



# Introduction to Artificial Intelligence

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*Join us on a tour of AI!*

# Lecture 1

## Introduction

# Agenda for this week

- Brief self-introduction
- Recent “AI” boom
- Course logistics
- History of AI
- What is AI?
- What’s next for AI?



# Google



**HONDA**  
The Power of Dreams



# Recent “AI” Boom

Deep learning  
Reinforcement learning  
Monte Carlo Tree Search  
Multi-agent RL

# Games (DeepMind)



credit: shorturl.at/cltD2



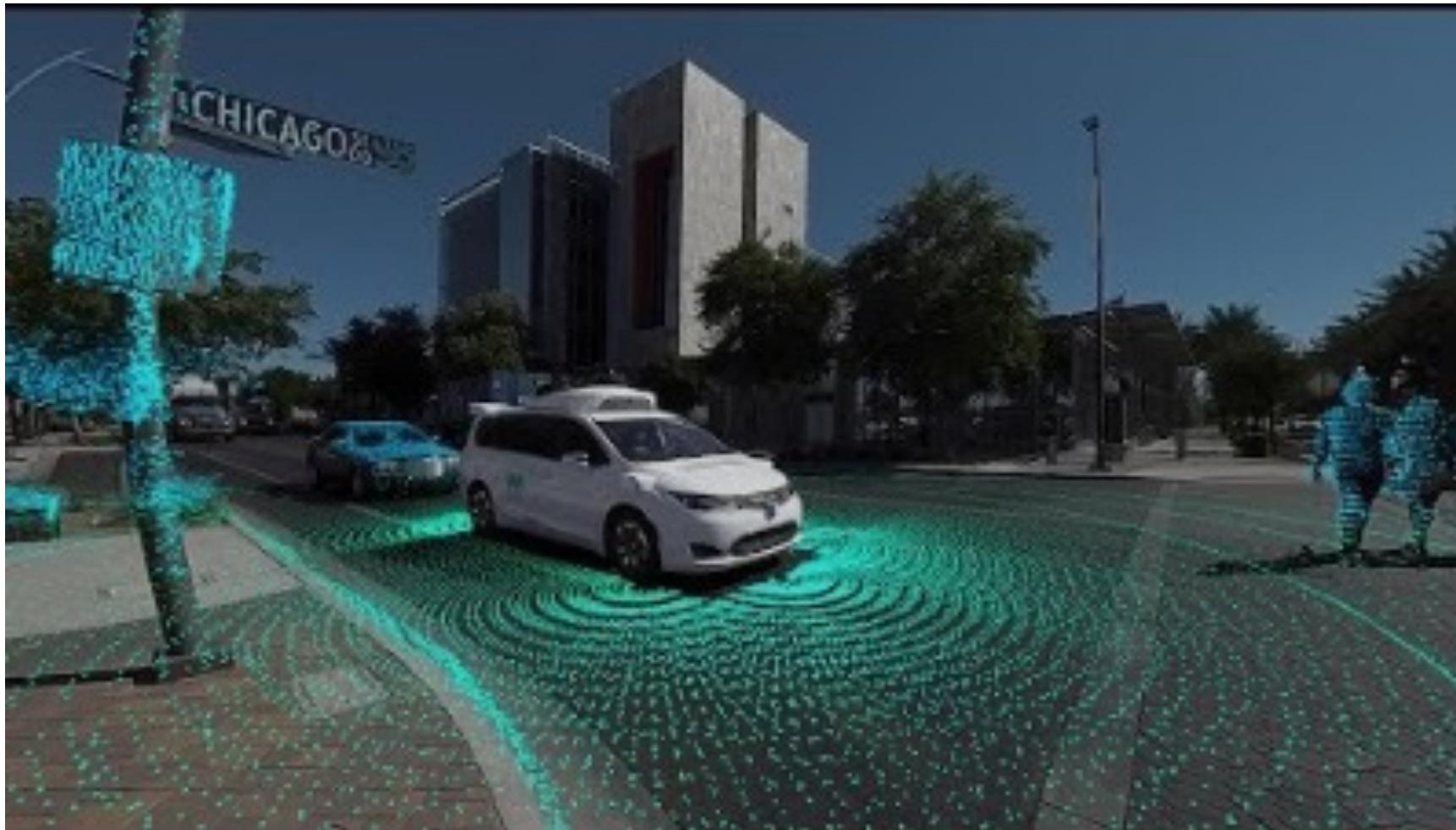
2/23/21



[https://www.youtube.com/watch?v=jtlrWblOyP4&feature=emb\\_logo](https://www.youtube.com/watch?v=jtlrWblOyP4&feature=emb_logo)

# Self-Driving Vehicles

Scene understanding  
Machine learning  
Mapping & localization  
Planning/decision making



<https://www.youtube.com/watch?v=B8R148hFxPw>

Camera & Radar based solutions  
Scene understanding  
Vehicle control (Emergency braking)

# Driver Assist Systems



<https://youtu.be/nHmTWxcbCTQ?t=7>

# Parking Lot Monitoring Systems

License plate recognition  
Decision making  
Car tracking & localization  
Data Management

