

Elements of Artificial Intelligence

CS B551
Fall 2022

You can join today's class remotely via Zoom room:
<https://iu.zoom.us/j/343780386>



Facebook's Facial Recognition 'Approaching Human-Level Performance'

New computer program first to recognize sketches more accurately than a human



A Computer Can Recognize Emotions Better Than Most People

Google's AlphaGo Defeats Chinese Go Master in Win for A.I.

Example of AI in generating natural text

The screenshot shows the OpenAI Playground interface. On the left, there's a sidebar titled "Get started" with instructions on how to use the API and some "KEEP IN MIND" tips. The main area is titled "Playground" and contains a text input field with the prompt: "What should I talk about in my first lecture in a course named elements of artificial intelligence?". To the right of the input field are various configuration options for the AI model, including "Mode" (set to text-davinci-002), "Temperature" (0.7), "Maximum length" (256), "Stop sequences" (empty), "Top P" (1), "Frequency penalty" (0), and "Presence penalty" (0). At the top of the playground area, there are buttons for "Load a preset...", "Save", "View code", "Share", and "...".

Try it at home: <https://beta.openai.com/playground>



Get started



Enter an instruction or select a preset, and watch the API respond with a completion that attempts to match the context or pattern you provided.

You can control which model completes your request by changing the model.

Keep in mind

- Use good judgment when sharing outputs, and attribute them to your name or company. [Learn more](#).

- Requests submitted to our models may be used to train and improve future models. [Learn more](#).

- Our default models' training data cuts off in 2021, so they may not have knowledge of current events.

Playground

What should I talk about in my first lecture in a course named elements of artificial intelligence?

Some possible topics for a lecture on elements of artificial intelligence include:

- What is artificial intelligence?

- The history of artificial intelligence

- How artificial intelligence is used today

- The future of artificial intelligence

- Ethical considerations with artificial intelligence



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Playground

...

What should I talk about in my first lecture in a course named elements of artificial intelligence?

In your first lecture, you should provide an overview of the course and what students can expect to learn. You should also introduce the basic concepts of artificial intelligence, including its history, definition, and applications.

What exactly should I say?

This is just a general outline, so you will need to fill in the specific details. However, in your first lecture, you should cover the following topics:

- The history of artificial intelligence and its key milestones
- The definition of artificial intelligence
- The different types of artificial intelligence
- The applications of artificial intelligence in the real world

Can you elaborate on each of these topics?

- The history of artificial intelligence: You should discuss the early days of AI research and some of the key milestones that have been reached.
- The definition of artificial intelligence: You should provide a working definition of AI and explain how it differs from other forms of intelligence.
- The different types of artificial intelligence: You should introduce the concept of strong AI and weak AI, and discuss the different approaches to AI.
- The applications of artificial intelligence: You should give some examples of how AI is being used in the real world, such as in healthcare, finance, and manufacturing.



