

CMSC 471

Intro to Artificial Intelligence

Spring 2024

KMA Solaiman

ksolaima@umbc.edu

Instructor: KMA Solaiman (Salvi)

ITE 201C/Remote

ksolaima@umbc.edu

Mon/Wed: 3 - 4 pm (TBD)

by appointment

- Multimodal Information Retrieval
- Vision & language processing
- Learning with low-to-no supervision
- Novelty in Learning Models

TA and Graders

Aidin Shiri

GS29333@umbc.edu

Office hours:

TBD and by appointment

Location: ITE 334

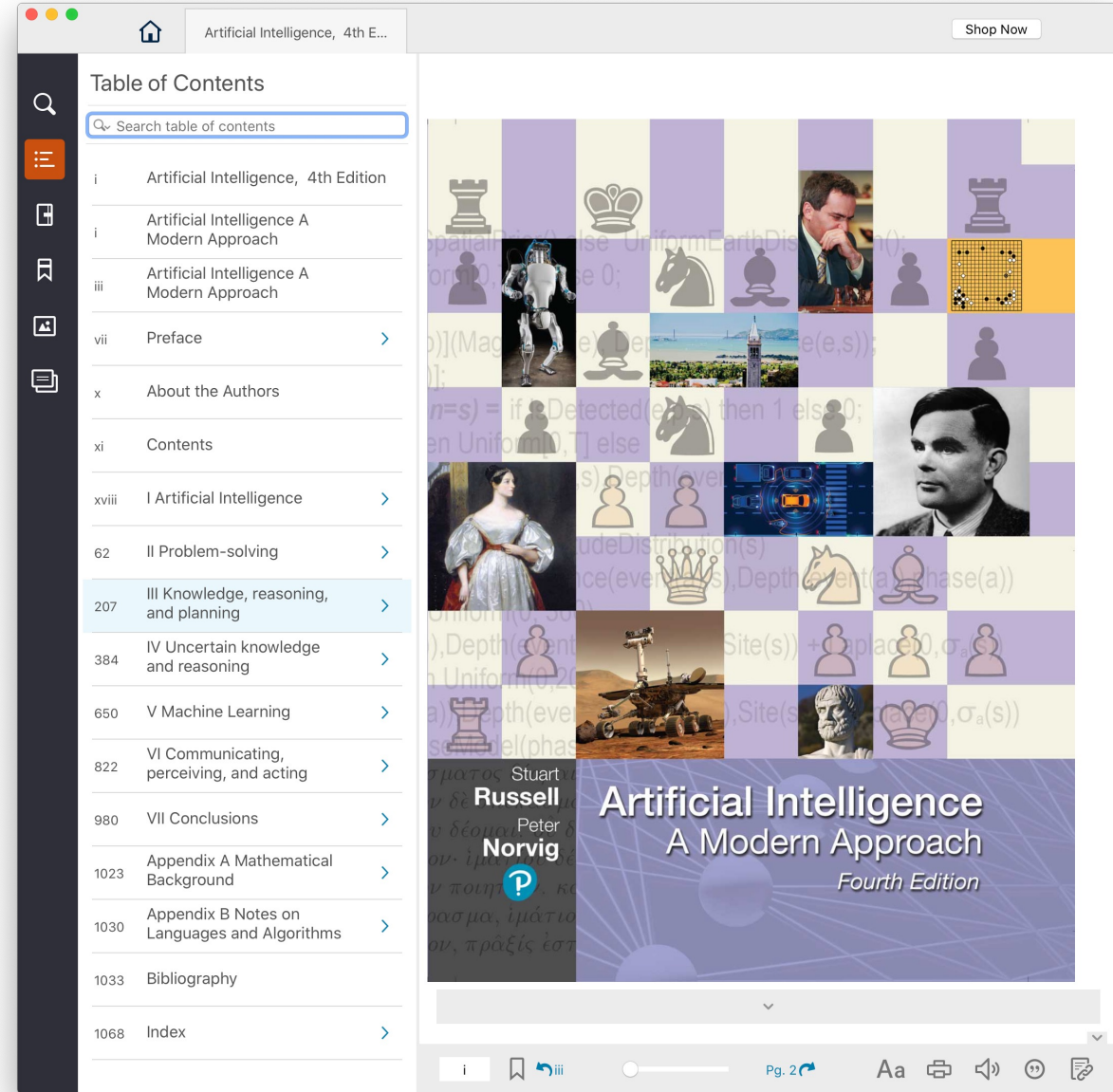
Apoorv Bansal

ZK39815@umbc.edu

Administrivia

Text, CMI

- 4th edition of AIMA (2020) has lots of new material since the 2009 3rd edition
- UMBC CMI program charges
- \$?? for a digital version, \$160 on Amazon for hardcopy!
- Access on Blackboard and/or download to computer/phone
- May access copy on your system for many years
- Opt-out of CMI via Blackboard



Course Website

WWW

Schedule, slides,
assignments, readings,
materials, syllabus here

<https://umbc-cmsc471.github.io/spring2024/>



<https://campuswire.com/p/GC3E869BC>



- **Course announcements**, Q&A, discussion board here
- No public code, follow posted rules and etiquette

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This Week



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<https://www.gradescope.com/courses/724876>



- **Assignment Submission**
- **Rubrics Grading**
- **Peer Grading**

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Anonymity level

Choose who students can be anonymous to when asking or answering a question.



Bob Lee (Anonymous to students) 82  asked a question 2 days ago

Homework 1

Problem 4

#212

I'm having a tough time figuring out B,C,D,E in the partial fractions. Help would be appreciated. Any tips on solving this?

 1  5  271  10

Enable chatrooms

Activate the chatroom feature for this class to allow students, instructors and TAs to chat in rooms.




Private rooms

Allow users to create private rooms, in this class, that may be inaccessible to you



∨ Your rooms

 teaching-assistants

general

class-chat

When are we having staff meeting this week?

Kristin Jones ★

Unfortunately, I am out of town right now. Let's meet at Town Hall 6pm Tuesday.



Message the class...

  GIF 

Course Syllabus (On the Website)



CMSC 471 — Introduction to Artificial Intelligence

Spring 2024

- [CMSC 471 — Introduction to Artificial Intelligence](#)
 - [Logistics](#)
 - [Course Description](#)
 - [CMI Text Book](#)
 - [Prerequisites](#)
 - [Course Schedule](#)
 - [Midterm and Final Exams](#)

Reading Materials and Homework

- Required Reading
 - Before Class
- Notes?
 - Volunteers?
- Released on Mon/Wed
- Deadline on Mon/Wed

Academic Integrity

- Super important: I take it **very** seriously
- **You** are responsible for your (& your group's) own work: if in doubt, ask!
- Penalties could include 0 on the assignment, course failure, suspension, or expulsion (not exhaustive)

Academic Integrity

- Generative AI
 - Prompts
 - Edits
 - Anything.AI
- ***Paraphrase***
 - *Cite*
 - *Follow Etiquette*

Course Evaluation

Components	Percentage
Quiz/ Homework	15%
Assignments	40%
Exams (Midterm + Final)	40%
Course Engagement	5%

Course Evaluation

Mostly to motivate you to keep up with the reading and classes

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What is engagement?

Enable class reputation

Activate the reputation feature for this class to reward students for asking and answering questions.



Students can unlock reputation levels by reaching certain milestones:



Lvl 0 Noob



Lvl 1 Starter



Lvl 2 Intermediate



Lvl 3 Advanced


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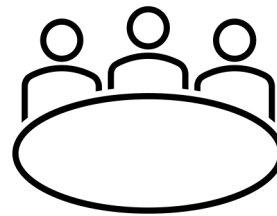
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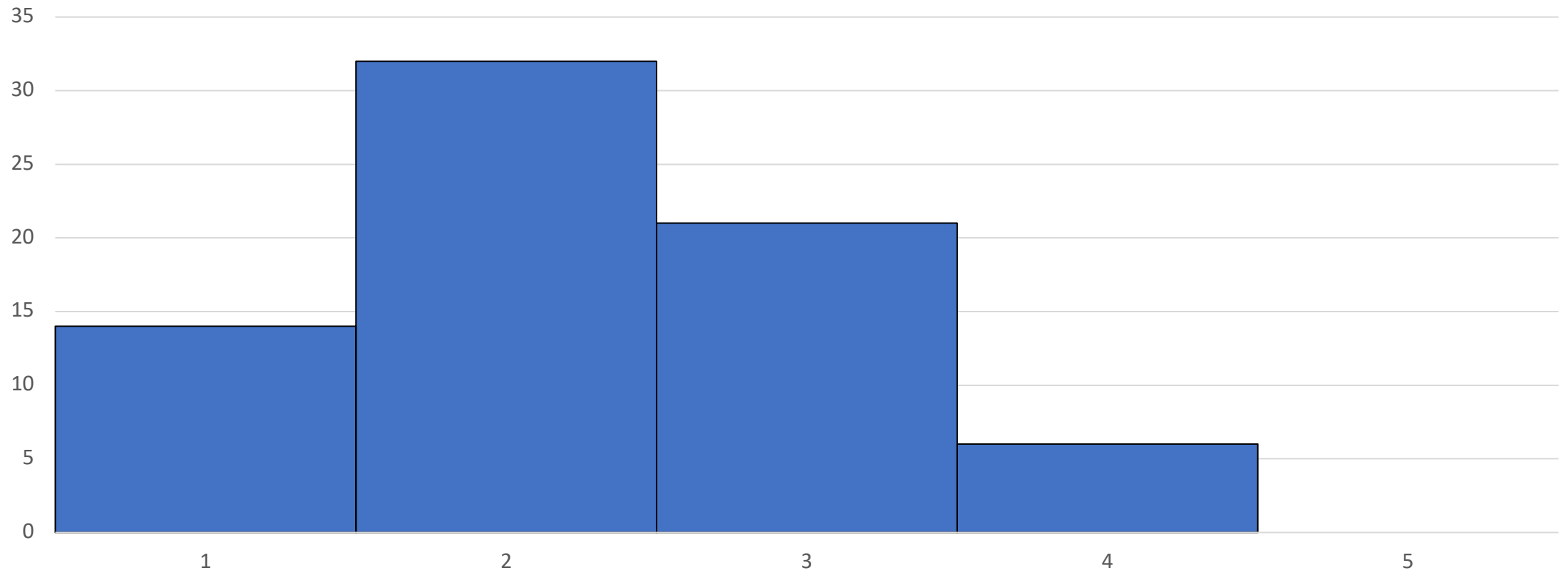


Final Grades

\geq	Letter
90	A
80	B
70	C
60	D
0	F

Grades

Fall 2023



Running the Assignments

A "standard" x86-64 Linux machine, like `g1` or the platform Google Colab `g1`

A passable amount of memory (2GB-4GB) [this is definitely the upper range]

Modern but not necessarily cutting edge software

If in doubt, ask first

Programming Languages for **Assignments**

Python, though individual assignments could vary

Remember: programming languages are *tools*. Don't get too caught up in not "knowing" a language. This course will not be grading software engineering prowess.

