

CMSC 471  
Intro to Artificial Intelligence  
Spring 2024

KMA Solaiman

[ksolaima@umbc.edu](mailto:ksolaima@umbc.edu)

# Instructor: KMA Solaiman (Salvi)

ITE 201C/Remote

[ksolaima@umbc.edu](mailto:ksolaima@umbc.edu)

Mon/Wed: 3 - 4 pm (TBD)  
by appointment

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

# TA and Graders

**Aidin Shiri**

[GS29333@umbc.edu](mailto:GS29333@umbc.edu)

**Office hours:**

TBD and by appointment

**Location:** ITE 334

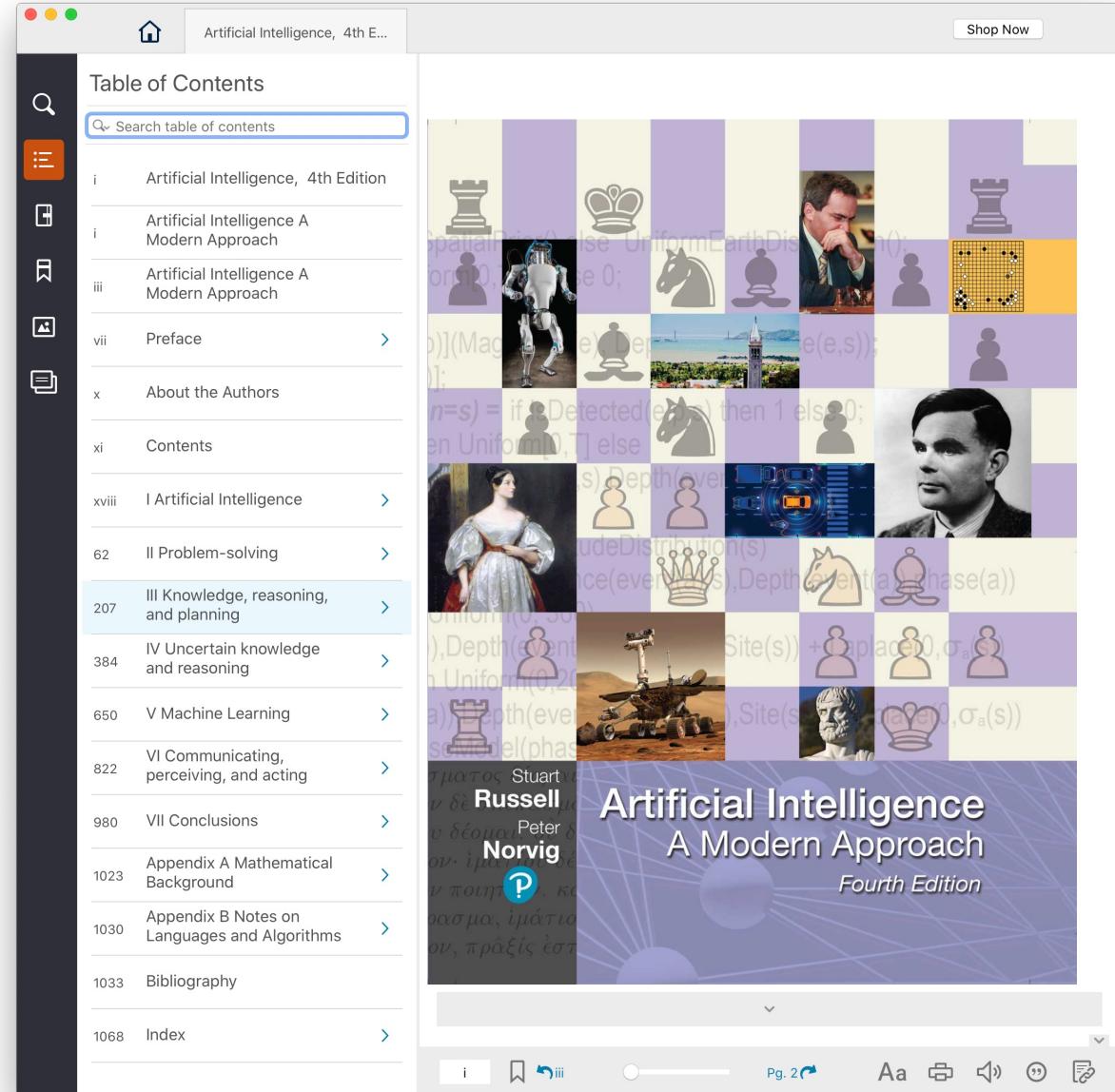
**Apoorv Bansal**

[ZK39815@umbc.edu](mailto:ZK39815@umbc.edu)

