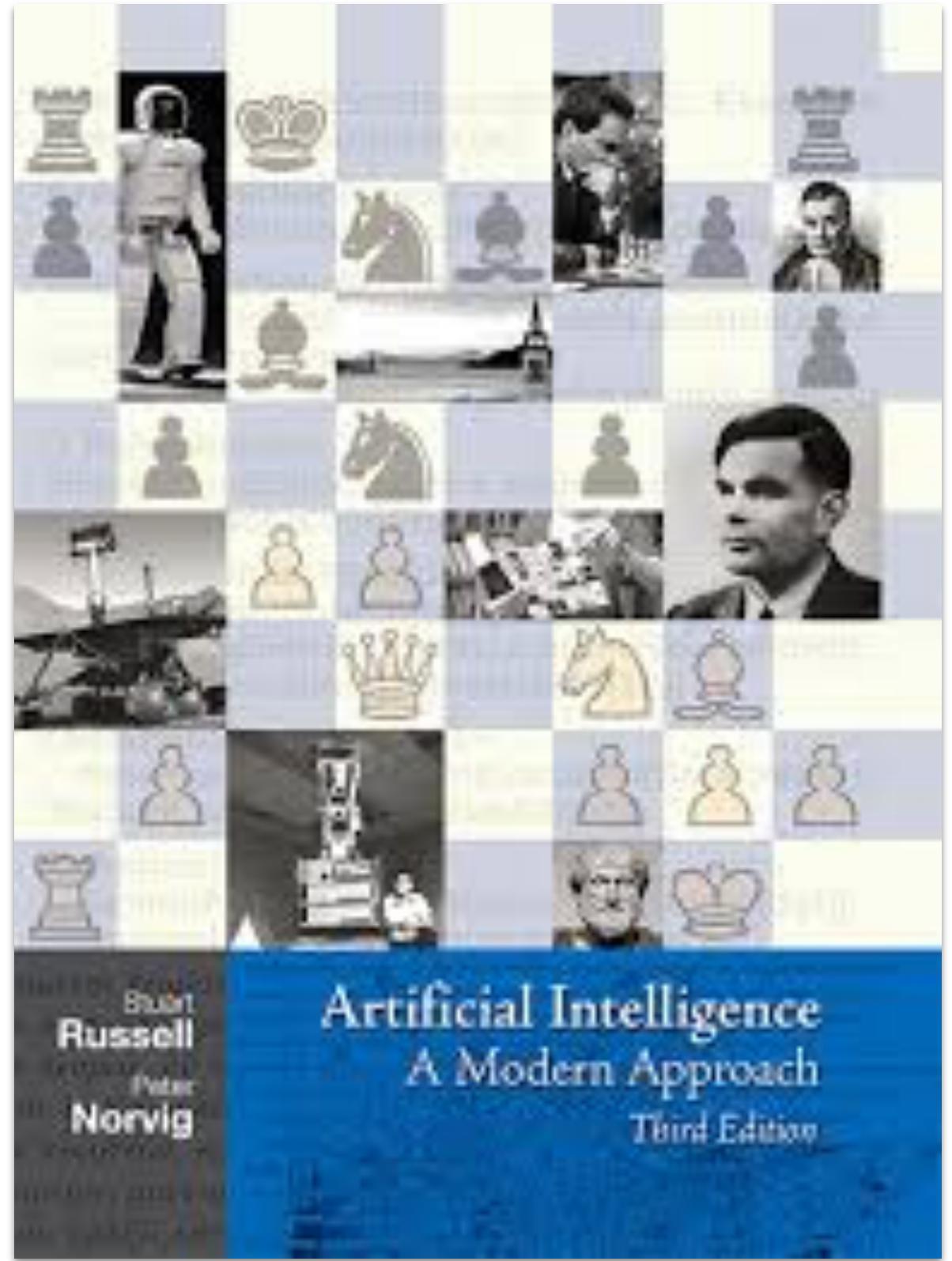
- ▶ See Ed Discussion form for Zoom links of office hours!