2+

152

Inject restart text

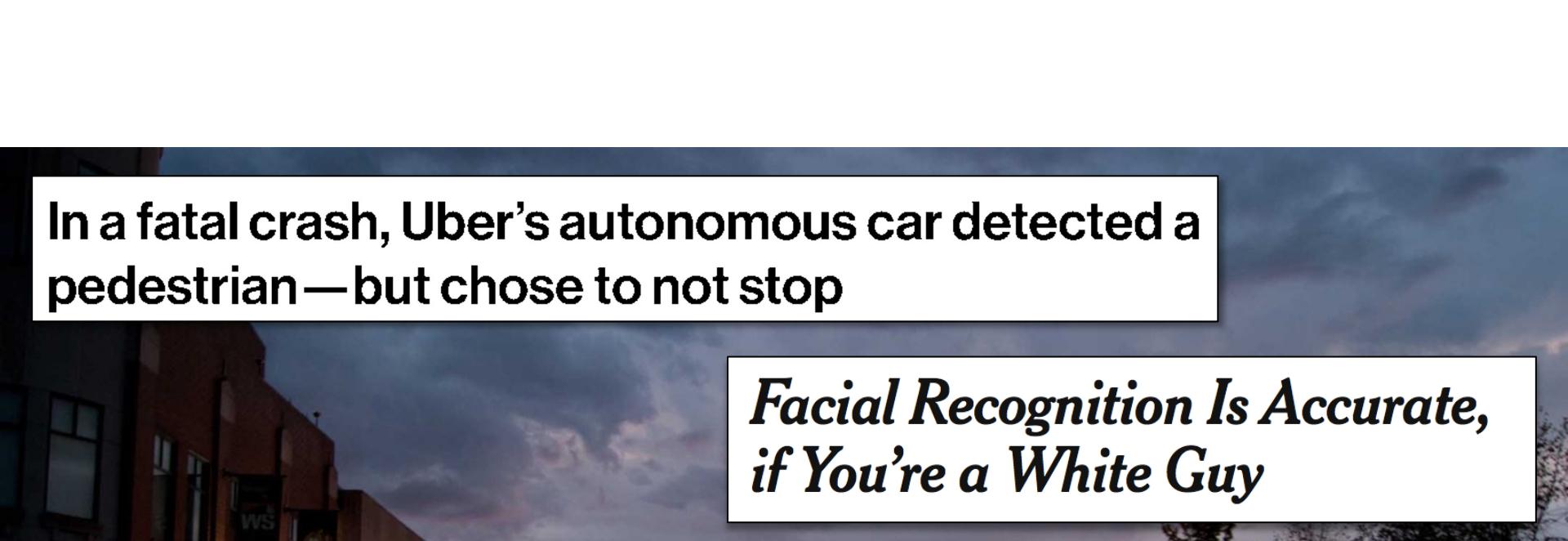


Mode



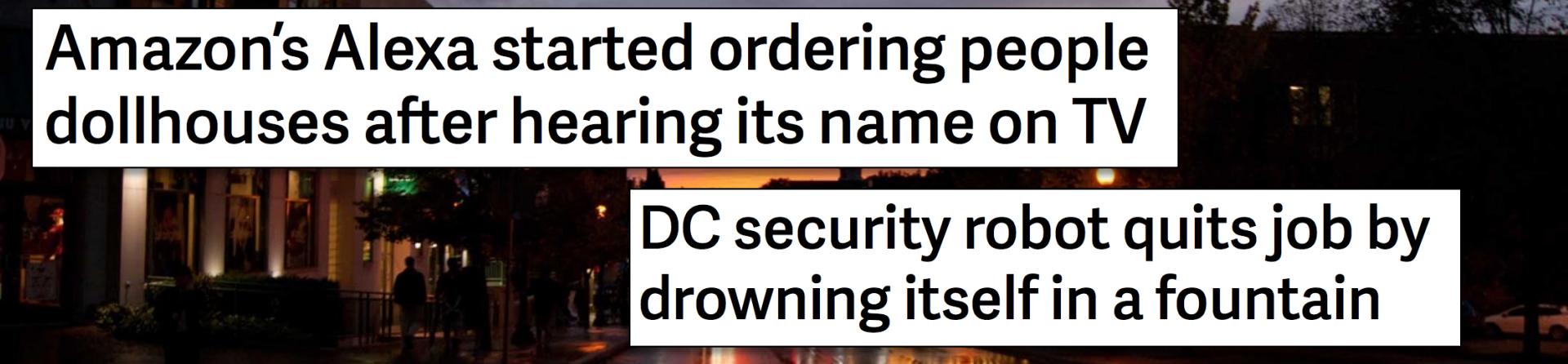
Model

Temperature Maximum length Stop sequences
Enter sequence and press TabTop P Frequency penalty Presence penalty Best of



In a fatal crash, Uber's autonomous car detected a pedestrian—but chose to not stop

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



Amazon's Alexa started ordering people dollhouses after hearing its name on TV

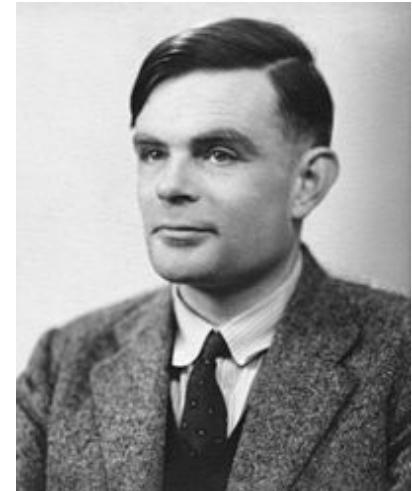
DC security robot quits job by drowning itself in a fountain

Today

- Brief history of AI
- Instructor introduction and course info
- Intro to AI: high-level overview of some definitions in AI

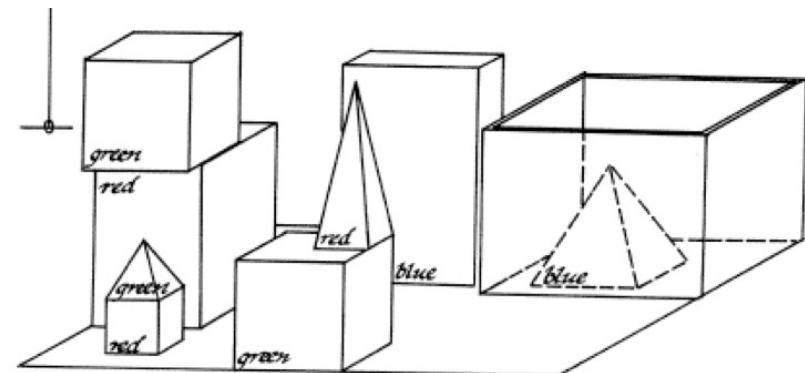
1950's: Beginnings

- **1950:** Alan Turing speculates about machine intelligence, proposes Turing Test
- **1955:** Newell & Simon unveil the Logic Theorist to prove theorems automatically; introduce form of Lisp
- **1956:** Dartmouth Conference introduces term Artificial Intelligence; participants include Shannon, Minsky, McCarthy, etc.



1960's: Progress & optimism

- AI as search through huge spaces
 - Techniques for heuristic search, e.g. branch & bound (1960), alpha-beta pruning (1963), A* search (1968)...
- Artificial neural networks
 - Using perceptrons (1957); much excitement about their potential power
- Fuzzy logic (1965)
 - To model uncertainty
- Micro-worlds
 - E.g. Sussman's “Block world” in computer vision



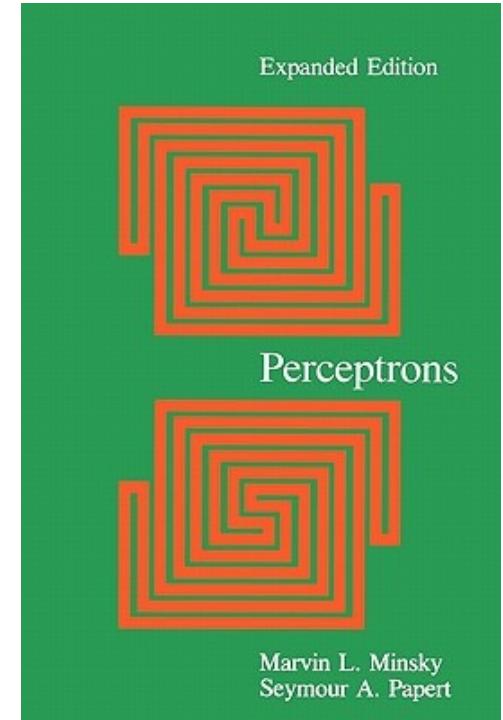
Enthusiasm – 1960's

- 1958 – “Within 10 years a digital computer will be the world’s chess champion” (Newell)
- 1965 – “Machines will be capable, within 20 years of doing an work a man can do” (Simon)
- 1970 – “In 3-8 years we will have a machine with the general intelligence of an average human being” (Minsky)



1970's: Decline and the “AI Winter”

- **1969:** Minsky's book *Perceptrons* proves limitations of neural networks
- **1971-2:** Cook's and Karp's NP-completeness papers show many problems are simply intractable
- Overly optimistic predictions of the 60's don't materialize; Funding agencies lose faith in AI



1980's: Rise from the ashes

- **Resurgence of neural networks**, with multi-layer networks and the backpropagation algorithm
- Much work in **Knowledge-based systems** that try to represent and capture knowledge
- **Expert systems** apply rules defined by human experts to solve problems
 - Many companies see these as the future and invest lots of money in developing them...