# Administrivia

# Text, CMI

- 4<sup>th</sup> edition of AIMA (2020) has lots of new material since the 2009 3<sup>rd</sup> 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>



**campuswire**

- 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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This Week



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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



The screenshot shows a user interface for managing chatrooms. On the left, there's a sidebar with a dropdown menu labeled "Your rooms" and a list of rooms: "teaching-assistants" (with a sub-menu "general" highlighted in blue), and "# class-chat". On the right, a message bubble from "Kristin Jones" contains a yellow star icon and the text: "When are we having staff meeting this week?". Below that, another message bubble from "Kristin Jones" says: "Unfortunately, I am out of town right now. Let's meet at Town Hall 6pm Tuesday." At the bottom of the interface, there's a text input field "Message the class..." and a row of icons for attachments, including a file, a function symbol, a GIF, and a smiley face.



# Course Syllabus (On the Website)



# UMBC

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%

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

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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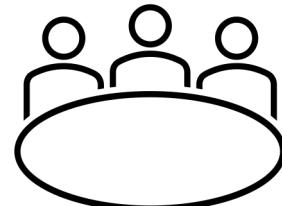
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Lvl 3 Advanced

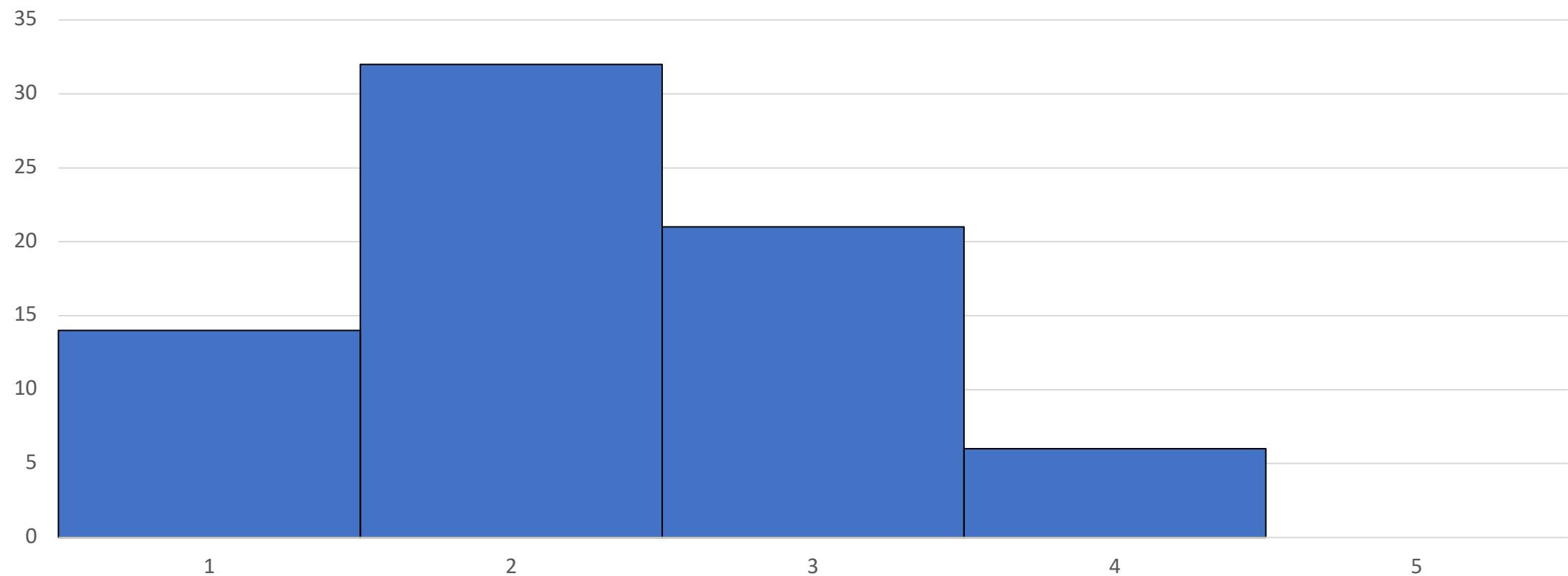


# Final Grades

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

Contact me privately if an extended absence will occur

**You** must know how  
many you've used

Q: What is AI  
(artificial intelligence)?