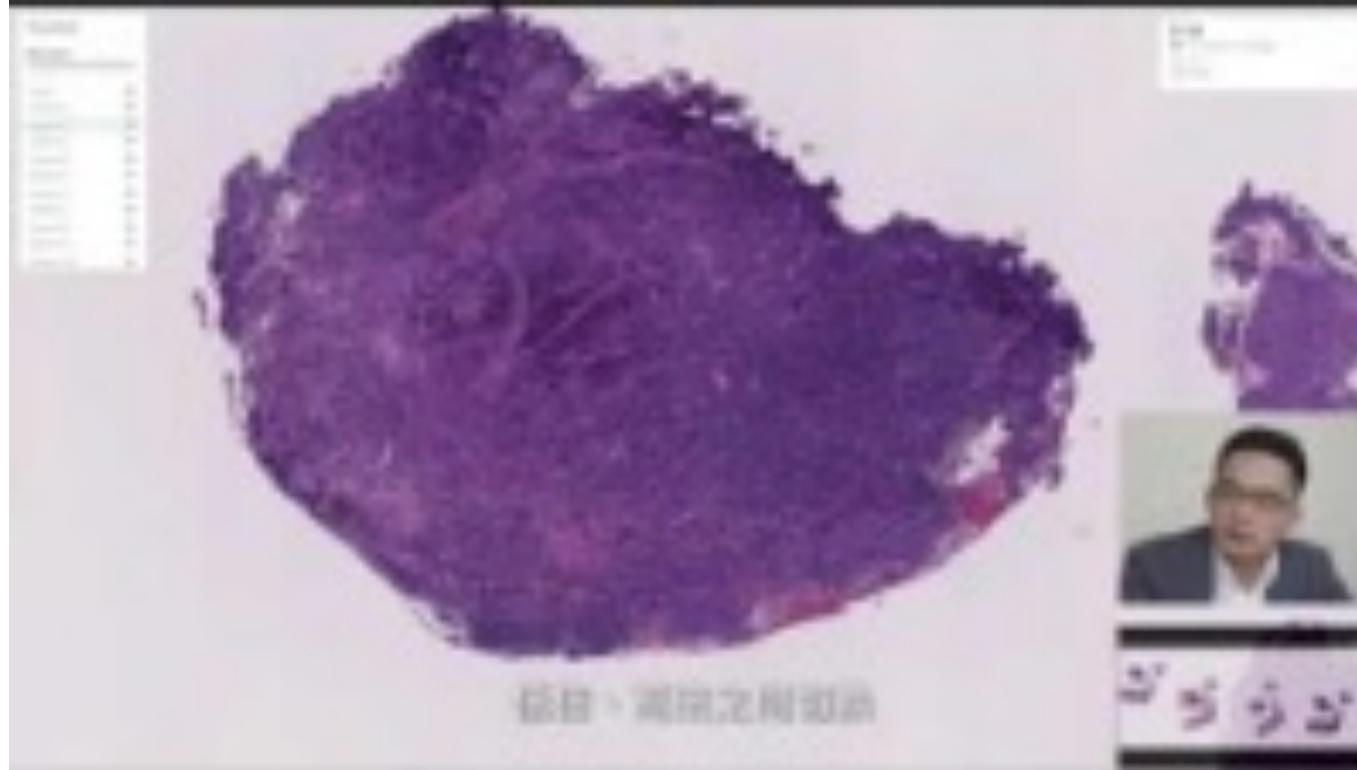


[https://www.youtube.com/watch?v=UR70XohKP\\_E](https://www.youtube.com/watch?v=UR70XohKP_E)

Domain knowledge  
Deep learning  
Advanced computing

# Medical Image Diagnosis

Image size  
 $21,500 \times 21,500$

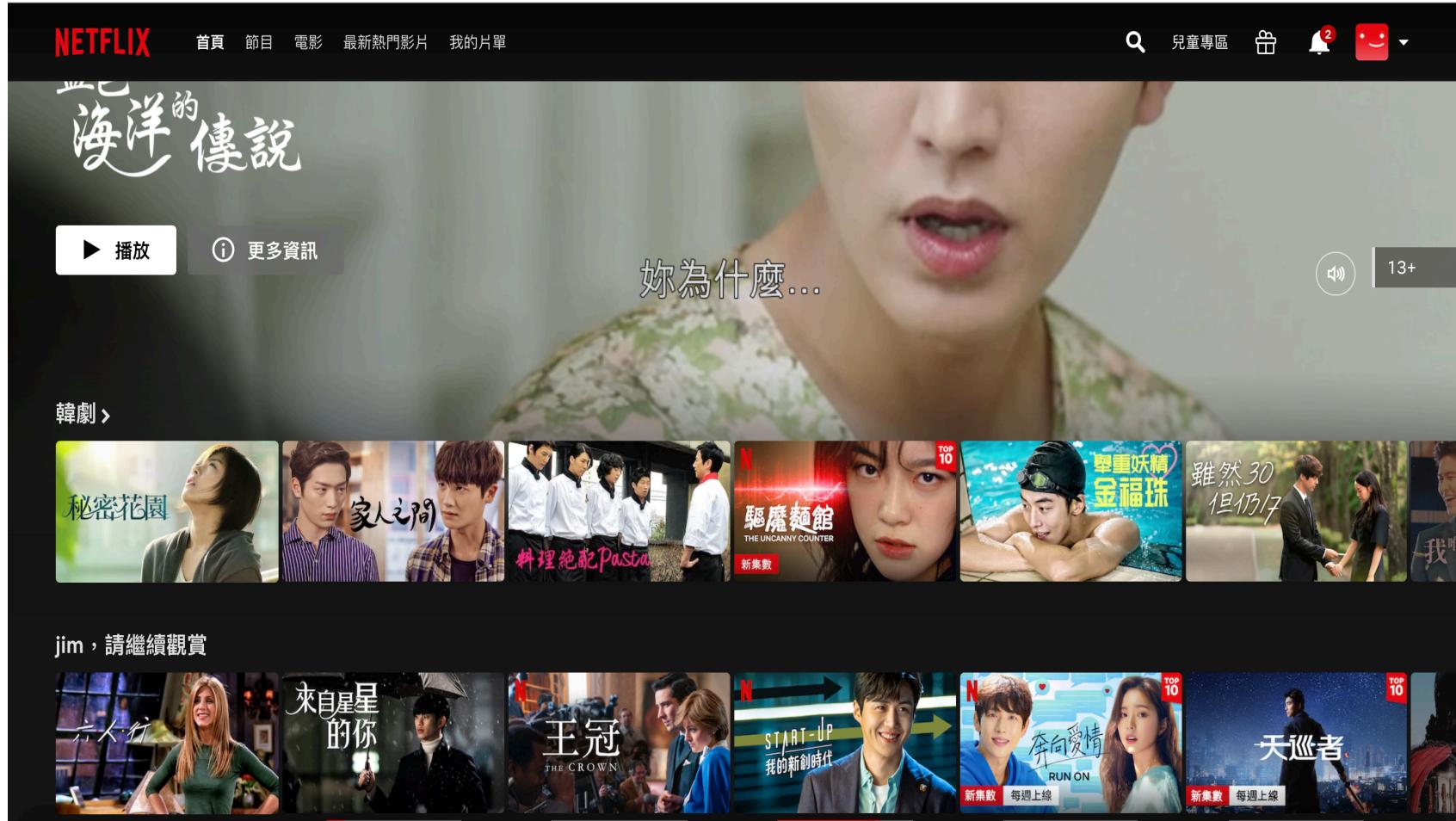


<https://youtu.be/TLuGamisw8E>

[https://www.nature.com/articles/s41467-021-21467-y?fbclid=IwAR1E4rkQwijrBSKjjDWNzcDb9e6RXfwhAGeLJsIEYNSVOfAgKr1I-4vQ\\_TU](https://www.nature.com/articles/s41467-021-21467-y?fbclid=IwAR1E4rkQwijrBSKjjDWNzcDb9e6RXfwhAGeLJsIEYNSVOfAgKr1I-4vQ_TU)

Credit: aetherAI

# Recommender Systems



Credit: Netflix

Face recognition  
Multi-sensor fusion  
Localization

# Cashierless Grocery Store



<https://www.youtube.com/watch?v=NrmMk1Myrxc>

# Robotics



<https://www.youtube.com/watch?v=6Zbhvaac68Y>

# Virtual Assistant (Siri, Alexa, ...)

Speech-to-text  
Natural language Understanding  
Database & Search



Credit: Stanford CS221 Note

# Machine Translation

Chinese (Traditional)  English

人工智慧到底是什么？

Réngōng zhìhuì dàodǐ shì  
shénme?