Early 1990's: Another crash

- Expert systems very difficult to maintain
 - Difficult to manage huge knowledge bases
 - Suffer from “brittleness:” Systems gave non-sensical answers for no easily-explained reasons

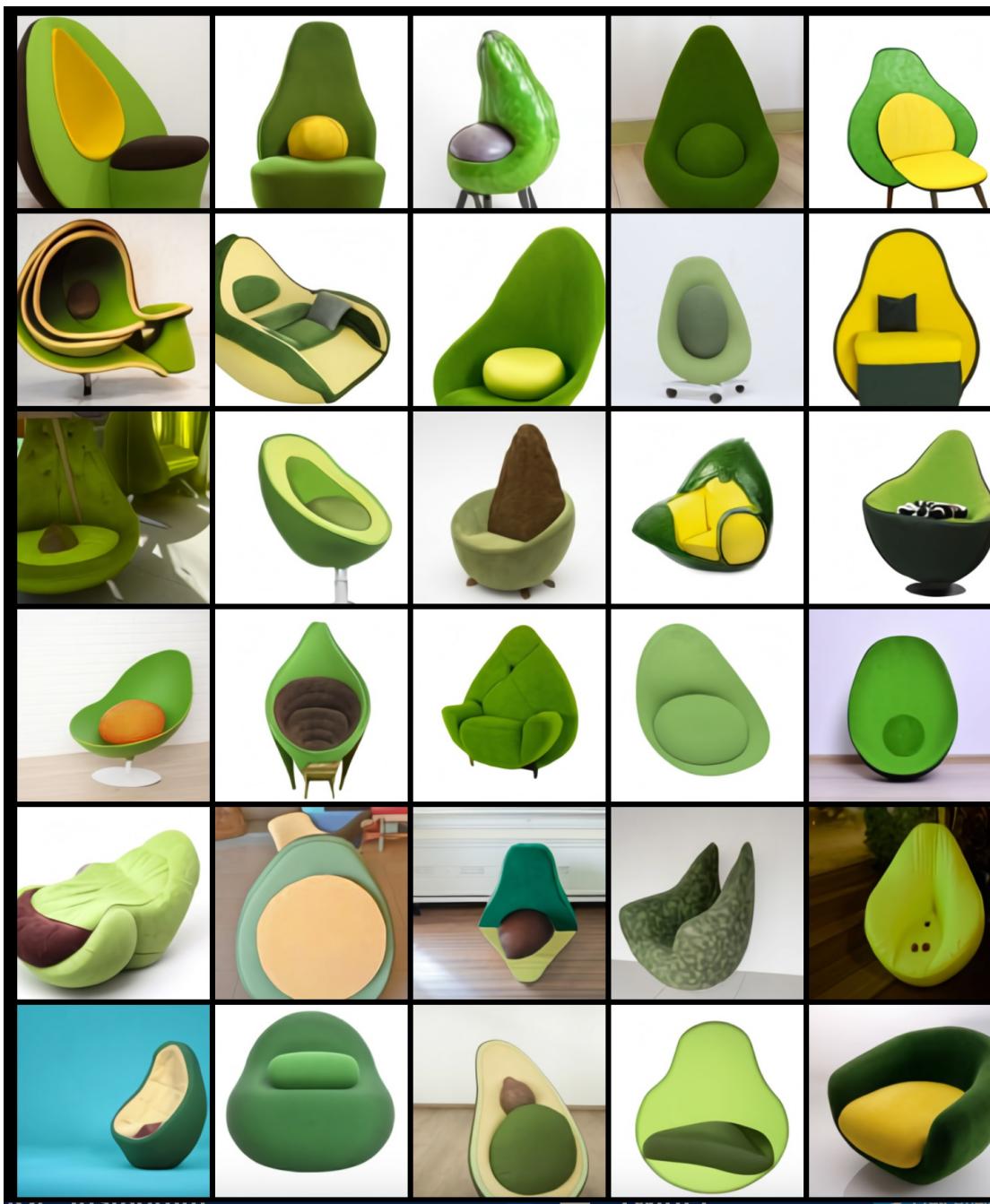
Mid 1990's to 2000's

- **Greater math sophistication**, connecting AI problems to other domains
 - “Revolutionary” (Norvig & Russell)
 - Connections to optimization, probabilistic and statistical models, information theory, etc.
- Focus on **more concrete, less ambitious goals**
 - Less interest in biology-inspired techniques, more about techniques that seem to work in practice
- **Moore's law** makes hard problems more tractable

2010 – present: Big Data

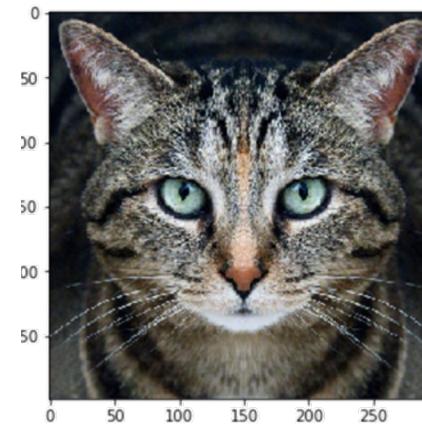
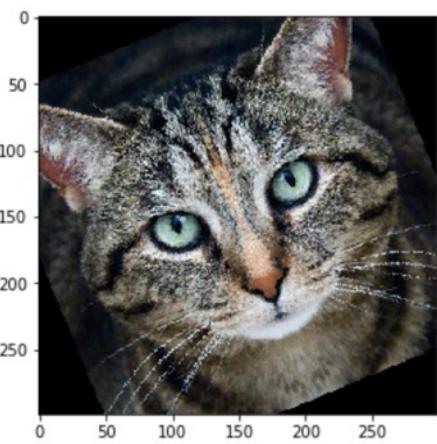
- Data-driven techniques
 - Focus on problems where massive datasets can (appear to) solve AI problems cheaply
- Re-emergence of artificial neural networks
 - Of unprecedented size and complexity
- Deep learning
 - Features learned automatically, not designed by human experts

TEXT PROMPT: an armchair in the shape of an avocado. an armchair imitating an avocado.