# Sci-Fi AI?

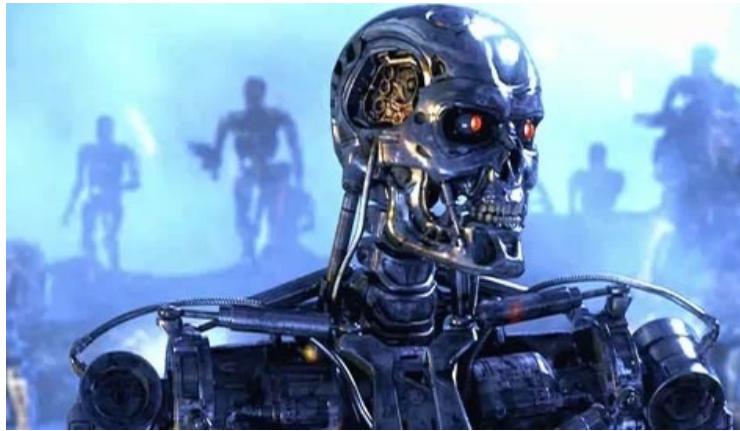
Partially Adapted from: Pieter Abbeel

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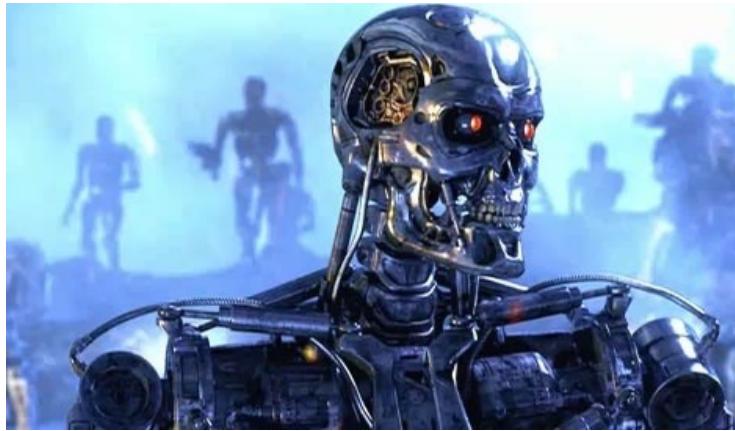
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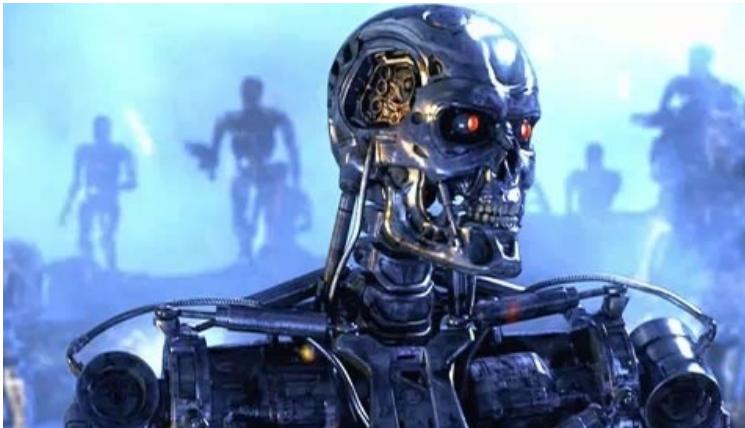
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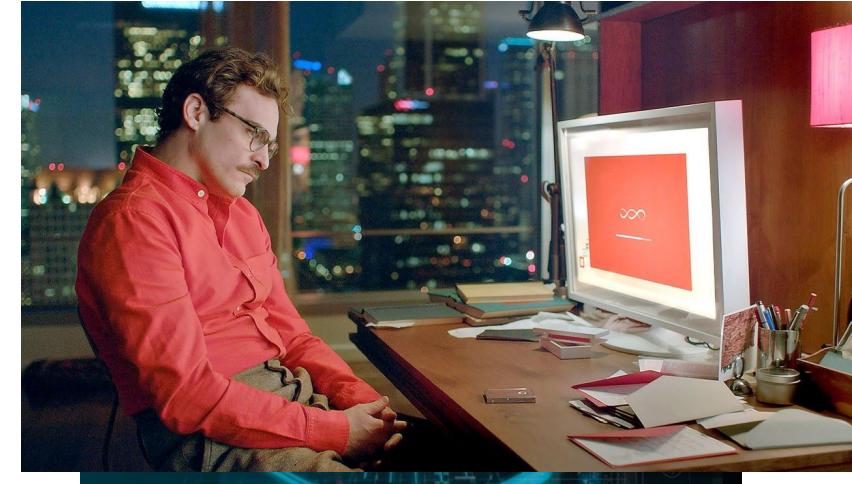
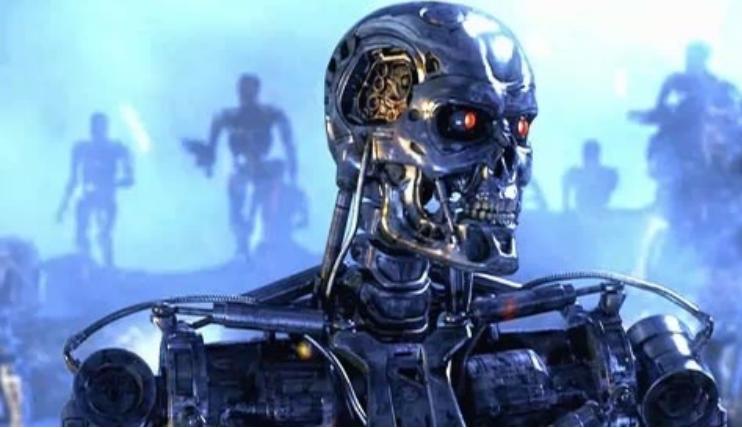
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Real AI