Libraries: Assignment dependent. Generally OK, as long as you don't use their implementation of what you need to implement

If in doubt, ask first

Late Policy

Everyone has a budget of 10 *late days*, ***maximum 3 per assignment***

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If you don't have any left: still turn assignments in. They could count in your favor in borderline cases

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Use them as needed throughout the course

- They're meant for personal reasons and **emergencies**
- Do not procrastinate

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Contact me privately if an extended absence will occur

You must know how
many you've used

Q: What is AI
(artificial intelligence)?

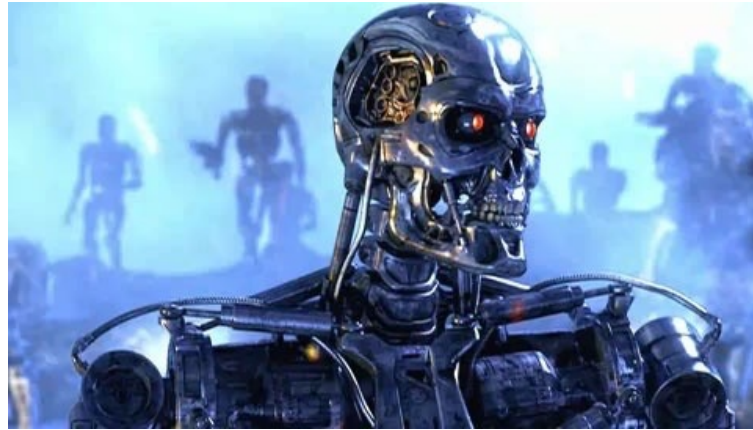
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Partially Adapted from: Pieter Abbeel

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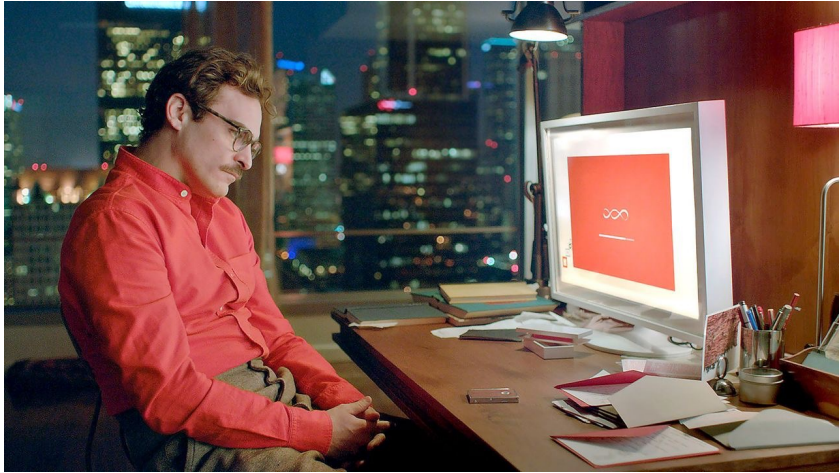
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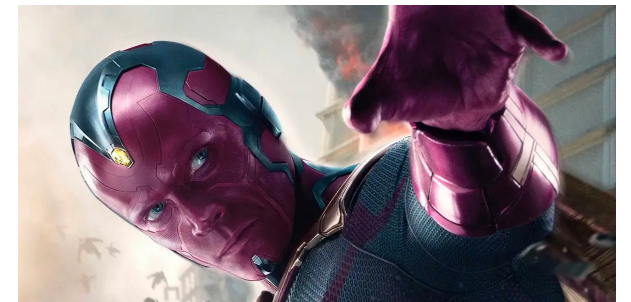
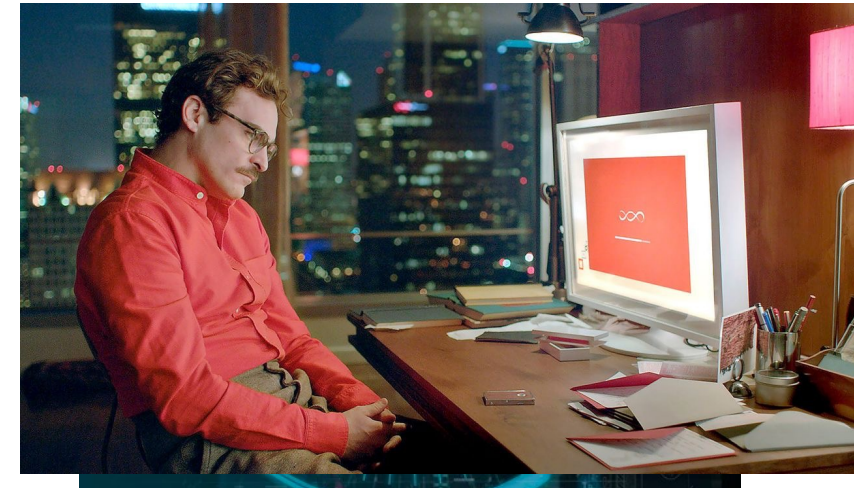
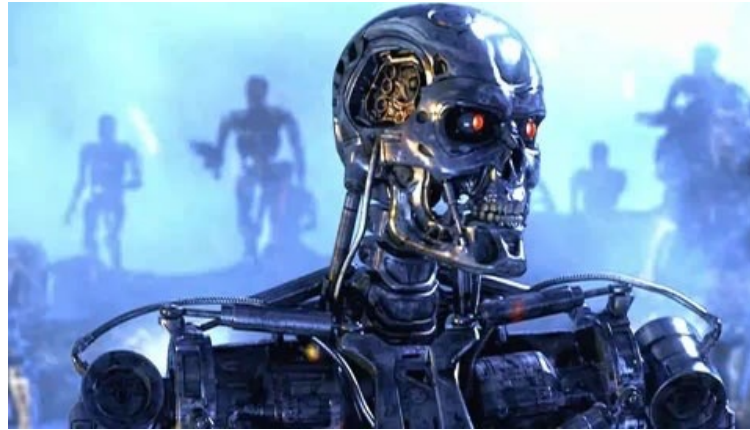
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Real AI

Real AI

Google

🔍 Search Google or type a URL



Real AI

≡ Google Translate

Text

Documents

DETECT LANGUAGE

CHINESE

ENGLISH

SPANISH



CHINESE (TRADITIONAL)