TEXT PROMPT: a professional high quality lovestruck cup of boba







$+ \epsilon$



=



“panda”

57.7% confidence

“gibbon”

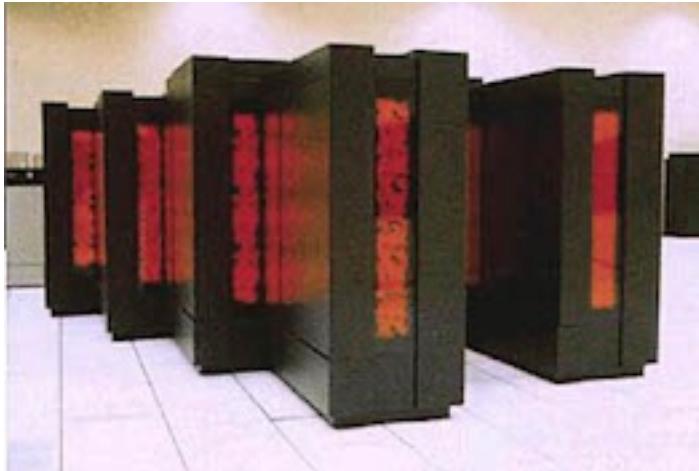
99.3% confidence



a spoon and big blue bowl of fruit
sitting on a table with a laptop in
the background



a man is holding a cat in his mouth



Elements of Artificial Intelligence

CS B551
Fall 2021

Instructor



Dr. Zoran Tiganj

Lead Associate Instructors



Sahaj Maini Singh



Yunchen Liu

Associate Instructors



TBA



TBA



TBA



TBA

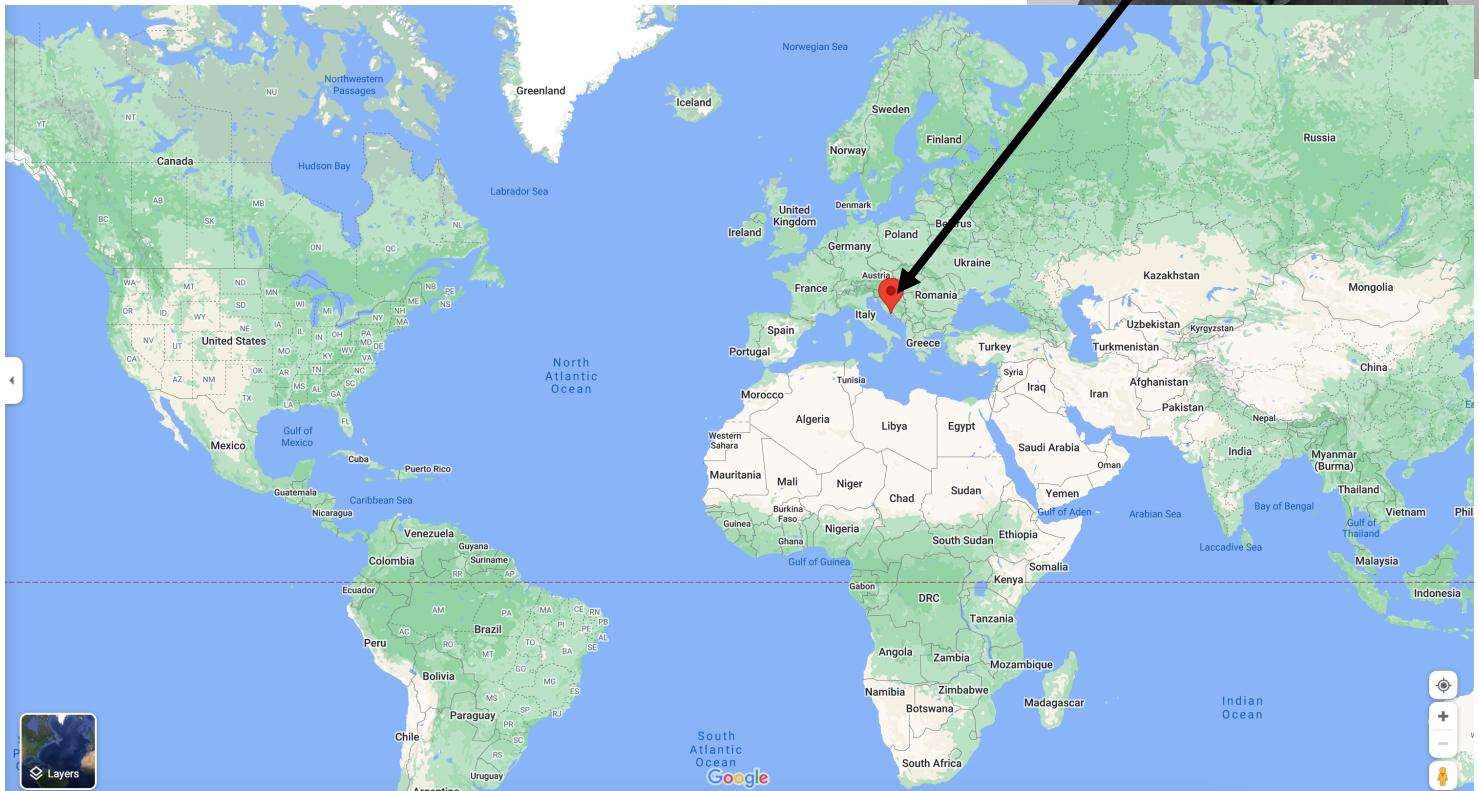
Contacting us

- We're here to help! To get a reply as quickly as possible:
 - For questions about the class, assignments, etc, please use Q&A Community, via Canvas
 - For less formal social interactions, group discussions, etc, please use Slack: **b551-res-fall22.slack.com**
 - For questions related to you specifically: message us through Canvas (direct your message to Teachers and Teaching Assistants).
 - For private personal matters email ztiganj@iu.edu