What exactly is  
artificial intelligence?

Chinese (Traditional)  English

是在哈囉

Shì zài hā luō

It's hello



Credit: Google Translation

*Are these AI*



# Course Logistics

# Course Logistics

- **Prerequisites**
  - Programming (C/C++)
  - Linear Algebra
  - Algorithm
  - Probability (suggested)
- **Lectures**
  - Tuesday 1:20pm-3:10pm @ ED B27
  - Fridays 9:00am-9:50am @ ED B27
- **Office Hours**
  - Tuesday 3:20pm-4:20pm @ EC625
  - Fridays 10:00am-11:00am @ EC625

# Course Logistics

- **Registration** (100 seats)
  - Department policy
  - Up to **110**
  - Computer Science 大四 > 大三 > 大二 > 大一
  - The rest : draw straws if any
- **Textbook:**
  - Artificial Intelligence: A Modern Approach by Russell & Norvig (3<sup>rd</sup> or 4<sup>th</sup> Edition)
  - *Optional*
- **Language**
  - Taught in English
  - Questions can be asked in either English or Chinese

# Course Logistics

- **Contact**
  - [ychen@nycu.edu.tw](mailto:ychen@nycu.edu.tw)
  - [ychen@cs.nctu.edu.tw](mailto:ychen@cs.nctu.edu.tw)
  - In your email, please put [CS Spring 2021 AI] in the beginning of the subject
    - E.g., [CS Spring 2021 AI] Meeting request for discussing the idea of my final project
- **TA**
  - 張桂華: amy09921@gmail.com
  - 胡瑞麟: linhu.cs09g@nctu.edu.tw
  - 周千貿: ya112358@gmail.com

# Course Logistics

- **Grading**
  - Homework: 40%
    - 4 programming assignments
  - Midterm exam: 30%
    - **5/4/2021**
  - Final Project: 30%
    - Report (20%)
    - Video recording (5%)
    - 5-min Demo (5%)

# Homeworks

- Main Purpose:
  - Practice implementing the material taught in classes into real problems
- Policy:
  - You may discuss homework problems with other students
  - All code and written material that you submit must be entirely your own unless specifically cited
- Programming language
  - Python

# Midterm

- Main purpose: test your ability to use knowledge to solve problems, not to memorize them
- Midterm will cover topics in course up to and including the lecture right before the midterm

# Final Project

- Main Purpose:
  - Apply what you learned in classes
  - Hands-on experience in solving real-world problems
  - Get a taste of research
- Work in groups of up to **3**
- Details will be announced

# Expected Learning Outcomes

After taking the class, students will be able to

- understand the foundational principles that drive existing AI applications
- have a strong appreciation of the big-picture of AI
- develop intelligent systems by assembling your solutions to real-world problems

# Interactions

*Ask Questions*

*Learn from your classmates*

*I got it!!!*



# Any Questions?



# Course Contents and Timeline

- **Week 1 (2/22~2/26)**: Introduction to Artificial Intelligence
- **Week 2 (3/1~3/5)**: Machine Learning I (supervised learning)
- **Week 3 (3/8~3/12)**: Machine Learning II (Unsupervised learning)
- **Week 4 (3/15~3/19)**: Machine Learning III (Introduction to Neural Network)
- **Week 5 (3/22~3/26)**: Problem Solving by Searching
- **Week 6 (3/29~4/2)**: Adversarial Search
- **Week 7 (4/5~4/9)**: Constraint Satisfaction Problems
- **Week 8 (4/12~4/16)**: Markov Decision Process
- **Week 9 (4/19~4/23)**: Reinforcement Learning
- **Week 10 (4/26~4/30)**: Bayesian Networks

# Course Contents and Timeline

- Week 11 (5/3~5/7): Knowledge, Reasoning, and Planning I
  - Midterm exam (5/4)
  - Final project proposal due (5/11)
- Week 12 (5/10~5/14): Knowledge, Reasoning, and Planning II
  - HW4 due (5/11)
- Week 13 (5/17~5/21): Robot Navigation and Manipulation
- Week 14 (5/24~5/28): AI Application
  - Interim progress checkpoint (5/28)
- Week 15 (5/31~6/4): AI Application
- Week 16 (6/7~6/11): AI Application
- Week 17 (6/14~6/18): Final Demo
  - Final report and video due (6/18)
- Week 18 (6/21~6/25): Final Demo