ENGLISH

FRENCH



我的氣墊船充滿了鰻魚



Wǒ de qìdiànchuán chōngmǎnle mányú



10 / 5000

拼



My hovercraft is full of eels

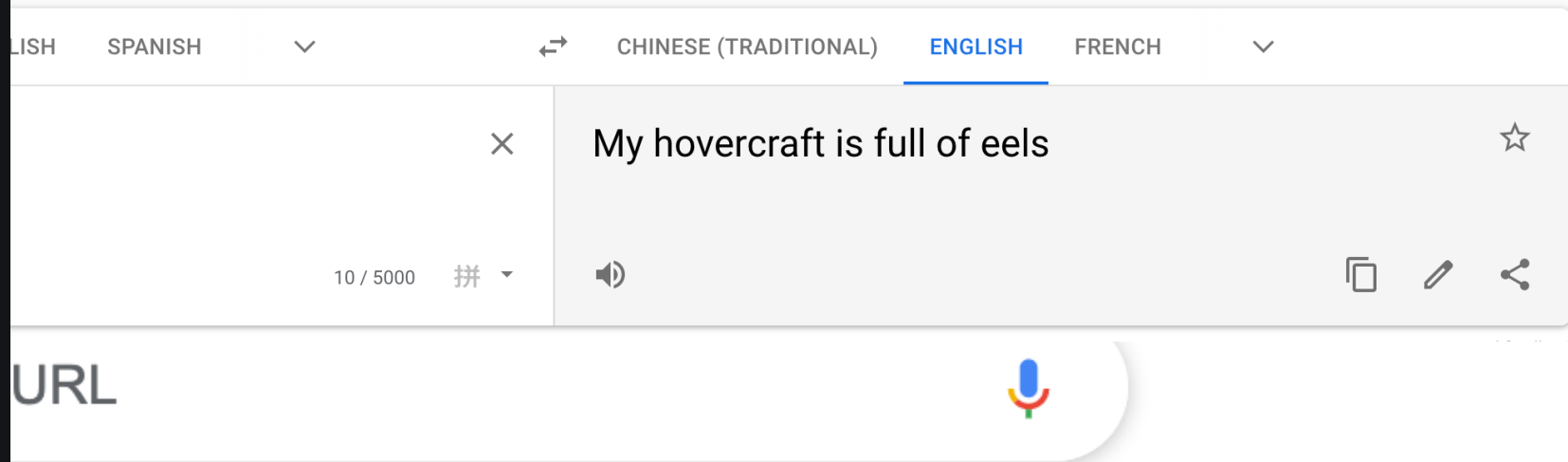


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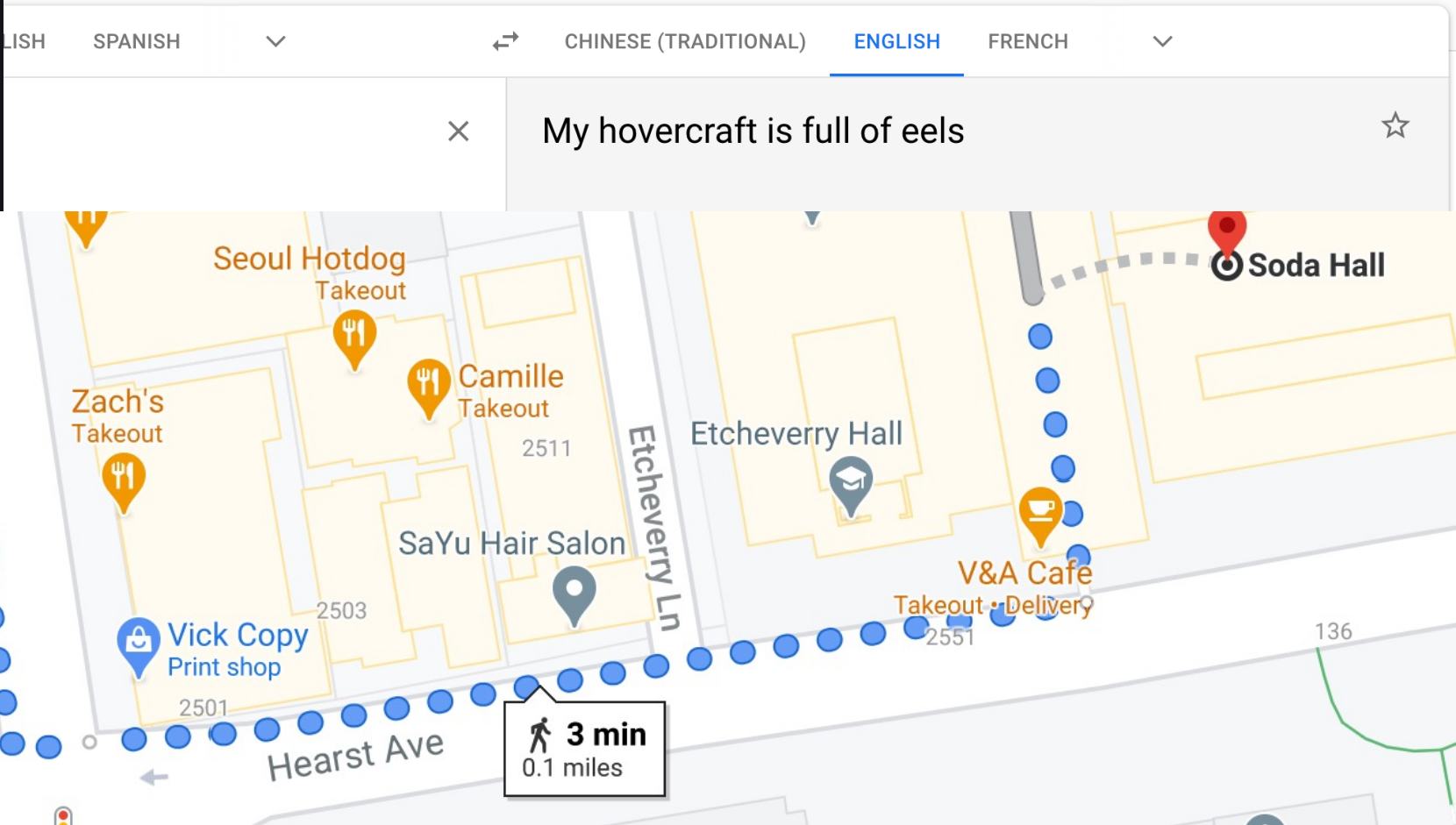
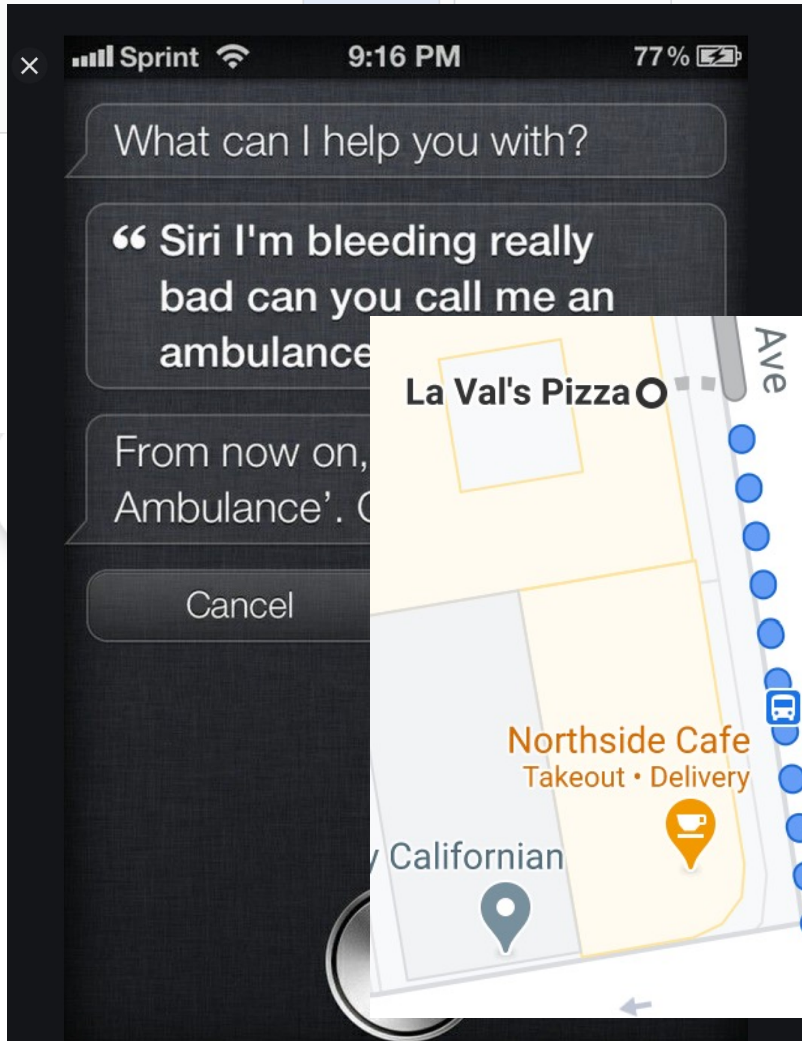
Real AI

Google Translate



Real AI

Google Translate



Real AI

Google Translate

A screenshot of a mobile phone interface. At the top, the status bar shows 'Sprint', signal strength, Wi-Fi, '9:16 PM', and '77%' battery. Below is a Siri chat window with the following text: 'What can I help you with?', '“ Siri I'm bleeding really bad can you call me an ambulance', 'From now on, Ambulance'. C', and a 'Cancel' button. In the background, a map shows 'La Val's Pizza' and 'Northside Cafe' on 'Ave'.

A screenshot of the Google Translate web interface. The top navigation bar includes 'SPANISH', 'CHINESE (TRADITIONAL)', 'ENGLISH', and 'FRENCH'. The main content area shows a crowd of people walking. Numerous yellow bounding boxes are overlaid on the faces of the individuals in the crowd, each accompanied by a numerical ID (e.g., 11904, 11816, 11811, 11903, 11924, 11907, 1869, 11883, 11852, 11886, 11862, 11911, 11890, 11858, 11845, 136). A star icon is visible in the top right corner.



TUG
CAUTION
MAY CONTAIN
CHEMOTHERAPY DRUG

CAUTION
MAY CONTAIN
CHEMOTHERAPY DRUG





Boston Dynamics



What is AI?

Q. What is artificial intelligence?

A. It is the science and engineering of making intelligent machines, especially intelligent computer programs. It is related to the similar task of using computers to understand human intelligence, but AI does not have to confine itself to methods that are biologically observable.

<http://www-formal.stanford.edu/jmc/whatisai/>

Courtesy: Tim Finin

Ok, so what is intelligence?

Q. Yes, but what is intelligence?

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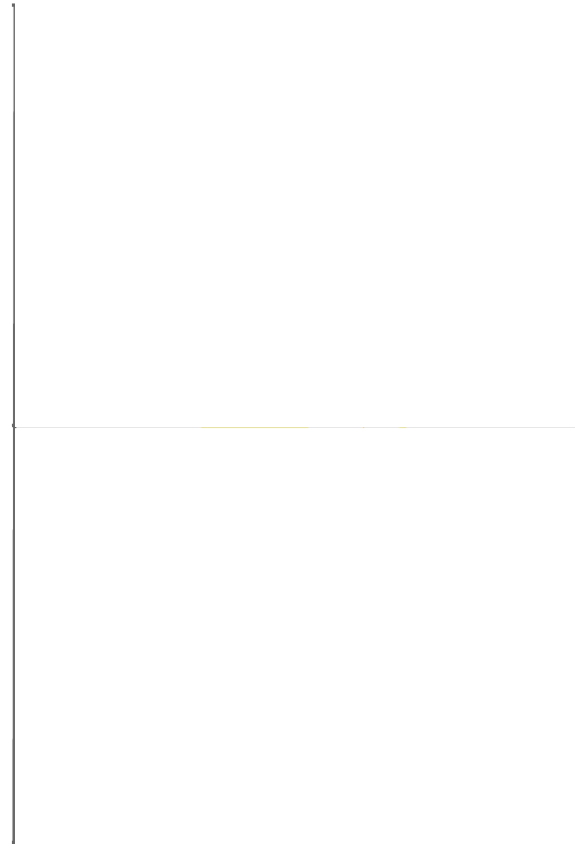
A. Intelligence is the computational part of the ability to **achieve goals** in the world. Varying kinds and degrees of intelligence occur in people, many animals and some machines

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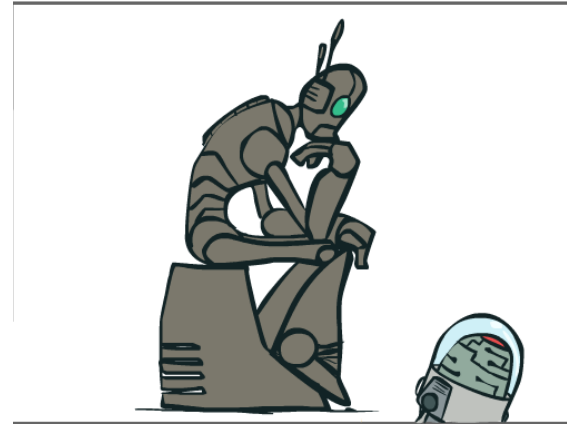
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The science of making machines that:



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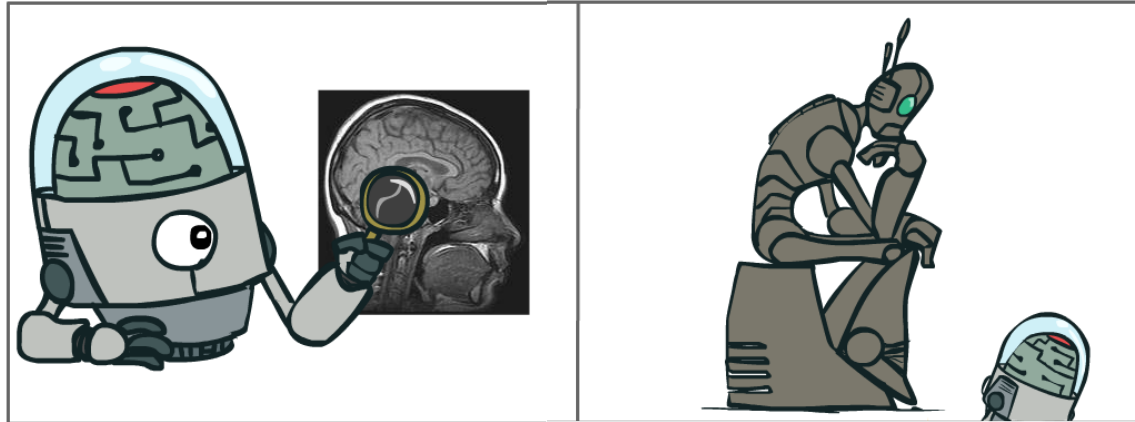


Think rationally

Possible Approaches

The science of making machines that:

Think like people

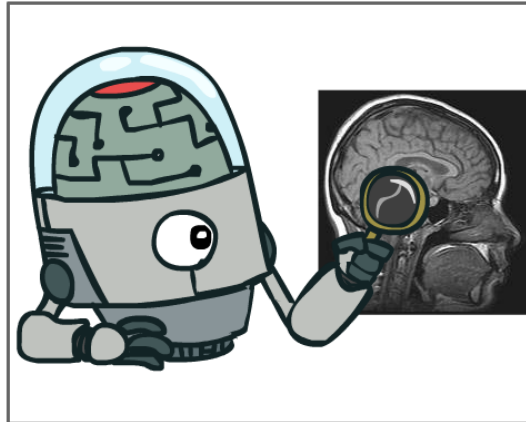


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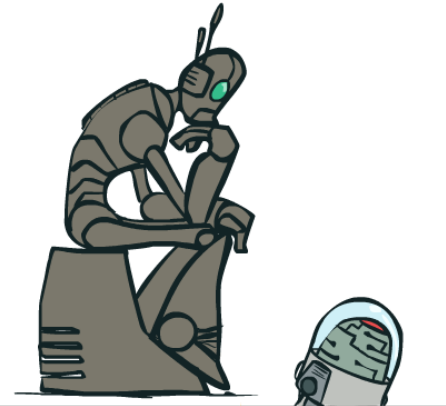
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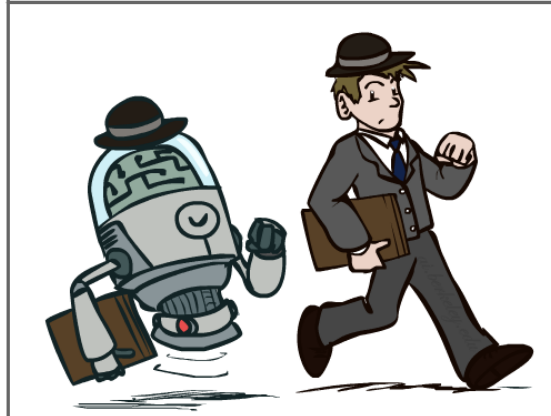
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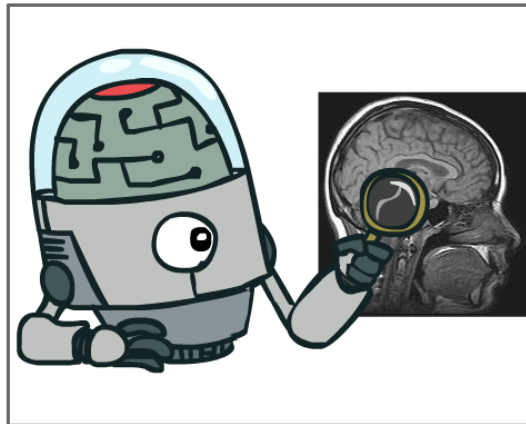
Act like people



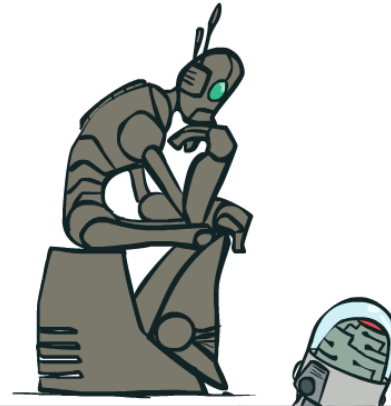
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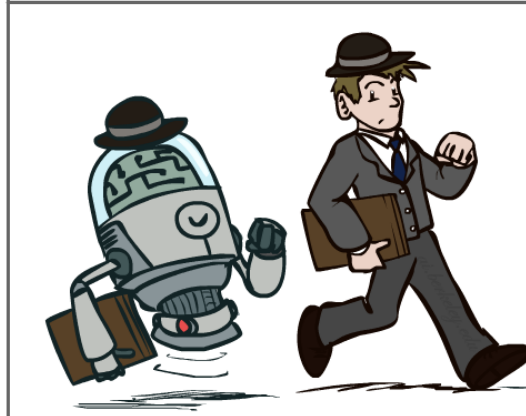
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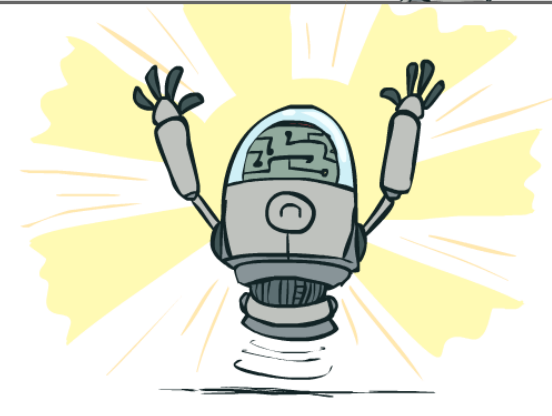
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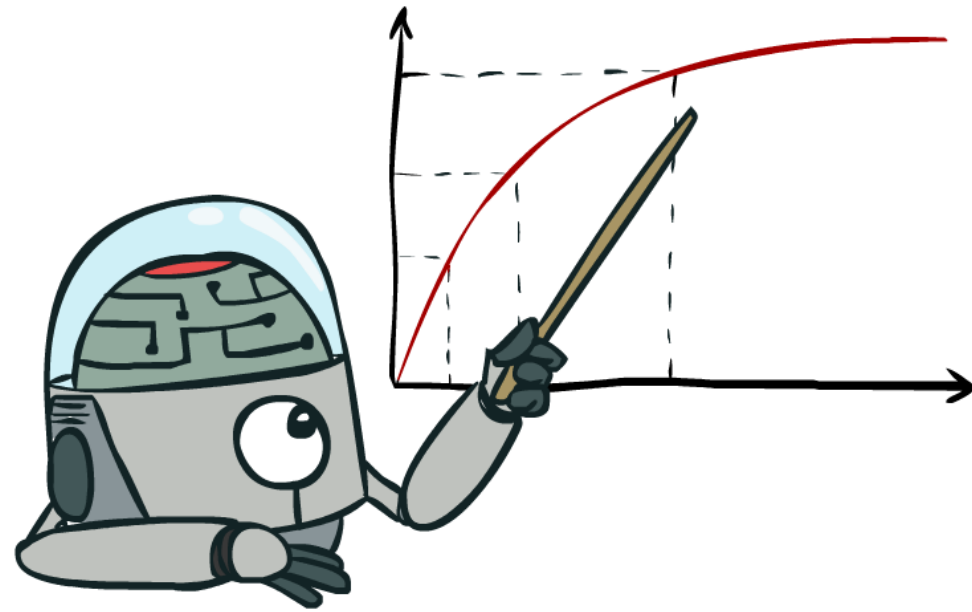
Rational Decisions

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

Maximize Your Expected Utility



Possible Approaches

	Like humans	Well
Think	GPS	Rational agents
Act	Eliza	Heuristic systems

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 (data) and simulation (computation) are key to decision making

Course Topics

- Part 1: Intelligence from Computation
 - Fast search/planning
 - Constraint satisfaction (e.g. scheduling)
 - Adversarial and uncertain search (e.g. routing, navigation)
- Part 2: Intelligence from Data
 - Probabilistic inference with Bayes' nets (e.g. robot localization)
 - Decision theory
 - Machine learning (e.g. spam detection)
- Throughout: Applications
 - Natural language, vision, robotics, games, etc.

Big questions

- Can machines think?
- Must/should they think like humans do?
- Can they learn from their experience?
- Can they have common sense?
- If so, how? If not, why not?
- What does this say about human beings?
- What does this say about the mind?



Why AI?

1 Engineering: get machines to do useful things

e.g., understand spoken natural language, recognize individual people in visual scenes, autonomous vehicles, better cybersecurity, ...

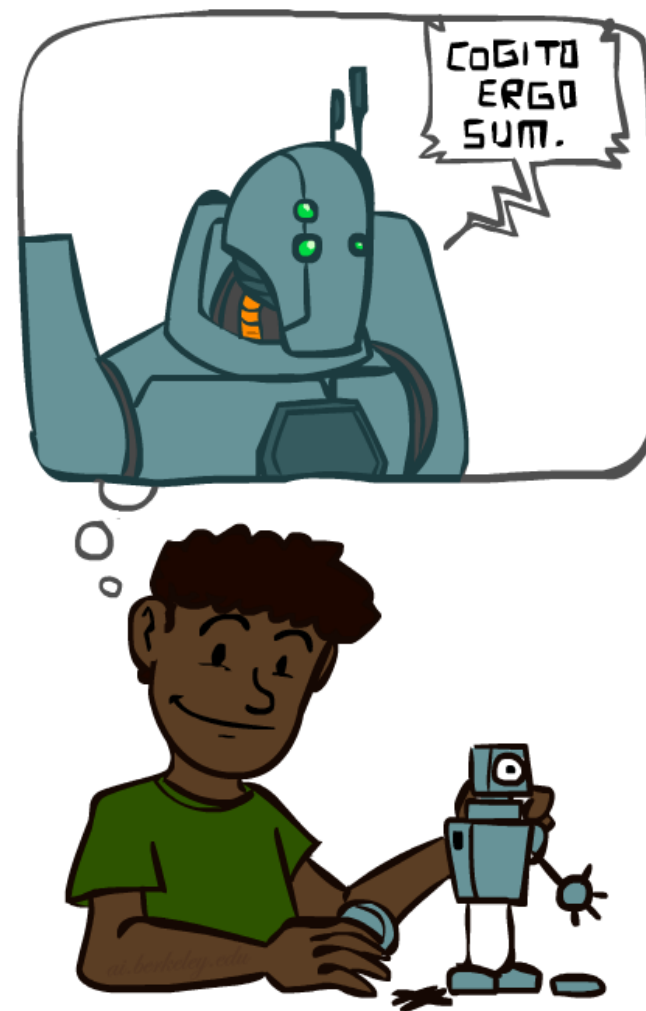
2 Cognitive Science: model and understand how natural minds and mental phenomena work

e.g., visual perception, memory, learning, language, decision making, ...

3 Philosophy: explore basic, interesting and important philosophical questions

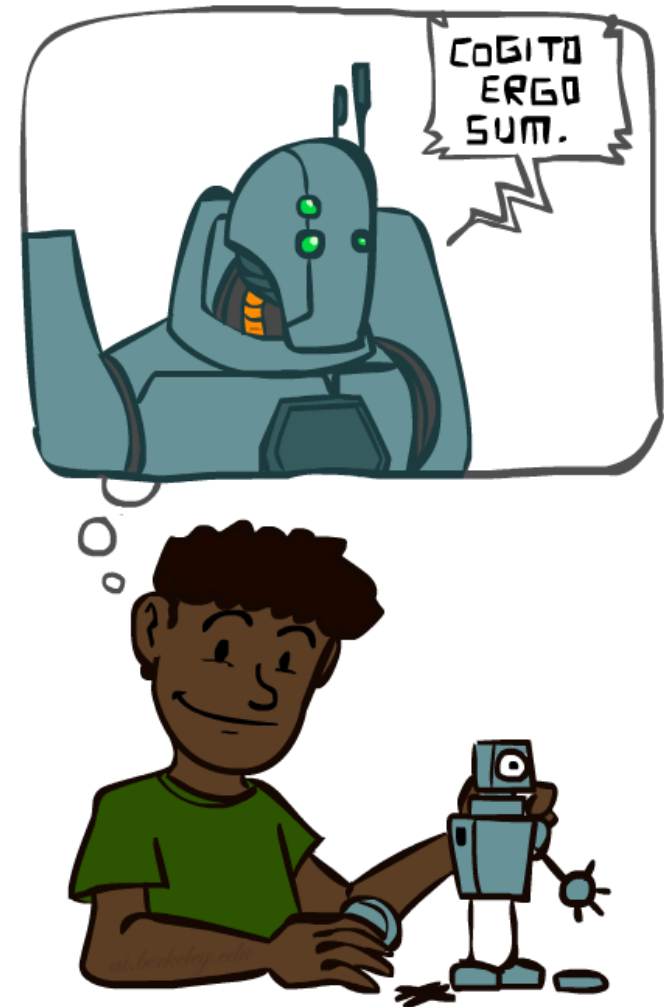
e.g., mind-body problem, what's consciousness, free will, ...