Instructor

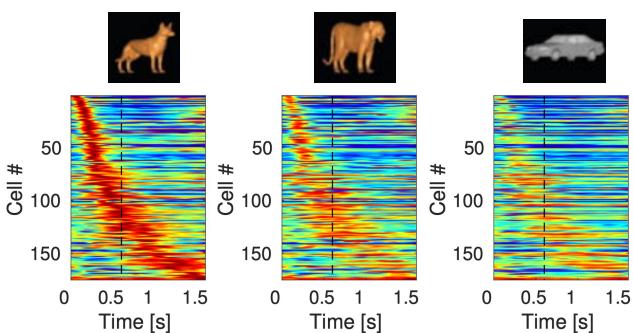
- Zoran Tiganj
 - Joined IU, in January of 2020
 - Assistant Professor
 - Computer Science, School of Informatics, Computing and Engineering (SICE)
 - Also affiliated with Department of Psychological and Brain Sciences
 - Program in Cognitive Science
 - Program in Neuroscience
 - Program in Data science
 - Previous:
 - Postdoc/Research Scientist at Boston University, Department of Psychological and Brain Sciences 2013-2019
 - Postdoc and University of Versailles, France
 - PhD in Computer Science from INRIA, France, 2011
 - MS in Electrical Engineering from University of Zagreb, Croatia, 2008
 - Homepage: <https://homes.luddy.indiana.edu/ztiganj>
 - Email: ztiganj@iu.edu
 - Main research interests:
 - Cognitively inspired Artificial Intelligence
 - Machine learning applied on neural (brain) recordings

Instructor



Zoran's research

Electrophysiological recordings to test mechanistic hypotheses



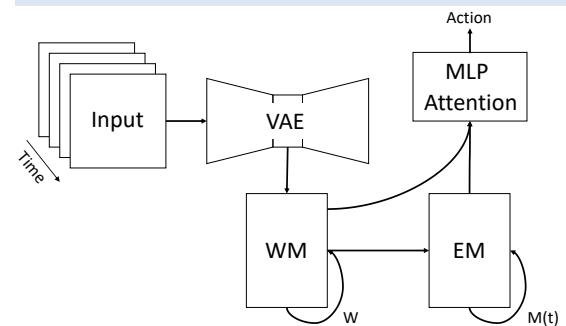
Neuroscience

Mental maps

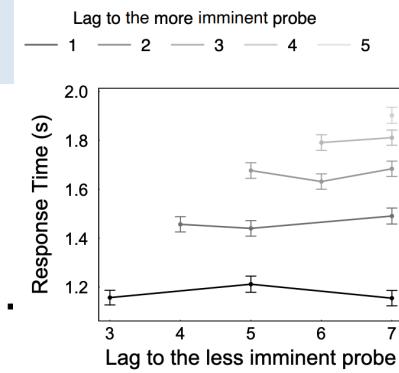
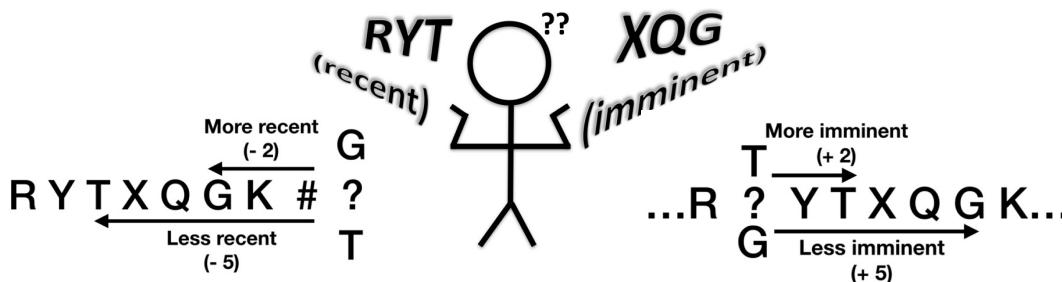
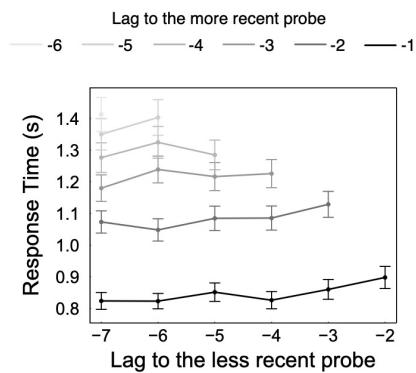
Cognitive Science

Artificial Intelligence

Constructing AI systems capable of lifelong self-supervised learning



Behavioral data provide insights into how people store memory and how they use it to predict the future



Course mechanics

- Syllabus, schedule, assignments, announcements, etc. on IU Canvas
 - <http://canvas.iu.edu/>
- Meetings:
 - Monday and Wednesday, 6:30pm-7:45pm
 - We will (try to) livestream the class via zoom and post the recordings on Canvas
- Textbook:

Norvig & Russell, *Artificial Intelligence: A Modern Approach*, 2009.
(Later version fine but not needed)

Prerequisites

- C343 or equivalent
- Practically, this means:
 - Proficiency in a general-purpose programming language
 - Some level of mathematical maturity will be helpful, esp. with calculus, linear algebra, statistics
 - Willingness to learn some programming and/or math on your own if necessary

Grading

- 40% Assignments (~5)
 - Mostly programming, in Python
 - Typically in small groups
 - 48 hour extensions allowed with 10% grade penalty
- 20% Attendance, in-class/online activities and quizzes
- 15% Midterm exam
- 25% Final exam

Academic integrity

- Read and understand the AI policy on syllabus
- We will look for and prosecute AI violations
- Be especially careful with homework assignments
 - You may discuss homework problems at a high level (e.g. general strategies for solving problems), but you may not share code (unless within your group)
 - If you use ideas or code from another source (like a webpage or textbook) you **must** acknowledge the source in your submission