*Are these AI*



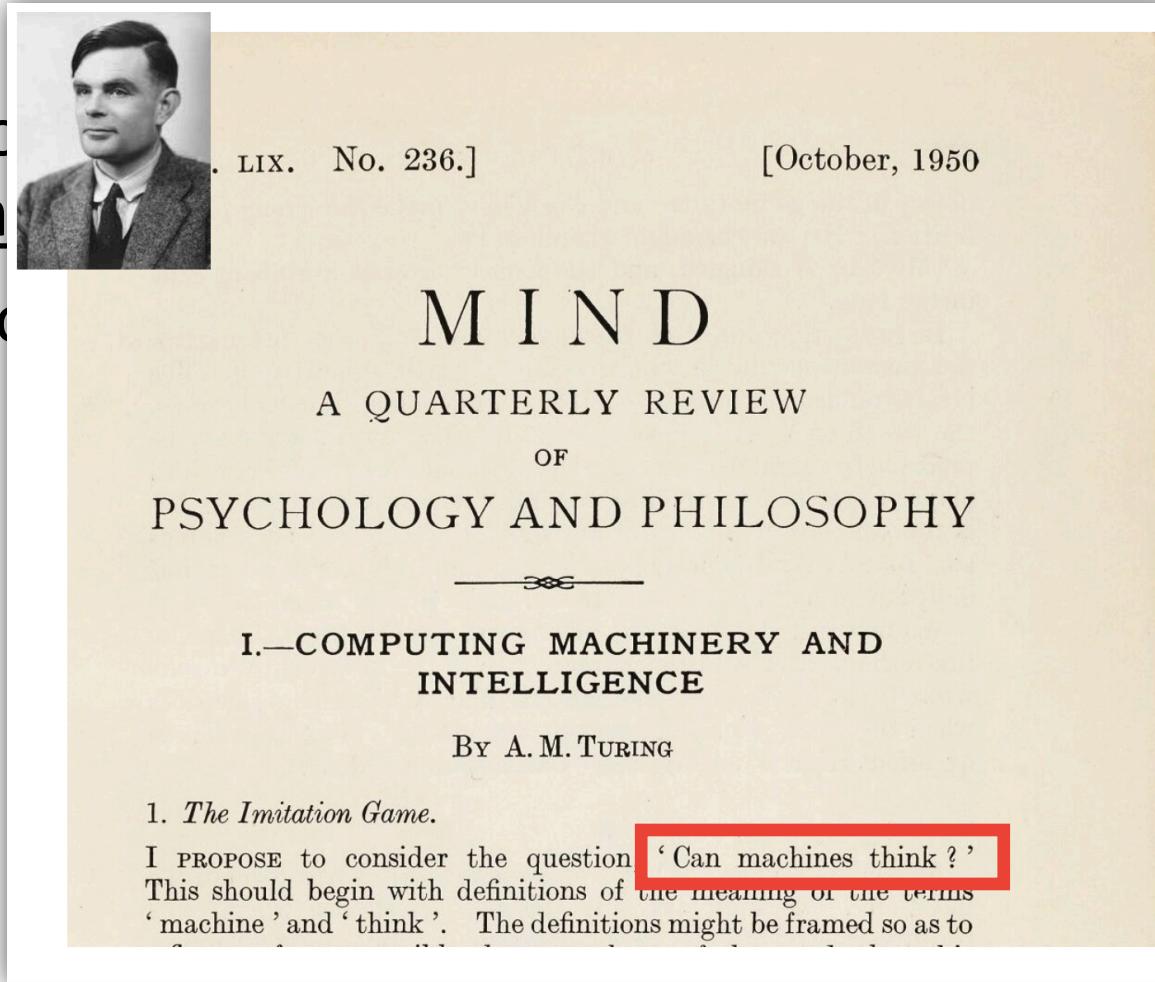
# *History of AI*

**History**  
is WHO we are and  
WHY we are **the way** we are.  
History is not just *the Past*.  
**History** is the **PRESENT**.

<https://www.pinterest.com/pin/395542779755764875/>

# Alan Turing

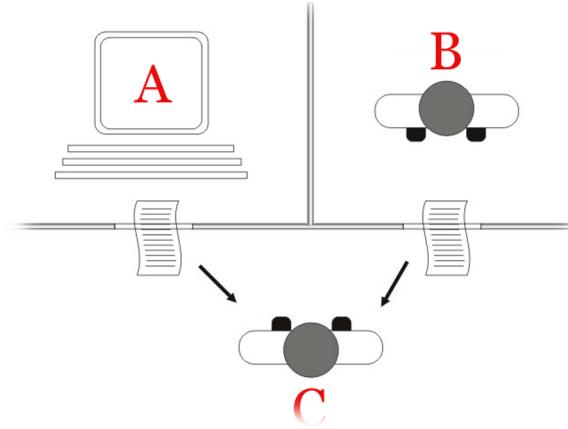
- Wildly being considered as the father of computer science and artificial intelligence
- In 1950, he wrote Machinery and Intelligence



Turing Award  
圖靈獎

[https://en.wikipedia.org/wiki/Alan\\_Turing](https://en.wikipedia.org/wiki/Alan_Turing)

# 1950: Turing Test



“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”

Are there imaginable digital computers which would do well in the *imitation game*?

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

# Movie: The Imitation Game



<http://www.butterflybalcony.com/2016/02/film-fashions-imitation-game.html>

# 1950: Turing Test (Cont.)

- 6 major disciplines in AI emerged because of Turing test:
  - **Natural Language Processing**
    - “Where is Taiwan?”
  - **Knowledge Representation**
    - “represent Taiwan geographically”
  - **Reasoning**
    - “Is the population of Taipei City larger than New Taipei City?”
  - **Machine Learning**
    - Adapt to new environment (e.g., your hometown to Hsinchu)
  - **Computer Vision**
    - Perceive and understand the scene (e.g., we are in a class room)
  - **Robotics**
    - Act in the world (e.g., move around or hold a cup)

# 1950: Turing Test (Cont.)

- 6 major disciplines emerged
  - Natural Language Processing
  - Machine Learning
  - Computer Vision
  - Reasoning
  - Knowledge Representation
  - Robotics

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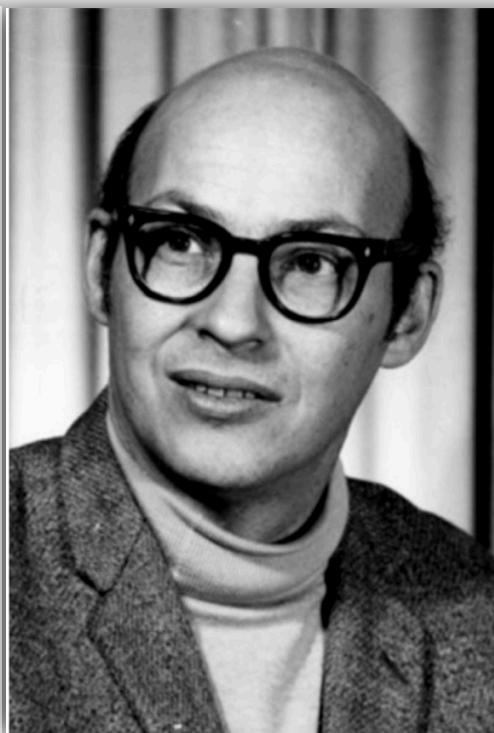
- Game theory
- Cognitive science/neuroscience

# 1955

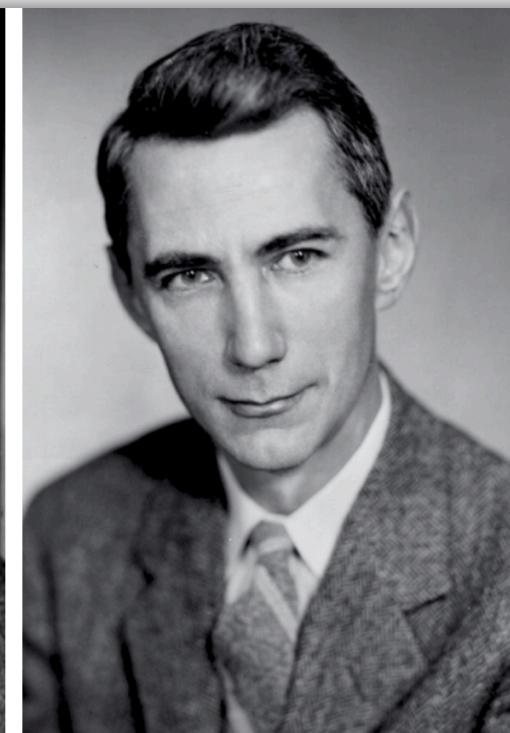
McCarthy “Lacking the focus on the possibilities of computers possessing intelligence”



McCarthy



Young Scientist



Shannon



Rochester

Senior Scientist

# 1955: A Proposal to Rockefeller Foundation

## A PROPOSAL FOR THE DARTMOUTH SUMMER RESEARCH PROJECT ON ARTIFICIAL INTELLIGENCE

J. McCarthy, Dartmouth College  
M. L. Minsky, Harvard University  
N. Rochester, I.B.M. Corporation  
C.E. Shannon, Bell Telephone Laboratories

August 31, 1955

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. We think that a significant advance can be made in one or more of these problems if a carefully selected group of scientists work on it together for a summer.