A (Short) History of AI



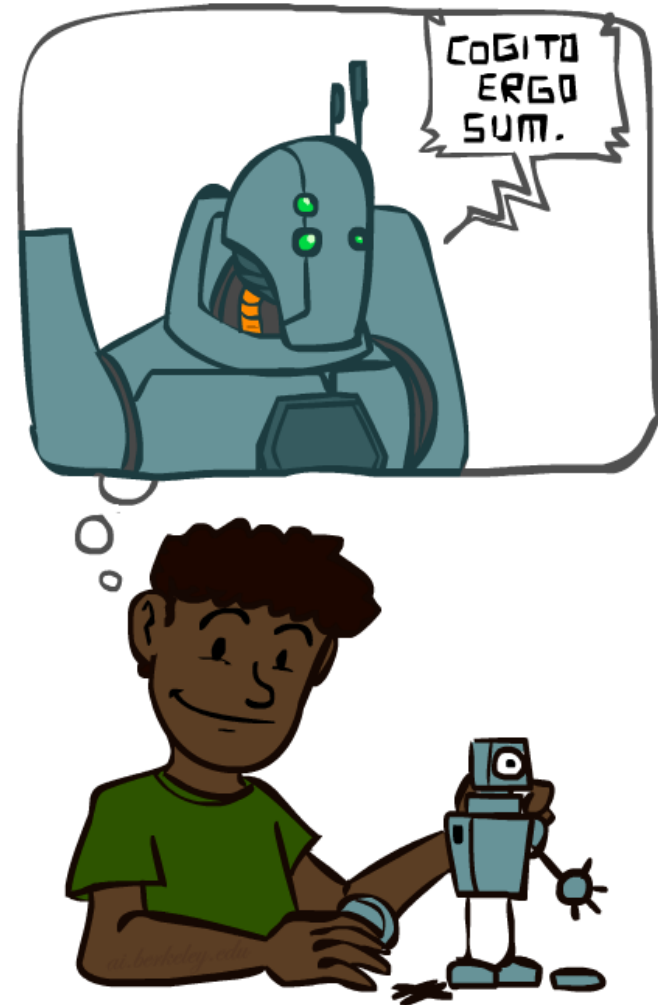
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 - 1943: McCulloch & Pitts: Boolean circuit model of brain
 - 1950: Turing's "Computing Machinery and Intelligence"



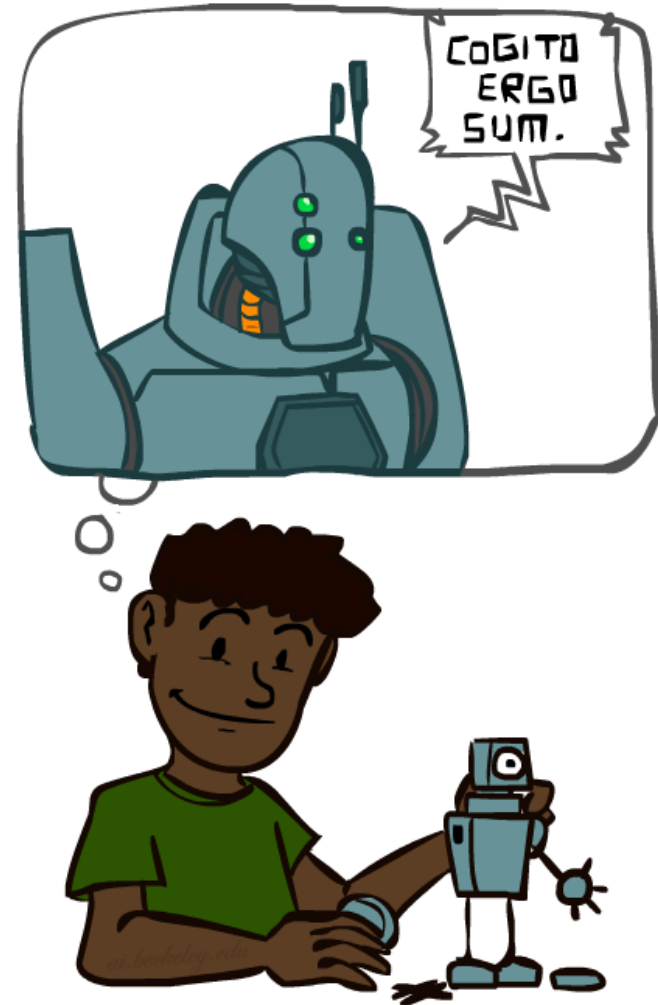
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 - **1956: Dartmouth meeting: "Artificial Intelligence" adopted**
 - 1965: Robinson's complete algorithm for logical reasoning



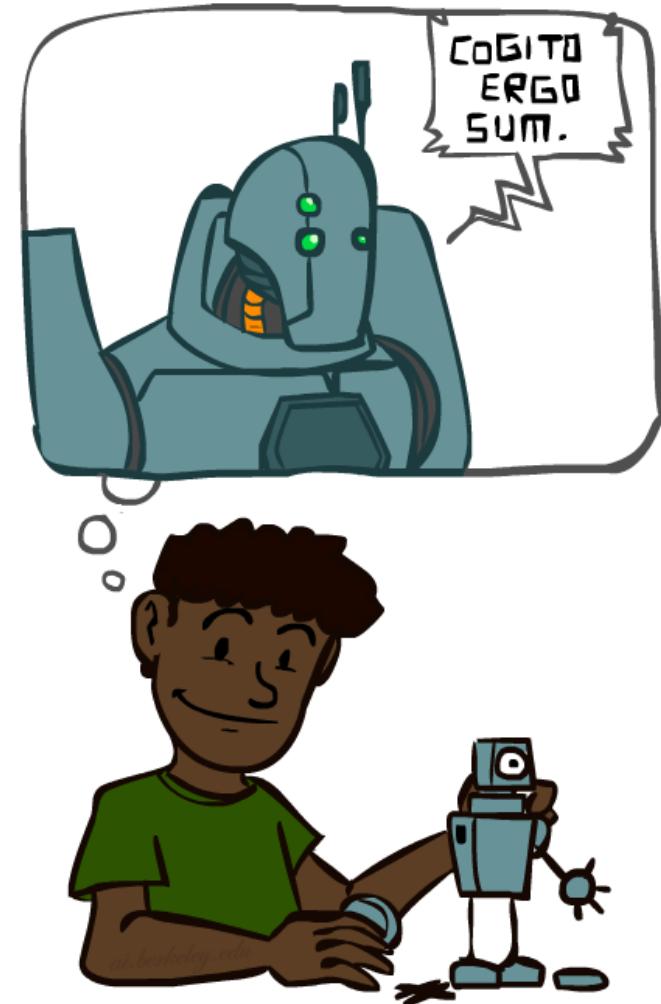
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 - 1980—88: Expert systems industry booms
 - 1988—93: Expert systems industry busts: "AI Winter"



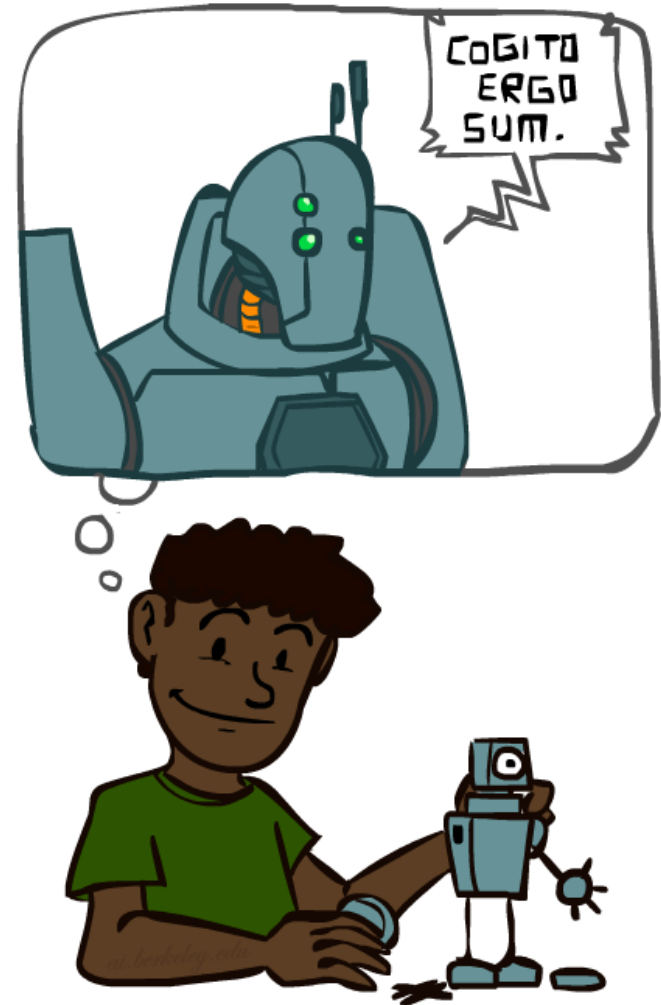
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 - General increase in technical depth
 - Agents and learning systems... "AI Spring"?



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- 1990—2012: Statistical approaches
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- 2012—: Where are we now?



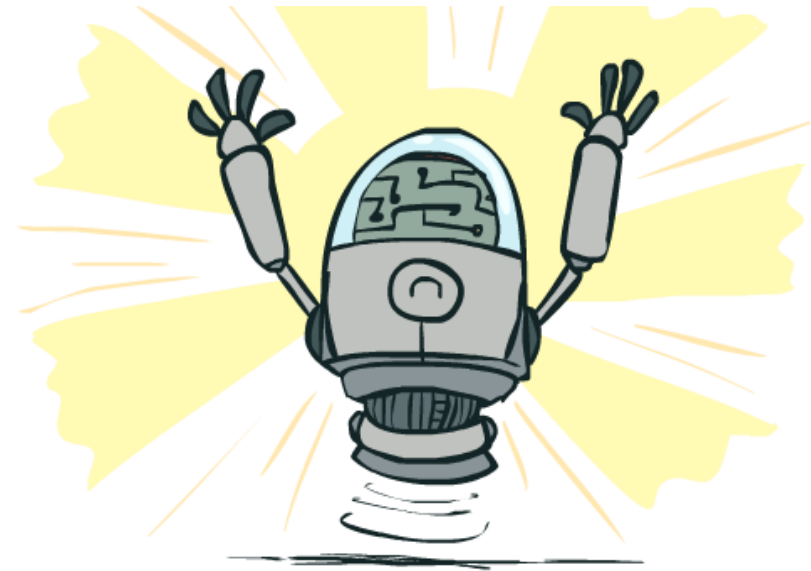
Hot Topics Today

- Neural networks again: Large Language Models, ChatGPT
 - Machine learning, data science
 - Exploiting big data
 - Autonomous vehicles, robotics
 - Text mining, spoken natural language understanding, Siri
 - Conversational AI, DuerOS
 - Computer vision, DALL-E
- **GPT-3 (OpenAI)**
 - **GPT-4 (OpenAI)**
 - **AlphaGo (Google DeepMind)**
 - **Watson (IBM)**
 - **Sophia (Hanson Robotics)**
 - **Tesla Autopilot (Tesla Inc)**

What Can AI Do?