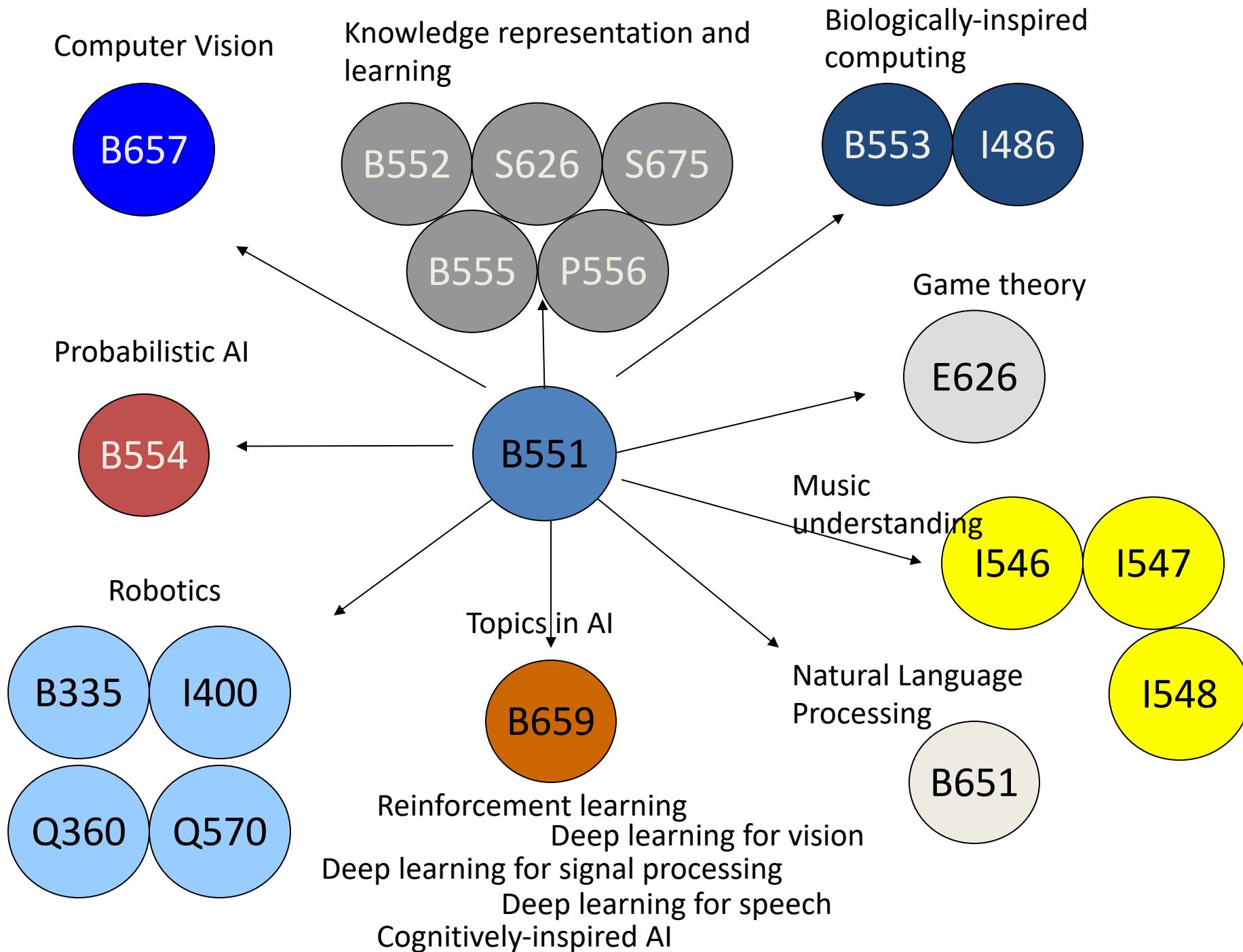
Course overview (tentative)

- AI goals, history, background
- Heuristic search and applications
 - A*, local search, constraint satisfaction problems...
- Representing and reasoning about uncertainty
 - Probabilistic models, Bayesian networks, inference...
- Logic and logical inference
- Machine learning
 - Neural networks, Support Vector Machines...
- Applications
 - Computer vision, natural language processing...

See syllabus for more information!

Why take this class?

- Learn a lot about Artificial Intelligence



Careers in AI



- 'Pure' AI
 - Academia, industry labs
- Applied AI
 - Almost any area of CS!
 - NLP, vision, robotics
 - Economics
- Cognitive Science