LOGISTICS

- ▶ Slides, videos, announcements on Brightspace <https://purdue.brightspace.com/>
- ▶ Discussion on Ed: <https://edstem.org/us/join/X32erd> (Please sign up!)
- ▶ Gradescope: <https://www.gradescope.com/>
- ▶ Prerequisites: CS251 Data Structures (grade of C or better)

TEXTBOOK

- ▶ S. Russell and P. Norvig (2002). *Artificial Intelligence: A Modern Approach*. Prentice Hall, 3rd Edition.
- ▶ We call it AIMA.
- ▶ A 4th edition was published in 2020; but all references to AIMA on the website are based on the 3rd edition



COURSE OBJECTIVES

- ▶ Teach you key facts and skills
 - ▶ Understand core algorithms/data structures used in AI
 - ▶ Abstract real problems into prototypical tasks that have been studied in AI
 - ▶ Map between abstract tasks and basic AI techniques that address them
- ▶ Prepare you for the future
 - ▶ Learning about new developments and practical applications in AI
 - ▶ Understand what's easy and what's difficult to achieve algorithmically

TOPICS

- ▶ **Introduction:** What is artificial intelligence? Overview of AI history and associated application areas.
- ▶ **Search:** Problem solving as search, heuristic search, adversarial search, constraint satisfaction.
- ▶ **Reasoning with logic:** Propositional logic and first-order logic, logical reasoning and inference.
- ▶ **Reasoning with uncertain knowledge:** Basic probability and statistical reasoning, Bayesian and Markov networks, exact and approximate inference methods.
- ▶ **Planning and decision making:** Decision making under uncertainty, sequential decision making and Markov decision processes.
- ▶ **Learning:** Learning as search, logical formulation of learning, reinforcement learning.
- ▶ **Additional topics (time permitting):** Human-centered AI, interpretability/fairness/bias/ethics.

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- Data Mining & Knowledge Management
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- Multiagent Systems
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WORKLOAD

- ▶ Assignments (60%)
 - ▶ Four assignments including written/math exercises, programming questions in python (each 15%)
- ▶ Closed-book exams (40%)
 - ▶ Midterm: 20%
 - ▶ Final exam: 20%
- ▶ Late policy: 3 late days in total
 - ▶ Can be applied to any assignment; once applied, can not rearrange.
 - ▶ Otherwise, 10% deduction per late days but the assignment will NOT be accepted after being late for more than 5 days.

LEARNING DURING THE PANDEMIC

- ▶ Continuing monitor the situation...
- ▶ Challenge: a large class!
 - ▶ 150+ students. $\text{Prob}(\text{one student healthy}) = 0.99$, $\text{Prob}(\text{every student healthy}) = 0.99^{150} = \mathbf{0.22}$
 - ▶ CDC: Omicron BA.5 causes nearly 90% of the current cases in U.S (as of Aug 16).
 - ▶ Omicron BA.5 is able to evade previous immunity from infection and vaccination
 - ▶ Reinfection increases the risk for complications (e.g., stroke, diabetes, heart attack) and long COVID

LEARNING DURING THE PANDEMIC

- ▶ Do NOT come to class if you experience COVID-like symptoms: course videos will be uploaded online
- ▶ Think about learning outcomes when having 20 students lag behind because of 1 infection in the previous class! (Omicron BA.1 $R_0=9.5$; BA.2 is 1.4 times more transmissible than BA.1, BA.4/5 is more transmissible than BA.2)
- ▶ Exercise your judgement to protect yourself!
- ▶ Protect Purdue: Purdue students, faculty, staff and visitors may choose to further protect themselves by continuing to wear a high-quality mask at any time, and their decision to do so should be respected by all

TODO

- ▶ Sign up at the discussion platform: <https://edstem.org/us/join/X32erd> !