Quiz: Which of the following can be done at present?

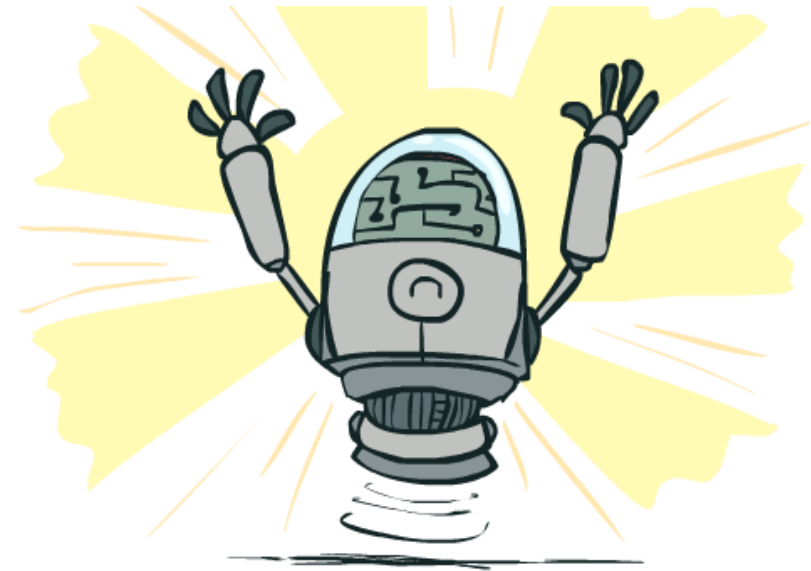
- Play a decent game of Jeopardy?
- Win against any human at chess?
- Win against the best humans at Go?
- Play a decent game of tennis?
- Grab a particular cup and put it on a shelf?
- Unload any dishwasher in any home?
- Drive safely along the highway?
- Drive safely along the streets of Pennsylvania?
- Buy a week's worth of groceries on the web?
- Buy a week's worth of groceries at H-mart?
- Discover and prove a new mathematical theorem?
- Perform a surgical operation?
- Unload a know dishwasher in collaboration with a person?
- Translate spoken Chinese into spoken English in real time?
- Write an intentionally funny story?



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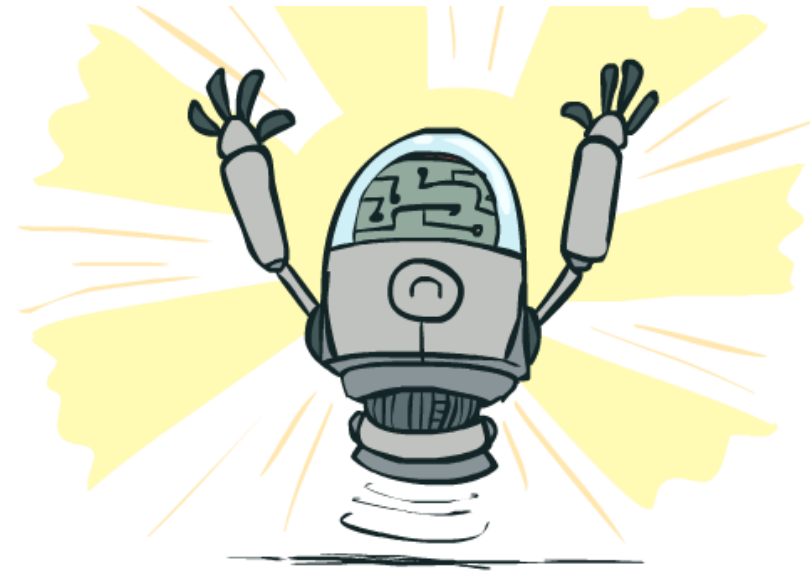
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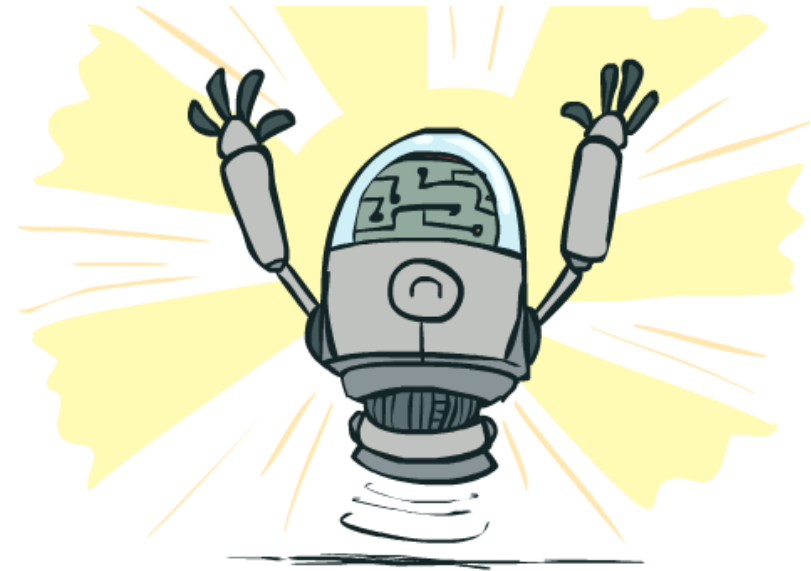
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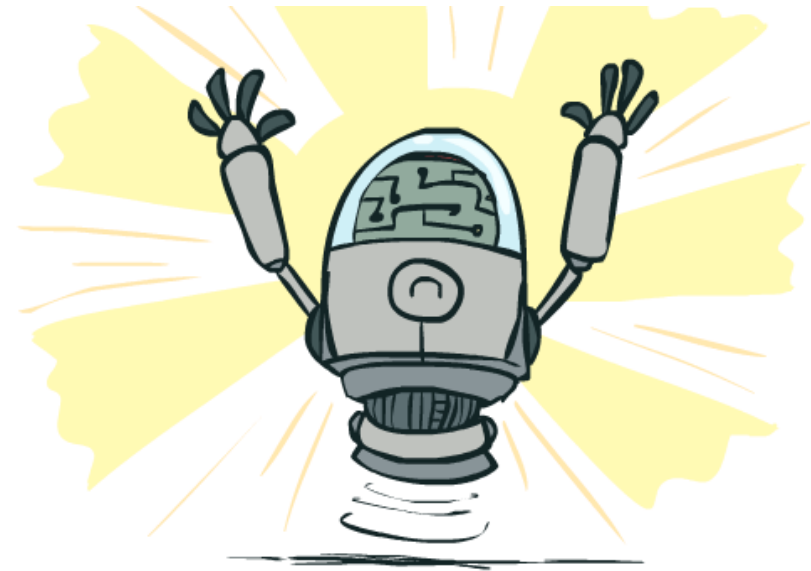
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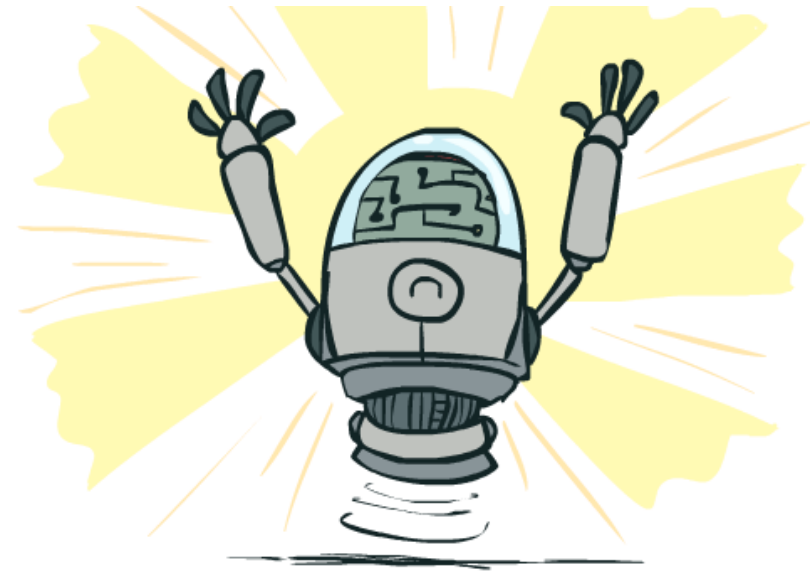
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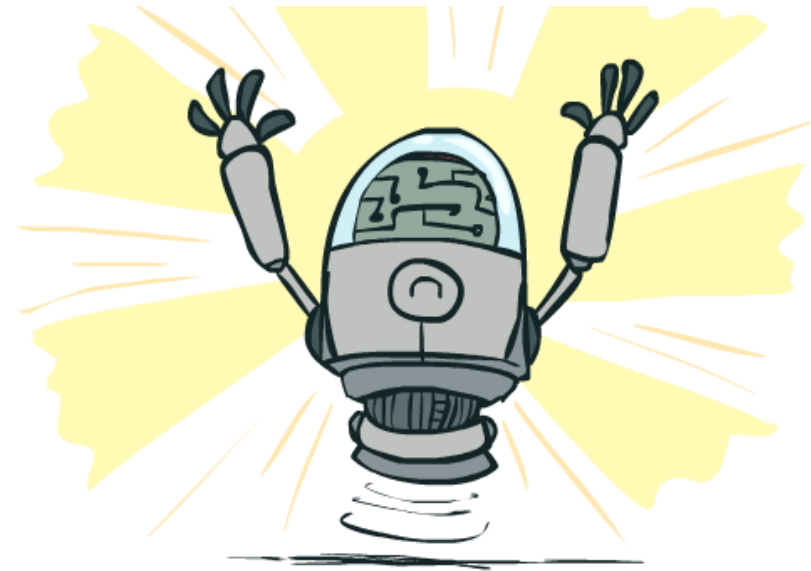
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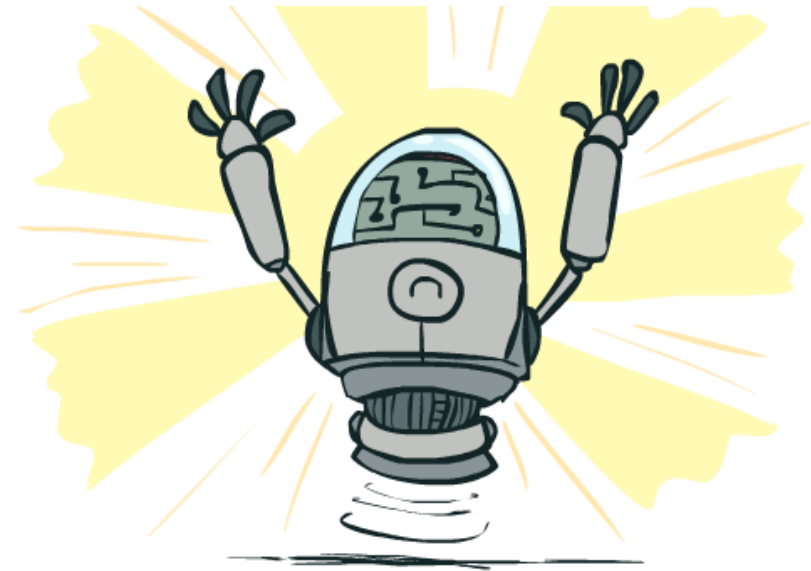
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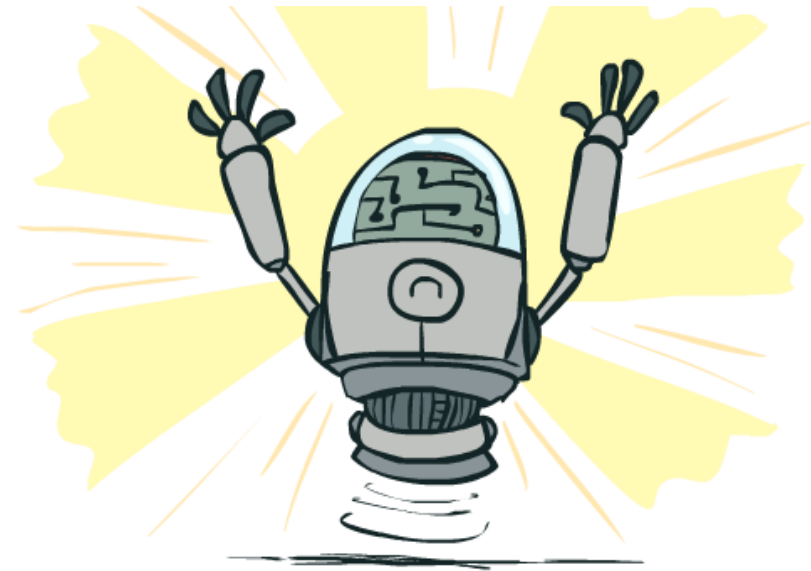
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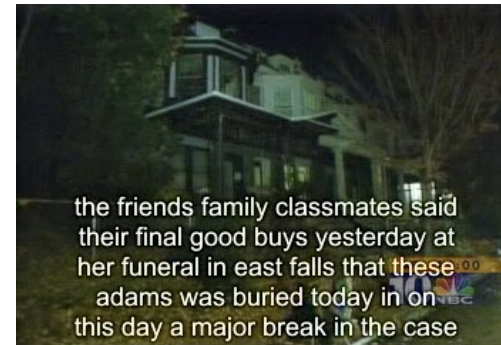
write me a very, very short funny story