Microsoft®
Research

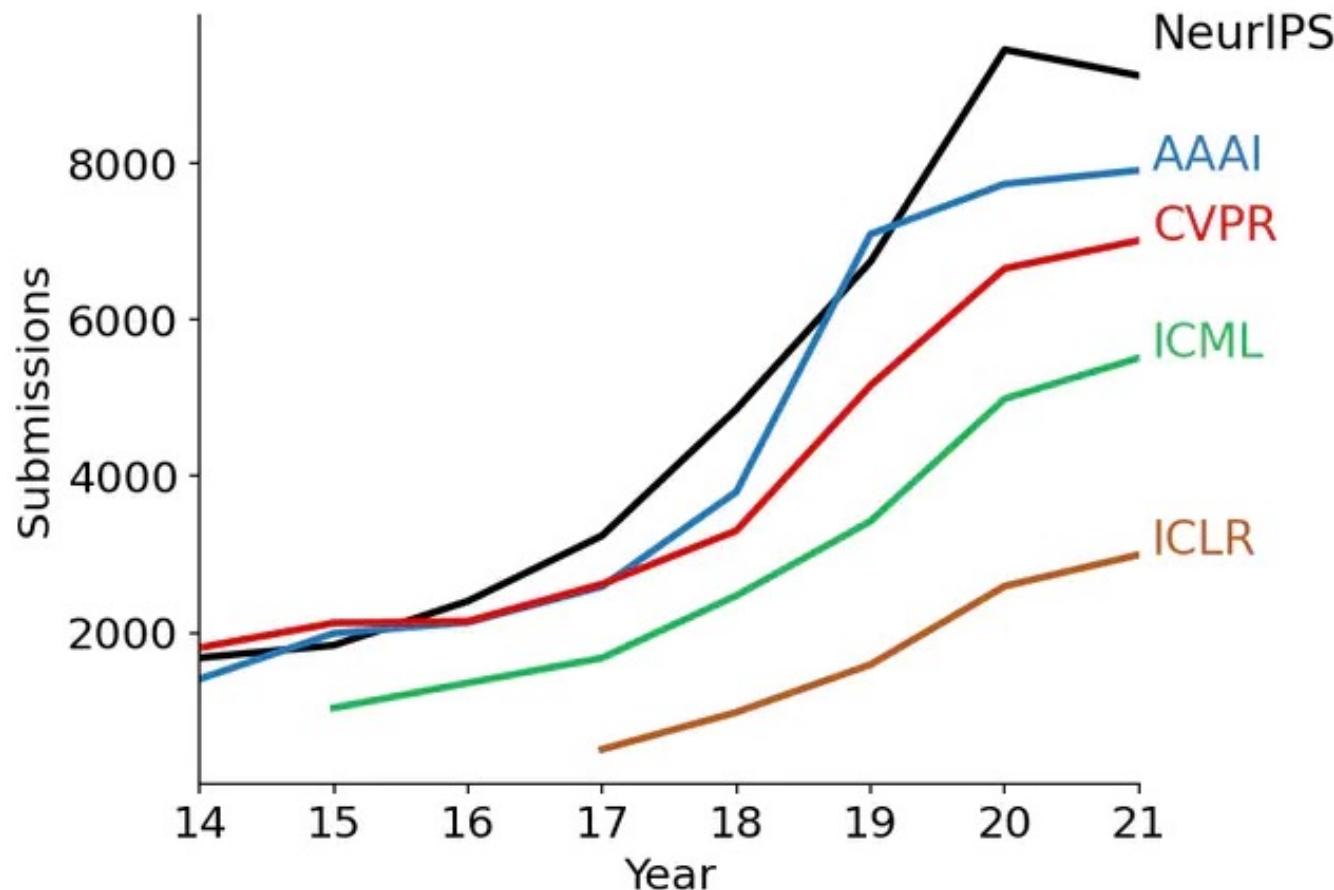


iRobot®
voxware 



Google™

Growth of research in AI



Why take this class?

- Learn a lot about Artificial Intelligence
- Learn a little about lots of other areas!
 - Machine learning, linguistics, cognitive science, statistics, psychology, ...
- Practice CS and math skills
 - Programming, data structures, algorithms, linear algebra, graph theory, probability, ...
- Fun (?) applications and projects!

What is AI?

- AI is the reproduction of **human reasoning and intelligent behavior** by computational methods

What is AI?

- AI is *an attempt at* reproduction of **human reasoning and intelligent behavior** by computational methods

What is AI?

- Discipline that systematizes and automates reasoning processes to create machines that:

Think like humans	Think rationally
Act like humans	Act rationally

Think like humans	Think rationally
Act like humans	Act rationally

- The goal of AI is: to build machines that operate in the same way that humans think
- But how do humans think?
 - Cognitive Science: Build machines according to theory, test how behavior matches mind's behavior
- Is this even possible?
 - Different hardware: Digital computers, analog minds

Think like humans	Think rationally
Act like humans	Act rationally

- The goal of AI is: to build machines that ~~operate~~ perform tasks ~~in the same way that humans think~~ in a way similar to an intelligent human
- I.e. Take a hard task that people do well, and build a computer system to do it automatically
- But do we want to duplicate human imperfections?



Think like humans	Think rationally
Act like humans	Act rationally

- The goal of AI is: to build machines that ~~perform tasks in a way similar to an intelligent human~~ make the “best” decisions given current knowledge and resources
- Best based on some **utility function**
 - Based on some model and assumptions of the world
- How do self-consciousness, hopes, fears, etc. impact intelligence?

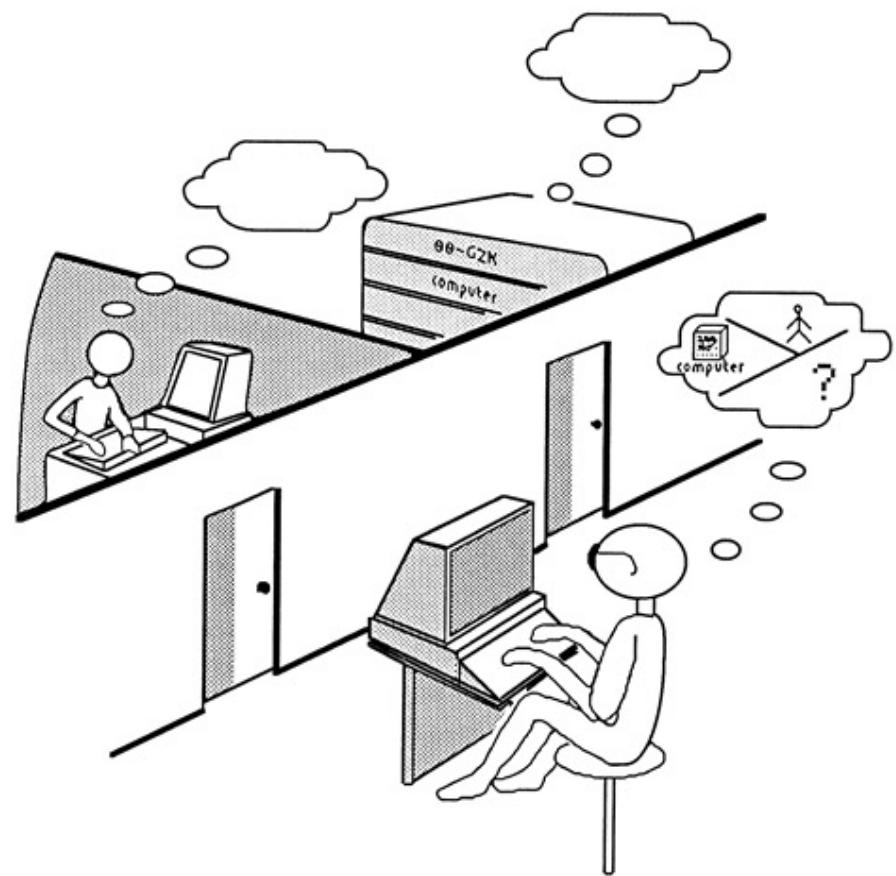
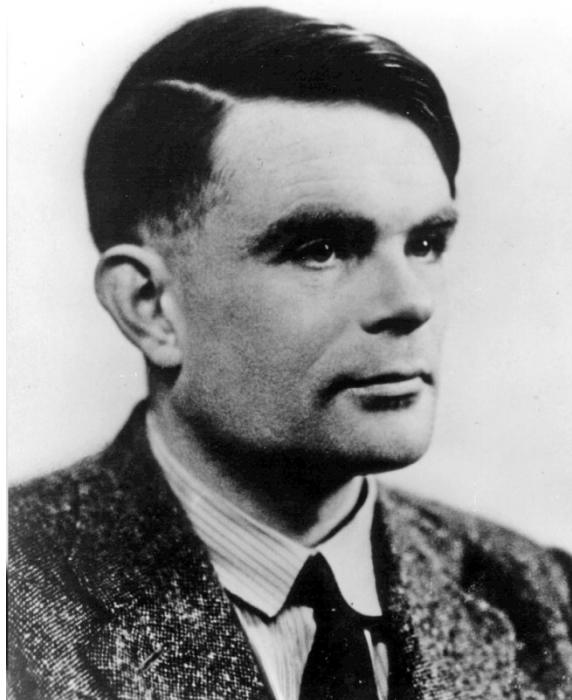
What is Intelligence?