<http://www-formal.stanford.edu/jmc/history/dartmouth.pdf>

[https://en.wikipedia.org/wiki/John\\_D.\\_Rockefeller](https://en.wikipedia.org/wiki/John_D._Rockefeller)

# 1955: A Proposal to Rockefeller Foundation (Cont.)

Aim for **general principles**:

Every aspect of learning or any other feature of intelligence can be so precisely described that a machine can be made to simulate it

# 1956: Birth of AI

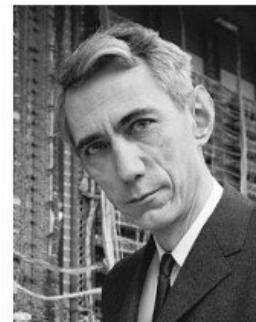
## 1956 Dartmouth Conference: The Founding Fathers of AI



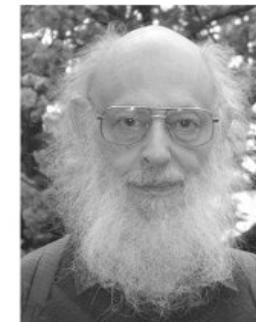
John McCarthy



Marvin Minsky



Claude Shannon



Ray Solomonoff



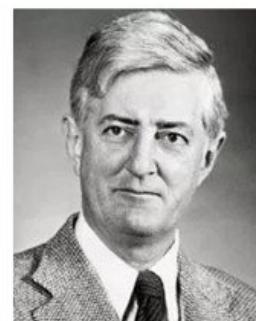
Alan Newell



Herbert Simon



Arthur Samuel



Oliver Selfridge



Nathaniel Rochester



Trenchard More

## A side note...

McCarthy proposed

“We think that a significant advance can be made in one or more of these problems if a carefully selected group of scientists work on it together for a summer.”

60+ years passed... We are still working on AI ;-)

# 1952~1958: Early Successes



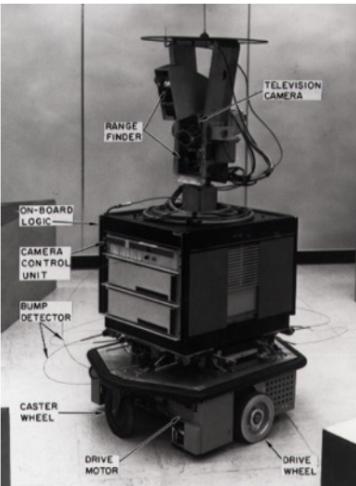
1952 – Arthur Samuel develops checkers program, learns via self-play

1958 – McCarthy LISP, advice taker, time sharing

1958 – Rosenblatt's Perceptron algorithm learns to recognize letters

1968-72 – Shakey the robot

1971-74 – Blocksworld planning and reasoning domain



# First AI Winter

- Too optimistic...
  - “Machines will be capable, within twenty years, of doing any work a man can do.” by Herbert Simon
  - “Within 10 years the problems of artificial intelligence will be substantially solved.” By Marvin Minsky
  - “I visualize a time when we will be to robots what dogs are to humans, and I’m rooting for the machines.” by Claude Shannon
- Promises of AI fall short... so, the cut of funding...
  - Write grant proposals to agencies
  - US: NSF, DARPA, US Armed Forces, NIH, and ...
  - TW: 科技部

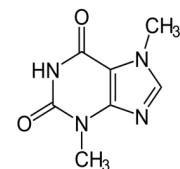


# Why they fail?

- Search algorithms play essential roles before the first AI winter
- Problems
  - **Limited computation**: search space grow exponentially
  - **Limited information**: complexity of real-world problems (e.g., number of words, objects, concepts in the world)

# 1970s~1980s: Knowledge-based Systems

- Expert systems: Encoding domain expert knowledge as logical rules
  - Combat limitations in the previous era
  - Building narrow practical systems in targeted domains instead of general principles in 50s and 60s



DENDRAL: infer molecular structure from mass spectrometry

- Real impacts:



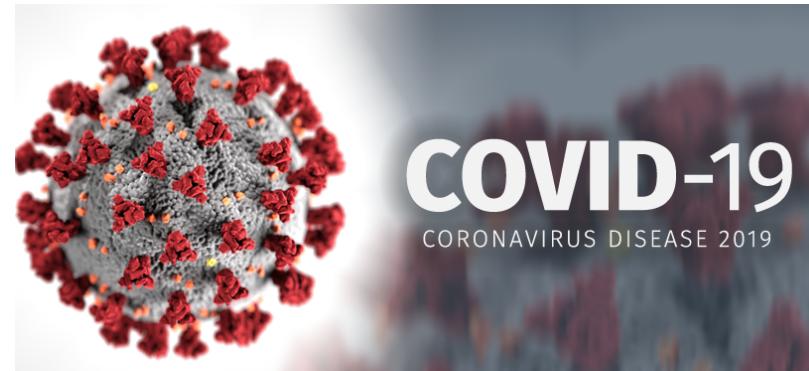
MYCIN: diagnose blood infections, recommend antibiotics



XCON: convert customer orders into parts specification;  
save DEC \$40 million a year by 1986

# Second AI Winter...

- These systems failed again...
- Why?
  - Requires significant amount of manual effort to **create and maintain rules**
  - Real situations are not composed of if-else rules, modeling **uncertainty**
    - E.g, COVID-19 testing

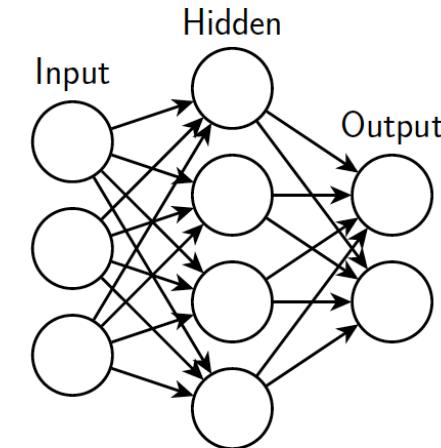


# After the Second “AI” Winter

- AI research split into subfields: machine learning, computer vision, natural language processing, robotics, multiagent systems, and so on...
- We will cover some of these topics in this semester