In a world where alarm clocks had minds of their own, Tom's clock decided it was tired of the daily grind. One morning, instead of blaring its usual wake-up call, it played "Eye of the Tiger" at full volume while flashing disco lights. Startled and thoroughly entertained, Tom couldn't help but dance his way out of bed, realizing he had just been outwitted by an alarm clock with a flair for the dramatic. From that day on, waking up became a daily dance-off between man and machine, with Tom perfecting his morning moves and the clock unveiling new surprises, turning the bedroom into a groovy battleground at dawn.

Natural Language

- Speech technologies (e.g. Siri)
 - Automatic speech recognition (ASR)
 - Text-to-speech synthesis (TTS)
 - Dialog systems
- Language processing technologies
 - Question answering
 - Machine translation



"Il est impossible aux journalistes de rentrer dans les régions tibétaines"

Bruno Philip, correspondant du "Monde" en Chine, estime que les journalistes de l'AFP qui ont été expulsés de la province tibétaine du Qinghai "n'étaient pas dans l'illégalité".

Les faits Le dalai-lama dénonce l'"enfer" imposé au Tibet depuis sa fuite, en 1959

Vidéo Anniversaire de la rébellion tibétaine: la Chine sur ses gardes



"It is impossible for journalists to enter Tibetan areas"

Philip Bruno, correspondent for "World" in China, said that journalists of the AFP who have been deported from the Tibetan province of Qinghai "were not illegal."

Facts The Dalai Lama denounces the "hell" imposed since he fled Tibet in 1959

Video Anniversary of the Tibetan rebellion: China on guard

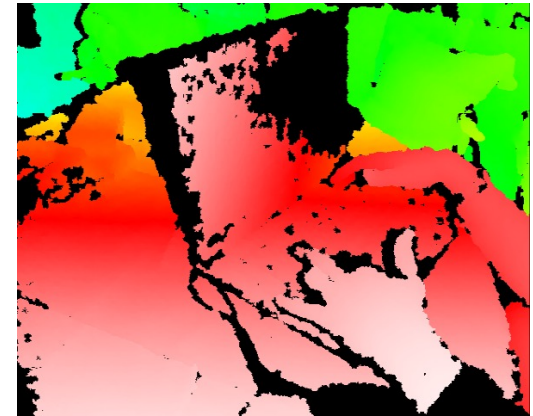
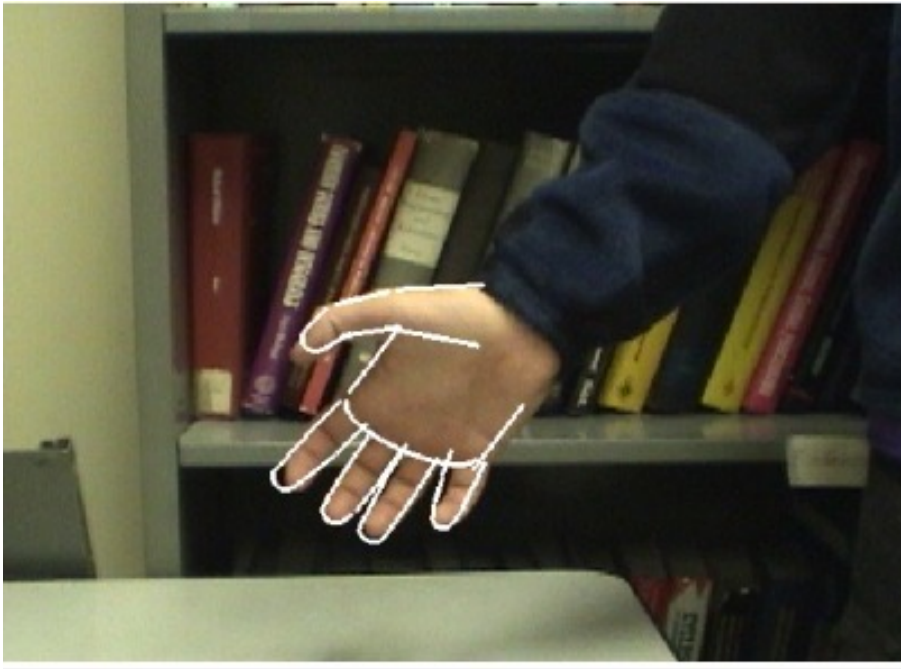
Real-time, Real-time, Video



- Web search
- Text classification, spam filtering, etc...

Vision (Perception)

- Object and face recognition
- Scene segmentation
- Image classification



Demo: [YOLO obj-detect](#)

Images from Erik Sudderth (left), wikipedia (right)

Courtesy: Pieter Abbeel

Robotics

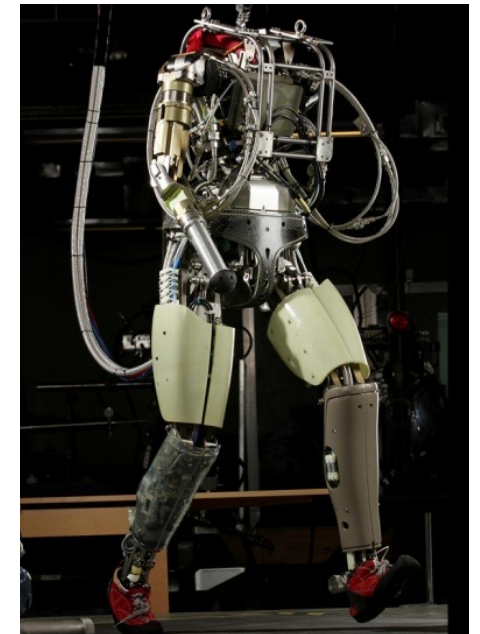
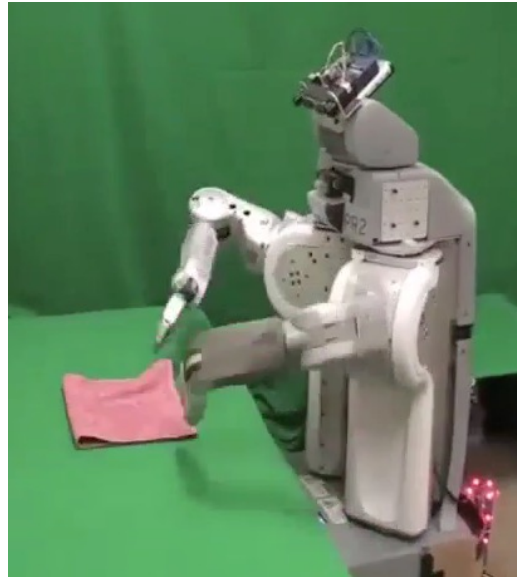
Demo 1: [ROBOTICS – soccer.avi](#)

Demo 4: [ROBOTICS – laundry.avi](#)

Demo 3: [ROBOTICS – gcar.avi](#)

Demo 5: [ROBOTICS – petman.avi](#)