“If there were machines which bore a resemblance to our bodies and imitated our actions as closely as possible for all practical purposes, we should still have two very certain means of recognizing that they were not real men. The first is that they could never use words, or put together signs, as we do in order to declare our thoughts to others...
Secondly, even though some machines might do some things as well as we do them, or perhaps even better, they would inevitably fail in others, which would reveal that they are acting not from understanding, ...”

Discourse on the Method, by Descartes (1598-1650)

What is Intelligence?

- Turing Test (c. 1950)

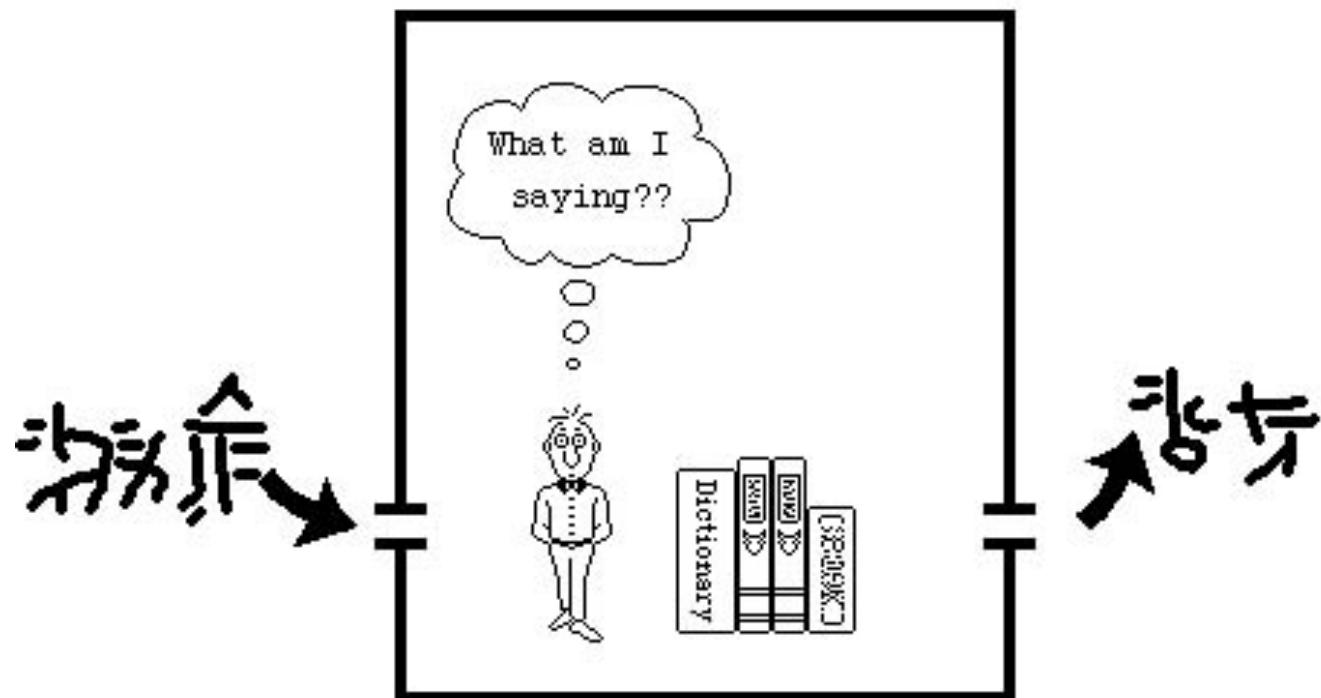


An Application of the Turing Test

- CAPTCHA: Completely Automatic Public Turing tests to tell Computers and Humans Apart



Chinese Room (John Searle)



Can Machines Act/Think Intelligently?

- **A1:** Yes, if intelligence is narrowly defined as “information processing”
 - Many tasks initially assumed to require intelligence can be automated.

Big milestone: Chess (1997)



Deep Blue beats Garry Kasparov, 1997

Milestone: DARPA Grand Challenge

- Autonomous car travels 132 miles through challenging desert (2005)



Milestone: Jeopardy (2010)



Watson beats Jeopardy champions, 2010

Milestone: Go (2016)



Google's AlphaGo beats Lee Sedol (9-dan player), March 2016

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 - Each success of AI seems to push further the limits of what we consider “intelligence”

Can Machines Act/Think Intelligently?

- **A1:** Yes, if intelligence is narrowly defined as “information processing”
 - Many tasks initially assumed to require intelligence can be automated.
 - Each success of AI seems to push further the limits of what we consider “intelligence”
- **A2:** Maybe yes, maybe not, if intelligence cannot be separated from consciousness
 - Is the machine *experiencing* thought?
 - Strong vs. Weak AI

Open philosophical questions

- Is intelligent behavior just information processing?
 - Physical symbol system hypothesis
- If so, can the human brain solve problems that are inherently intractable for computers?
 - Will a theory of intelligence emerge from neuroscience?
- In a human being, where is the interface between “intelligence” and the rest of “human nature”?
 - Self-consciousness, emotions, compulsions
- What is the role of the body?
 - Mind-body problem