# Artificial Neural Network

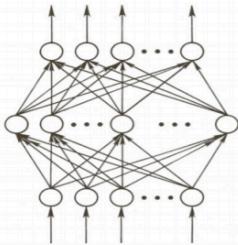
- 1943: McCulloch and Pitts
  - Inspired by the brain composed of neurons
- 1957: Rosenblatt's Perceptron algorithm learns to recognize letters
  - learn from data
  - general direction for tackling failures in second AI winter
- 1969: Minsky and Papert's "Perceptrons" book indicates that linear models could not solve **XOR**, killed neural network research



Credit: Stanford CS221 Note

# Back to the 80s...

## Training networks



1986: popularization of backpropagation for training multi-layer networks (Rumelhardt, Hinton, Williams)

5	0	4	1	1	9	2	2
3	5	3	6	1	7		
4	0	9	1	1	2		
3	8	6	9	0	5		
1	8	7	9	3	9		
3	0	7	4	9	8		

1989: applied convolutional neural networks to recognizing handwritten digits for USPS (LeCun)

# Turing Award 2018



<https://awards.acm.org/about/2018-turing>

# Recent “AI” Boom

- Driven by Deep Neural Networks, and
  - + Big Data
  - + Computing (GPUs)
  - + Note: **deep learning**  $\neq$  AI
- Tremendous real-world impacts!
- Rome wasn't built in a day...



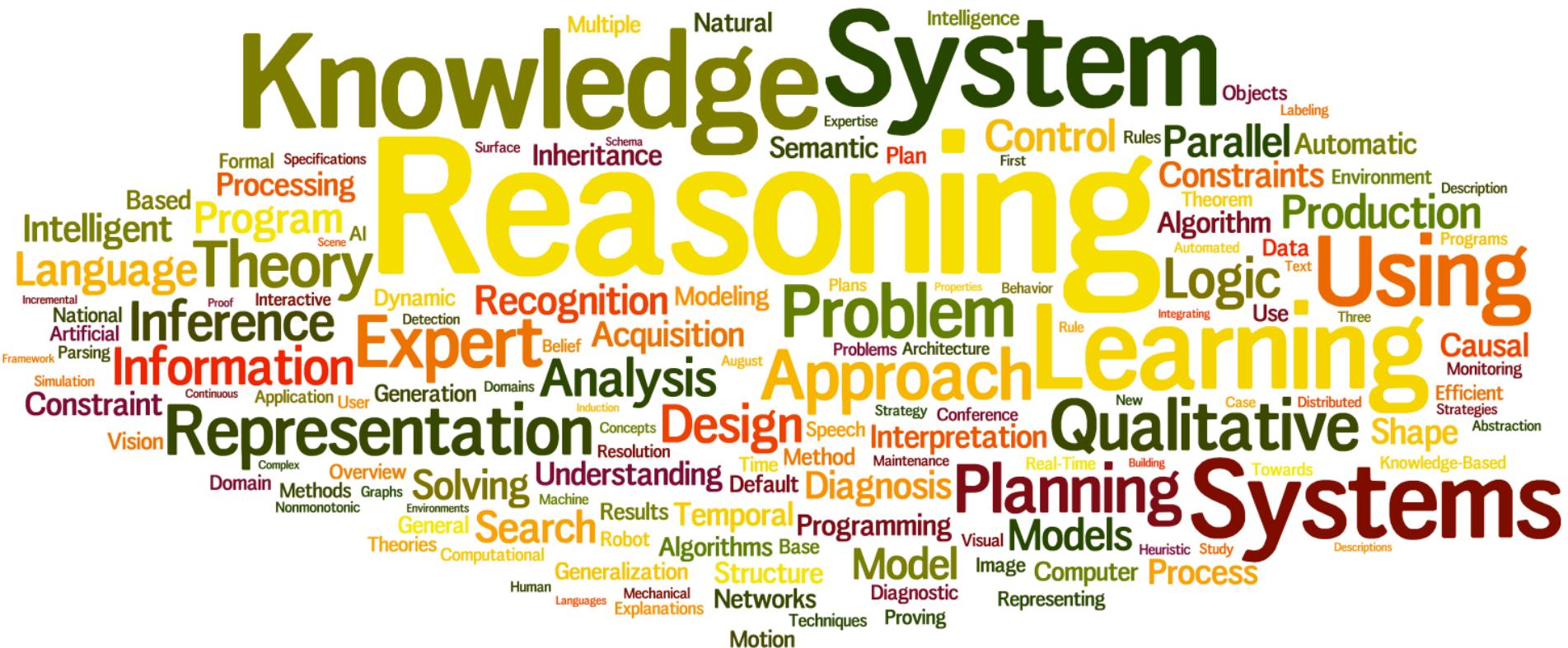
# What is Artificial Intelligence?