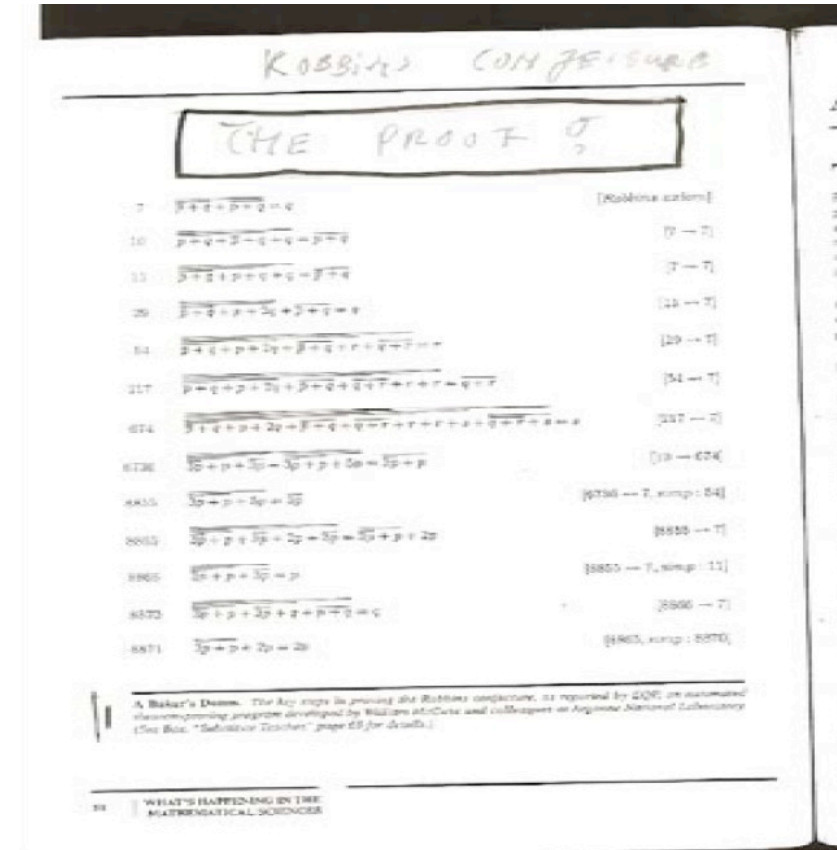
- Robotics
 - Part mech. eng.
 - Part AI
 - Reality much harder than simulations!
- Technologies
 - Vehicles
 - Rescue
 - Soccer!
 - Lots of automation...
- In this class:
 - We ignore mechanical aspects
 - Methods for planning
 - Methods for control



Images from UC Berkeley, Boston Dynamics, RoboCup, Google

Logic

- Logical systems
 - Theorem provers
 - NASA fault diagnosis
 - Question answering
- Methods:
 - Deduction systems
 - Constraint satisfaction
 - Satisfiability solvers (huge advances!)



Game Playing

- Classic Moment: May, '97: Deep Blue vs. Kasparov
 - First match won against world champion
 - “Intelligent creative” play
 - 200 million board positions per second
 - Humans understood 99.9 of Deep Blue's moves
 - Can do about the same now with a PC cluster
- Open question:
 - How does human cognition deal with the search space explosion of chess?
 - Or: how can humans compete with computers at all??
- 1996: Kasparov Beats Deep Blue
“I could feel --- I could smell --- a new kind of intelligence across the table.”
- 1997: Deep Blue Beats Kasparov
“Deep Blue hasn't proven anything.”
- Huge game-playing advances recently, e.g. in Go!

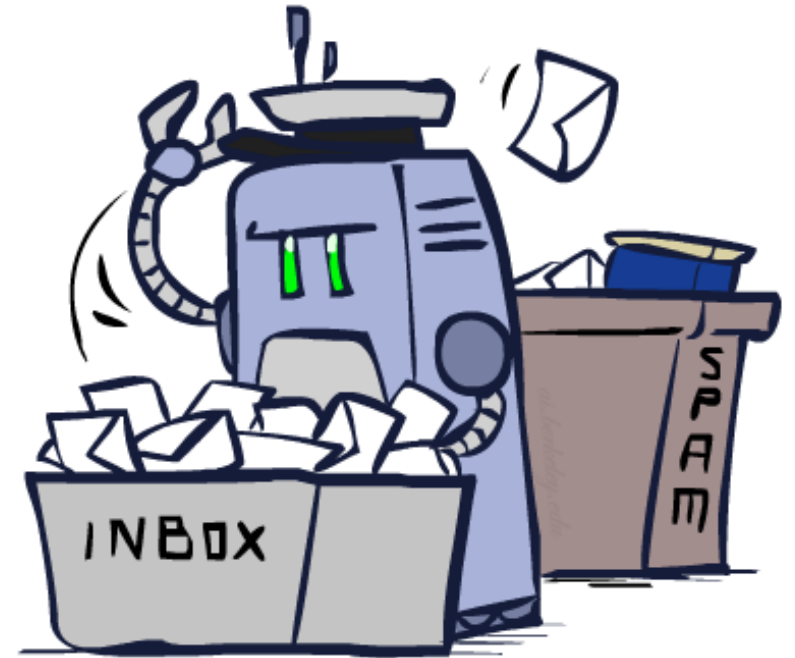


In March 2016, it beat Lee Sedol in a five-game match, the first time a computer Go program has beaten a 9-dan professional without handicap

Decision Making

- Applied AI involves many kinds of automation

- 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!



Challenges

- Constraints of physical world
- Variability of real world
- Digital world?

What can't AI systems do yet? (Fully? Completely?)

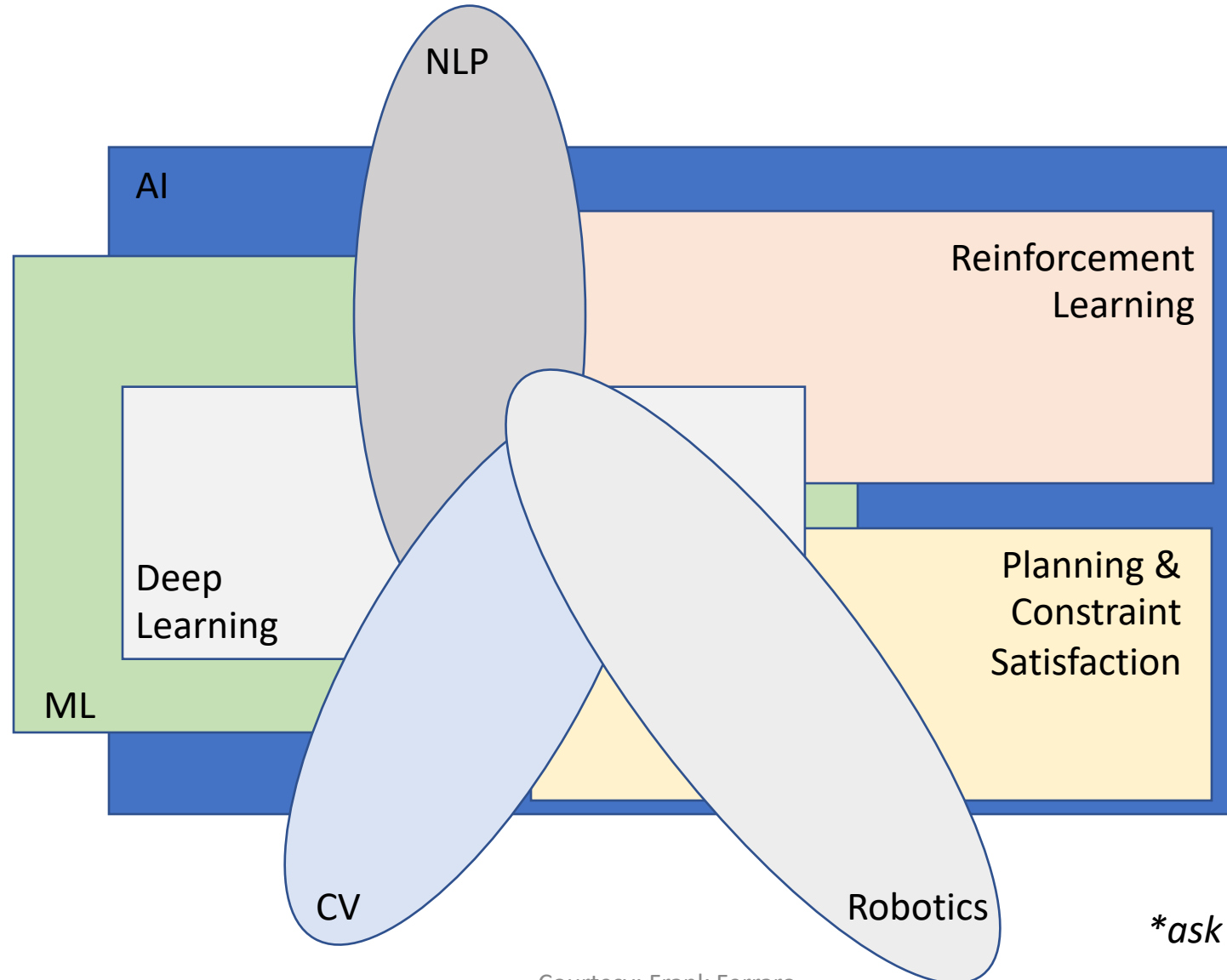
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- ~~Surf the web and find interesting knowledge~~
- ~~Interpret an arbitrary visual scene~~
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- ~~Play Go well~~
- Construct plans in dynamic real-time domains
- Refocus attention in complex environments
- Perform life-long learning

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**Exhibit true autonomy
and intelligence!**

A Partial, Incomplete View of AI, as a diagram of keywords*



Courtesy: Frank Ferraro

**ask 10 people, get
11+ opinions*

Course Topics

Search &
Planning

Reinforcement
Learning

Intelligence from
Computation

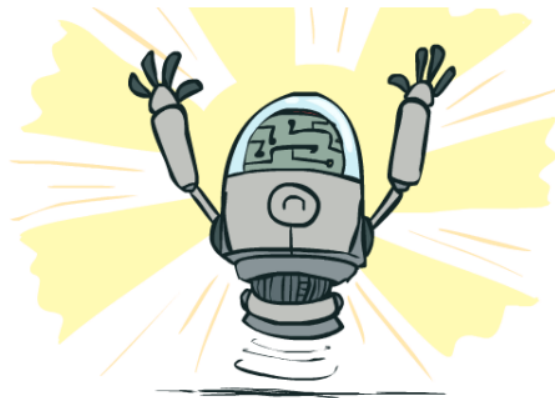
Probability &
Inference

Supervised
Learning

Intelligence from
Data/Experience

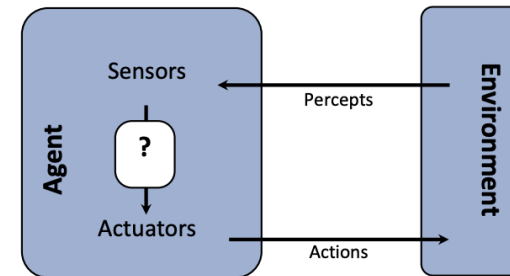
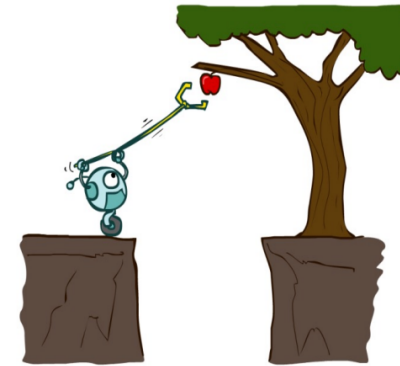
By the end of this course you'll:

- Build and understand math of rational, learning agents
- Select and apply the right AI methods for wide range of problems
- Recognize how these methods are used in modern AI systems
- Be prepared to make decisions on how AI is used in society



This Course: Designing Rational Agents

- An **agent** is an entity that perceives and acts.
- A **rational agent** selects actions that maximize its (expected) **utility**.
- Characteristics of the **percepts**, **environment**, and **action space** dictate techniques for selecting rational 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



Next Class