# Movies



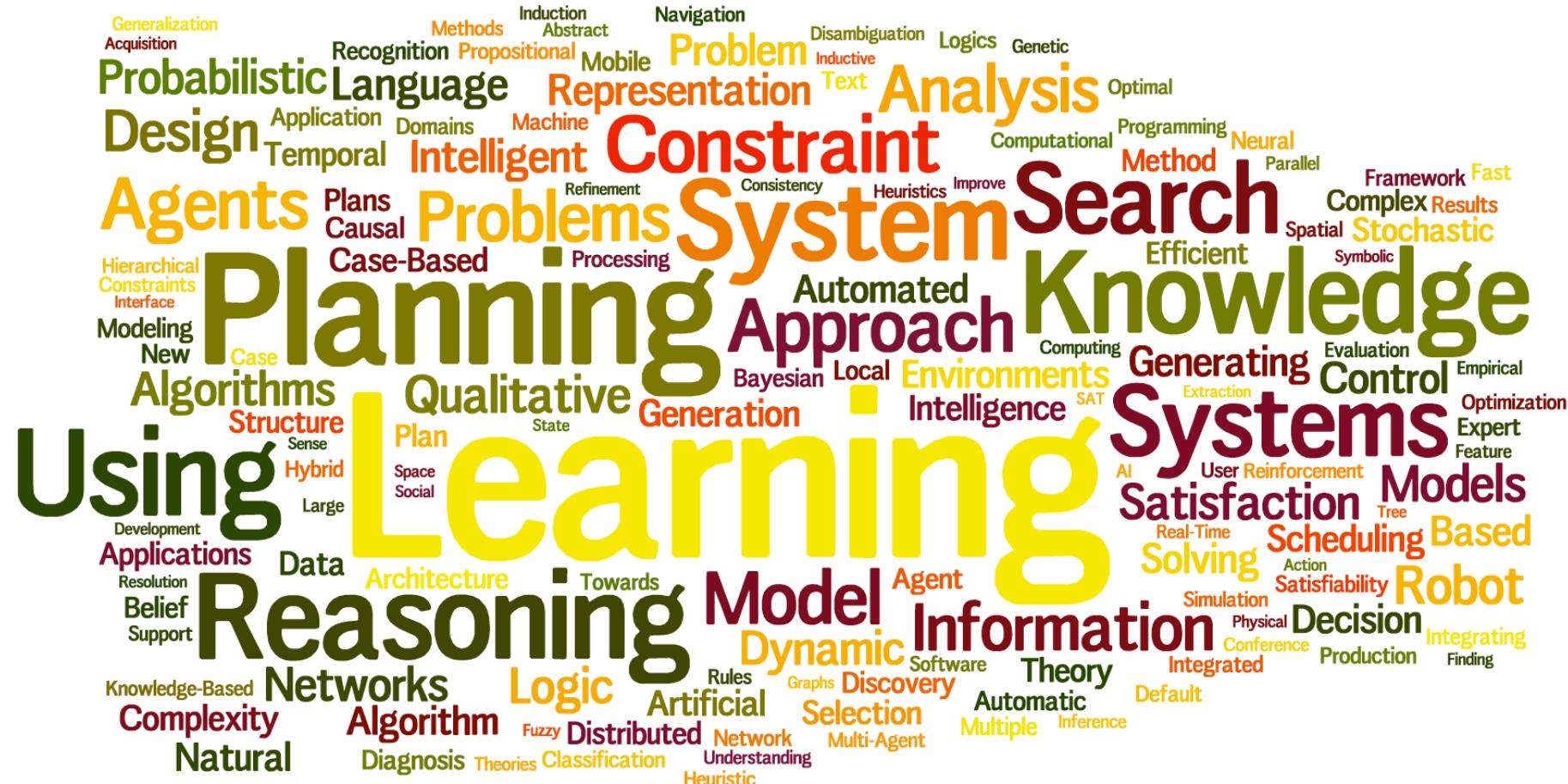
Credit: CMU 15-381 Note

# Paper titles in AAAI



1980s

# Paper titles in AAAI



1990s

# Paper titles in AAAI



2000s

# Paper titles in AAAI



2010s

# Classic Definitions

Build computers that

## **Think like a human**

- Cognitive science/neuroscience

## **Think rationally**

- Logic and automated reasoning

## **Act like a human**

- Turing test

## **Act rationally**

- Basis for intelligence agents framework

# Classic Definitions

Build computers that

## **Think like a human**

- Cognitive science/neuroscience
- Can't there be intelligence without humans?

## **Think rationally**

- Logic and automated reasoning
- Not all the problems can be solved by reasoning

## **Act like a human**

- Turing test
- “What is  $1228 \times 5873$ ?” ... “I don’t know, uhh, I’m just a human...”

## **Act rationally**

- Basis for intelligence agents framework

# AI as Computational Rationality

- **Machines** are intelligent to the extent that their **actions** can be expected to achieve **their** objectives
  - Autonomous agent:
    - Self-driving vehicles: reach destinations **safely**
    - Robot 'dog' (Boston Dynamics): acting as a solider in wars
  - Tool:
    - Parking lot monitoring systems: **minimize** man powers and **control** traffic flow
    - Recommender systems: **keep** your eyes on Netflix!!!

# What's next for AI?





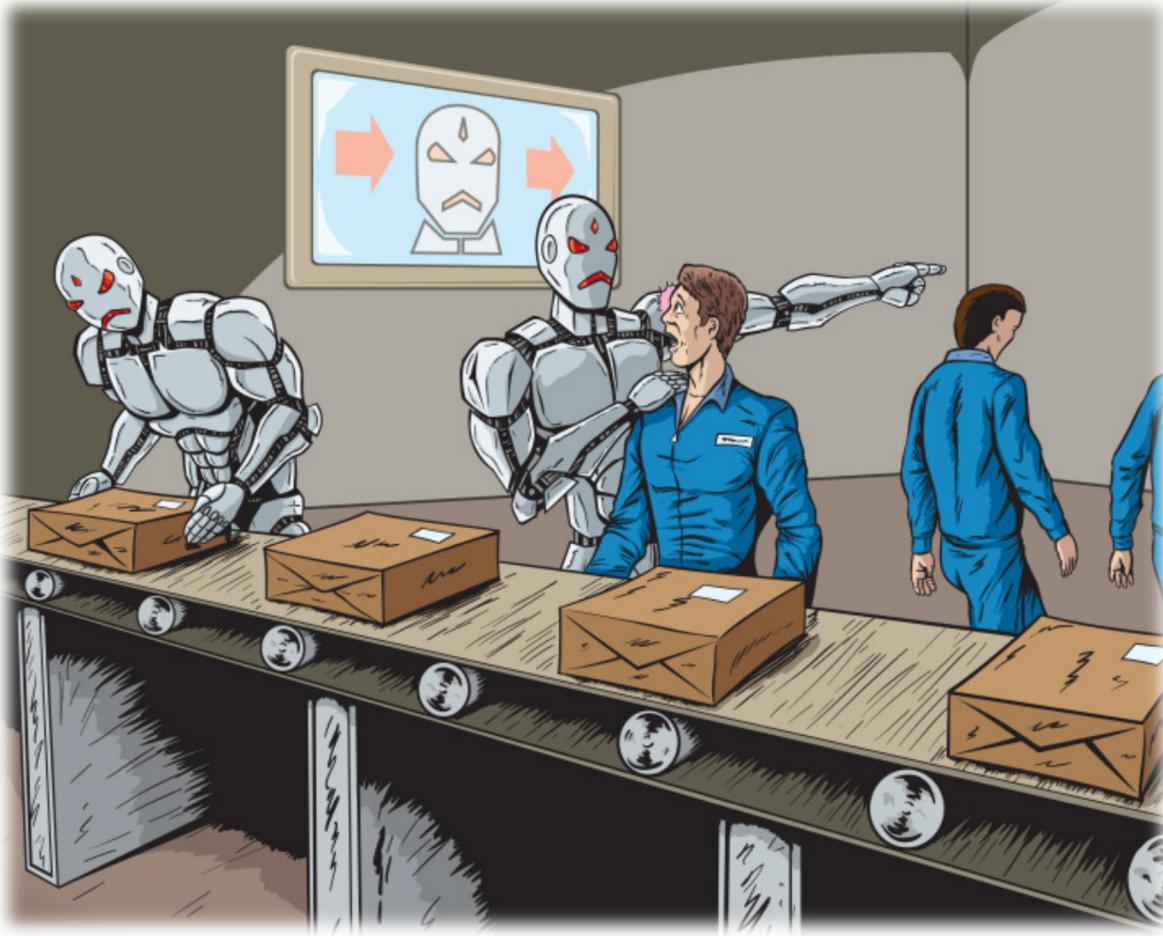
~50%

Of all current work activities can theoretically be automated now.

*McKinsey, 2017*



# Replace?



# Fake Videos...



<https://www.youtube.com/watch?v=AmUC4m6w1wo>

# Biases in AI

Jul 1, 2015, 01:42pm EDT

## Google Photos Tags Two African-Americans As Gorillas Through Facial Recognition Software



Maggie Zhang Forbes Staff

Tech

*I write about technology, innovation, and startups.*

### 1. Racism embedded in US healthcare

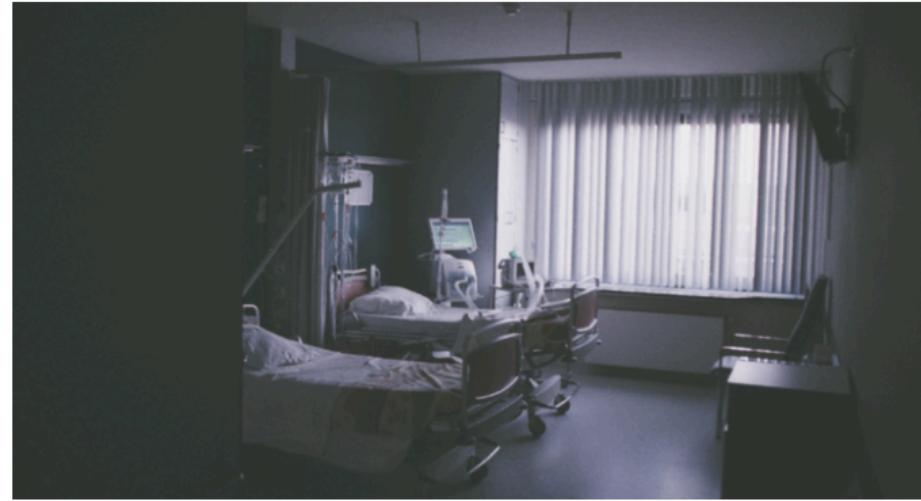


Photo by [Daan Stevens](#) on [Unsplash](#)

“predict which patients would likely need extra medical care heavily favored white patients over black patients.”

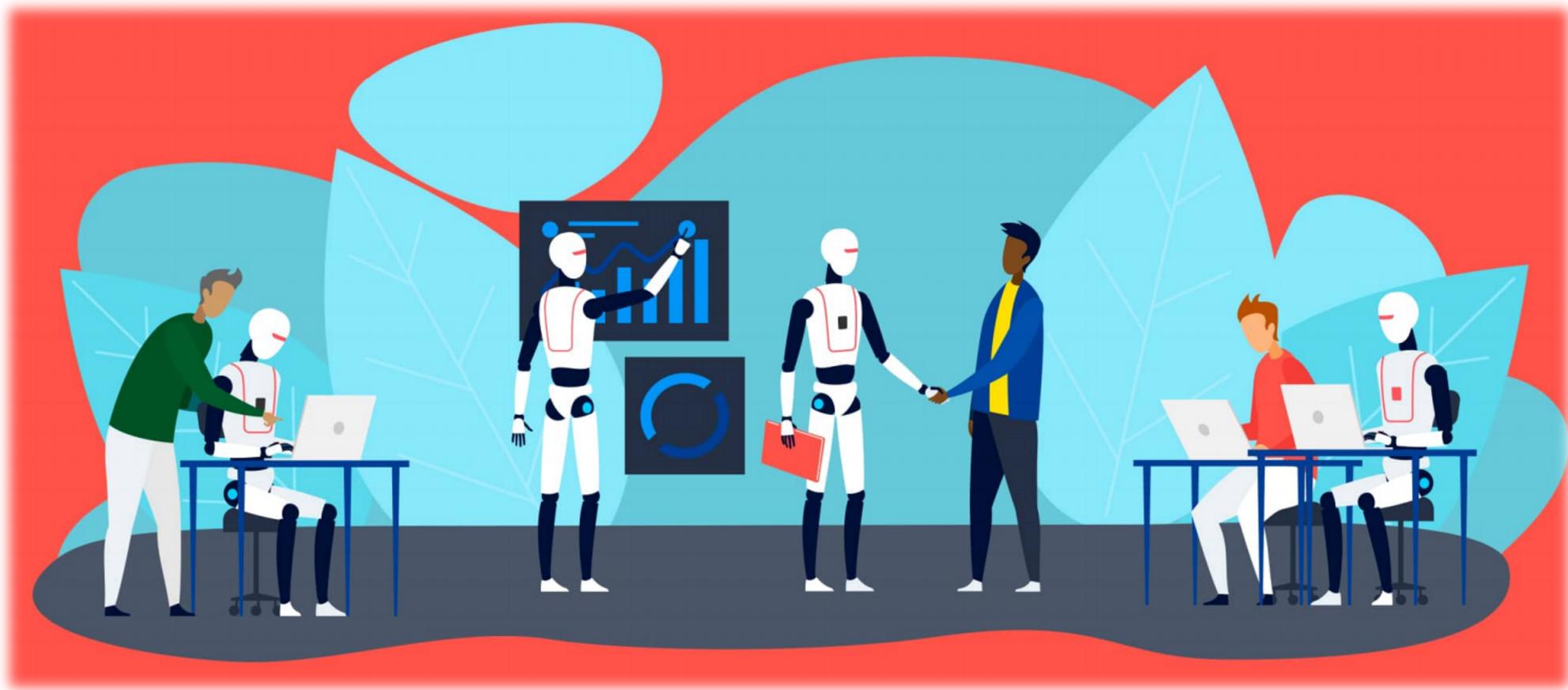
While machine learning algorithms are based on mathematical principles, where is the training data from?

# Human Compatible AI

- Machines are intelligent to the extent that their actions can be expected to achieve their objectives
- Machines are beneficial to the extent that their actions can be expected by human's objectives

[https://en.wikipedia.org/wiki/Human\\_Compatible](https://en.wikipedia.org/wiki/Human_Compatible)

# Augment Human Decision Making?



# Takeaway

- “AI” applications are around us
  - Recent AI boom is largely driven by corporate efforts (actual deployment)
- History of AI
  - Rome was not built in a day!
  - AI has been there for decades
- What is AI?
  - Many definitions have been explored
- What’s next?
  - Is human compatible AI the next? What else?
  - It is a good time to think about it!

# Any Questions?