Real AI



Search Google or type a URL



# Real AI

≡ Google Translate

The image shows the Google Translate interface. At the top, there are two tabs: "Text" (selected) and "Documents". Below the tabs, the "DETECT LANGUAGE" dropdown is set to "CHINESE", and the "TRANSLATE TO" dropdown is set to "ENGLISH". The main area displays a sentence in Chinese: "我的氣墊船充滿了鰻魚" (Wǒ de qìdiànchuán chōngmǎnle mán'yú), which is translated into English as "My hovercraft is full of eels". There are also phonetic transcriptions: "Wǒ de qìdiànchuán chōngmǎnle mán'yú" and "My hovercraft is full of eels". Below the sentence, there are microphone and speaker icons, and a character count of "10 / 5000". On the right side of the translation, there are edit and share icons. A small star icon is located at the top right of the translation result.

Search Google or type a URL



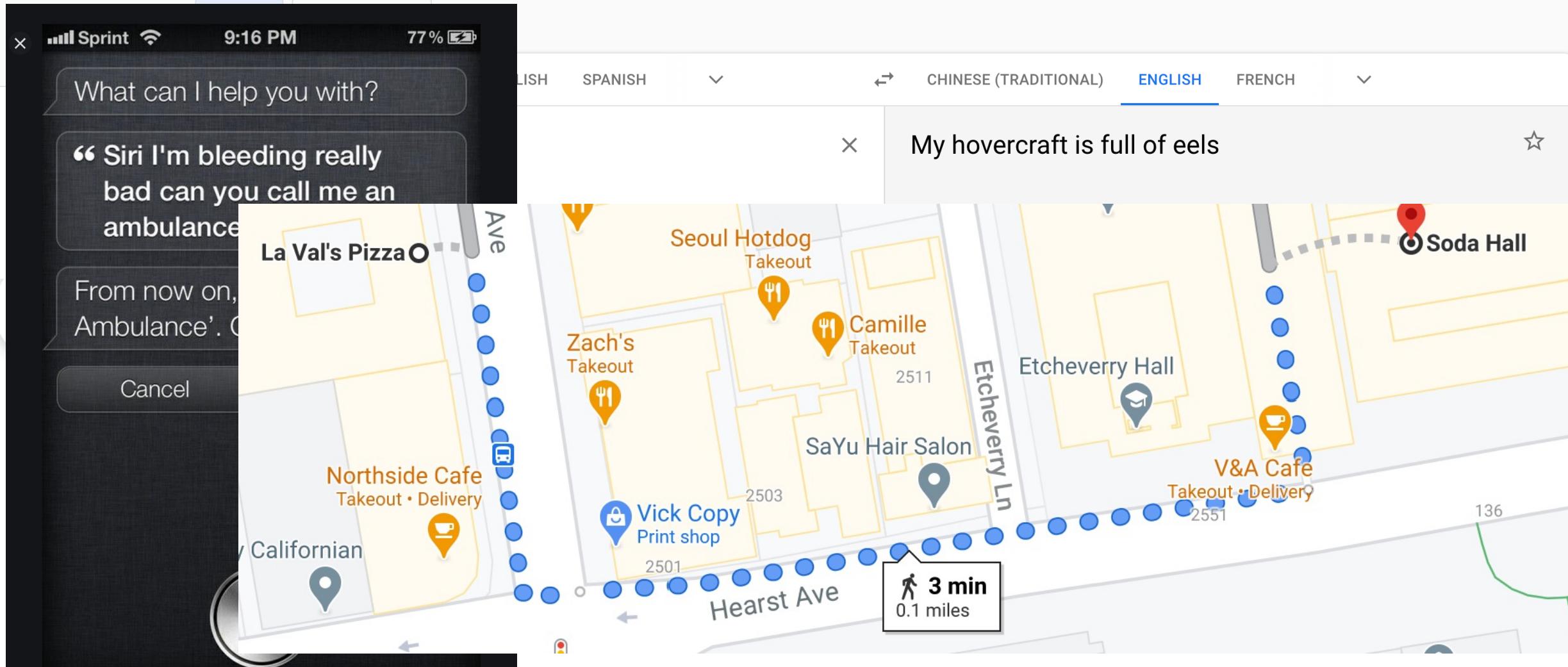
# Real AI

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# Real AI

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The image is a collage of three screenshots illustrating various AI applications:

- Smartphone Screen:** Shows a text message to Siri: "Siri I'm bleeding really bad can you call me an ambulance". Below the message is a map snippet showing the location of La Val's Pizza and Northside Cafe.
- Google Translate Interface:** Shows the English tab selected, with a list of language options: ENGLISH, FRENCH, CHINESE (TRADITIONAL), SPANISH, and RUSSIAN.
- Crowd Analysis:** A photograph of a crowded street with numerous people's faces highlighted by yellow boxes and numbered (e.g., 11904, 11903, 11924, 11869, 11883, 11852, 11886, 118362, 11911, 11845). This likely represents facial recognition or crowd monitoring technology.





A black BigDog robot is walking through a forest. It is a quadruped robot with a dark, textured body and a light-colored head. It is moving across a path covered in fallen brown leaves. The background consists of tall trees with green and yellow autumn foliage.

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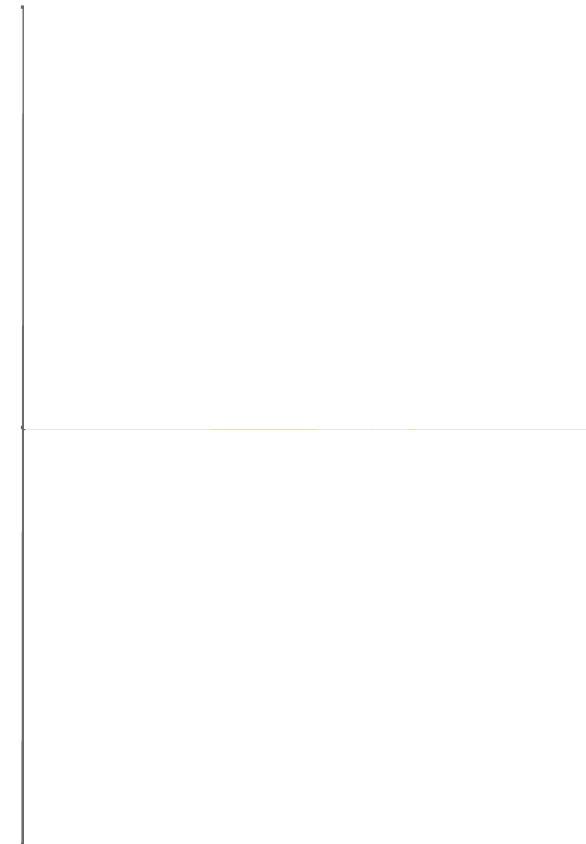
A. Intelligence is the computational part of the ability to achieve goals in the world. Varying kinds and degrees of intelligence occur in people, many animals and some machines

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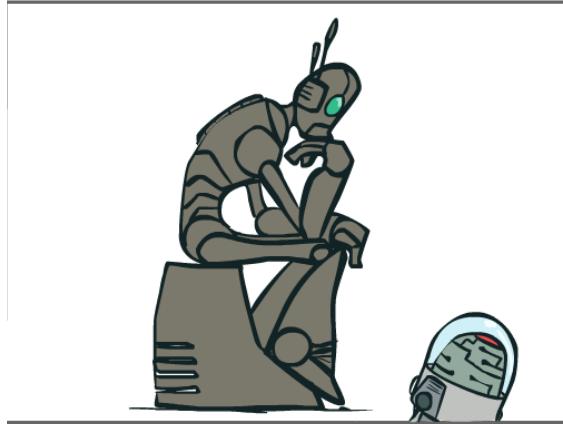
# Possible Approaches

The science of making machines that:



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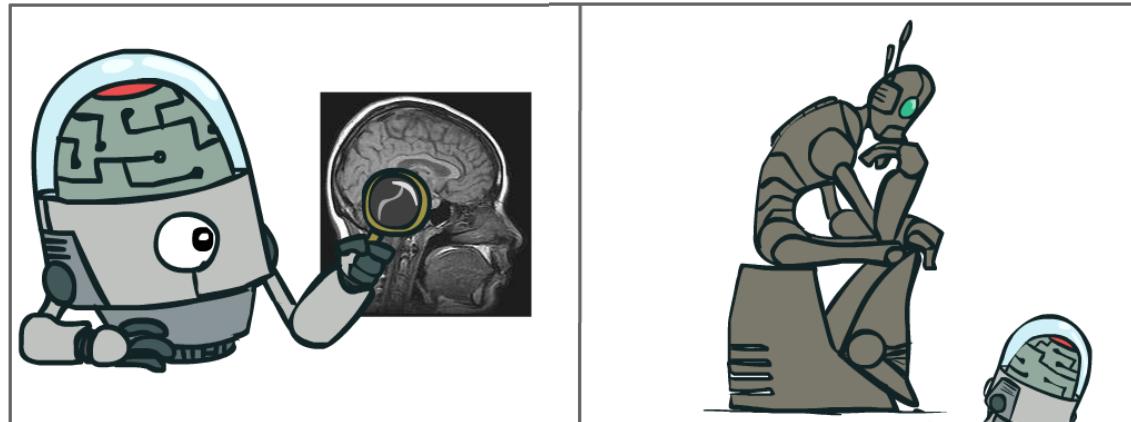


Think rationally

# Possible Approaches

The science of making machines that:

Think like people

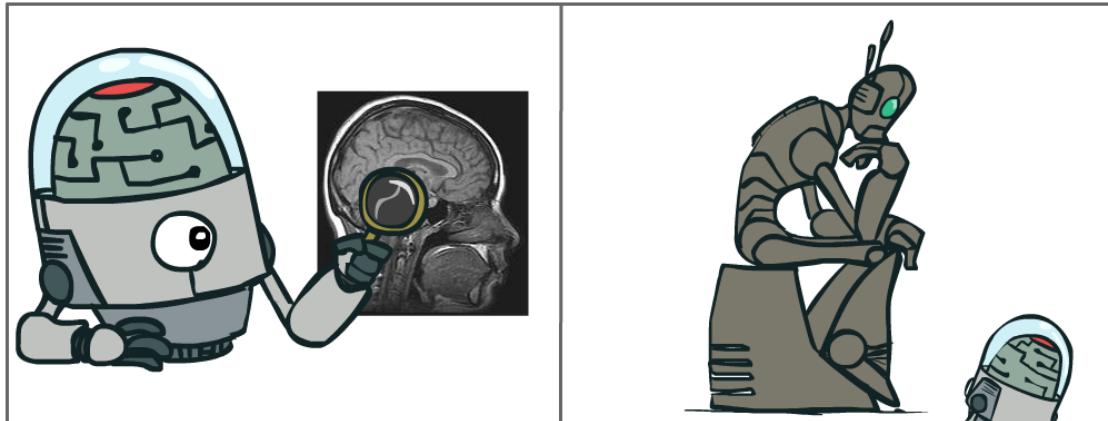


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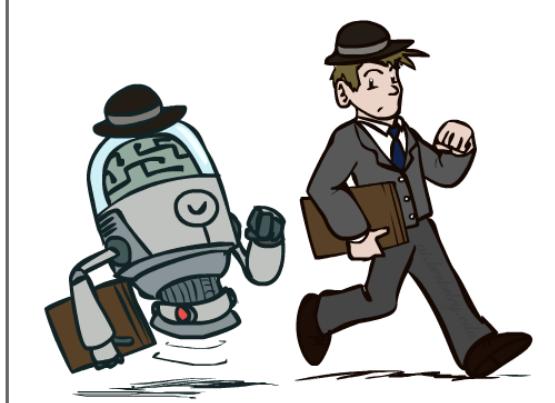
The science of making machines that:

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Think rationally

Act like people

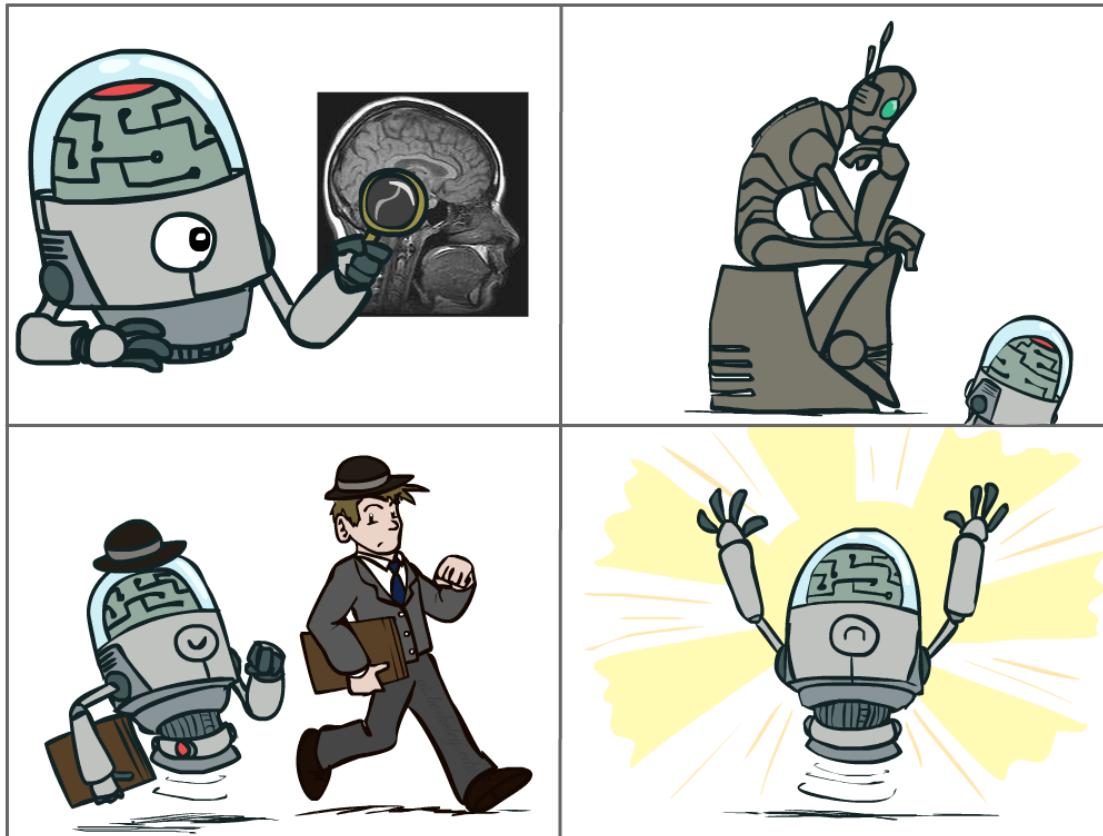


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# Possible Approaches

The science of making machines that:

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Think rationally

Act like people

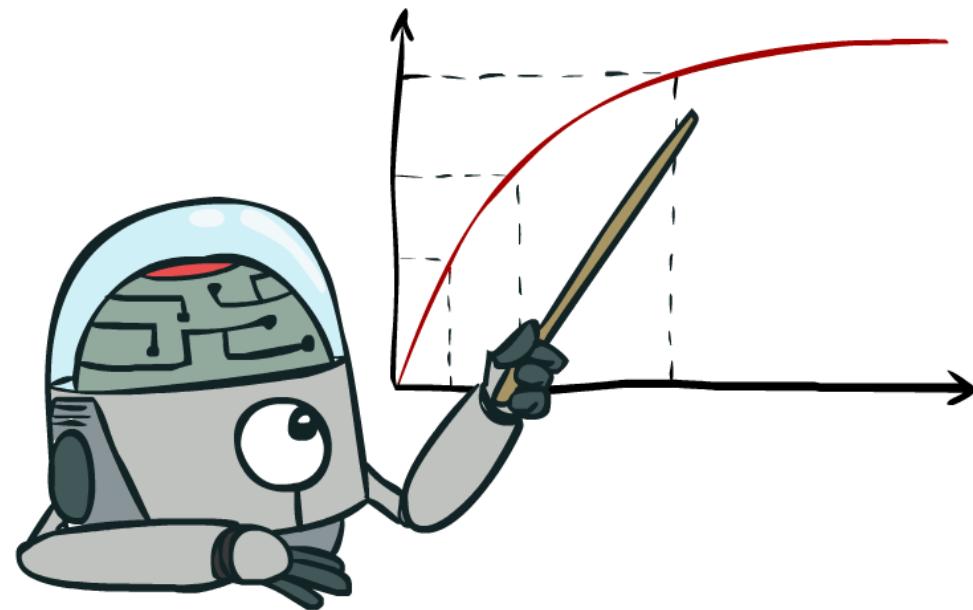
# Rational Decisions

We'll use the term **rational** in a very specific, technical way:

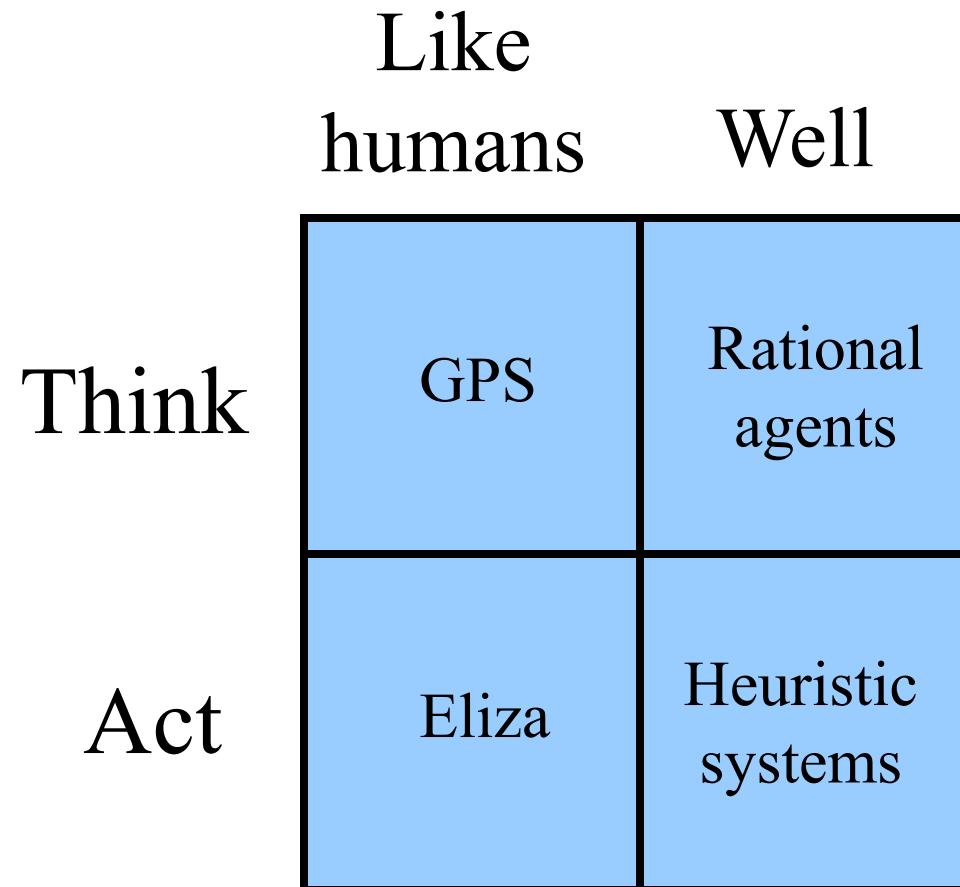
- Rational: maximally achieving pre-defined goals
- Rationality only concerns what decisions are made  
(not the thought process behind them)
- Goals are expressed in terms of the **utility** of outcomes
- Being rational means **maximizing your expected utility**

# Maximize Your Expected Utility

# Maximize Your Expected Utility



# Possible Approaches



# 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, ...

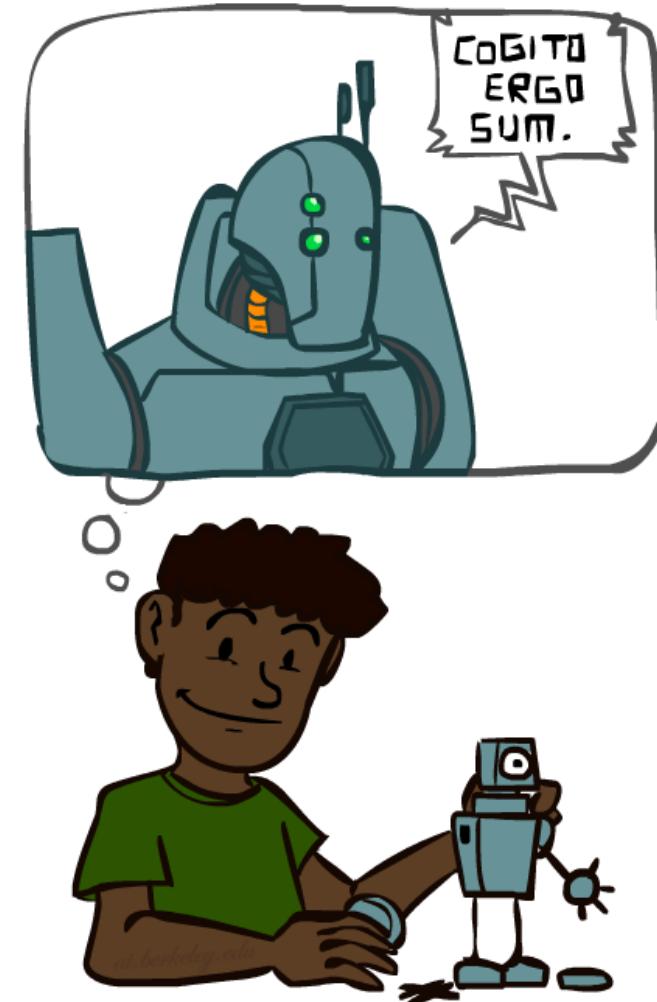
## **2 Cognitive Science:** model and understand how natural minds and mental phenomena work

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, ...

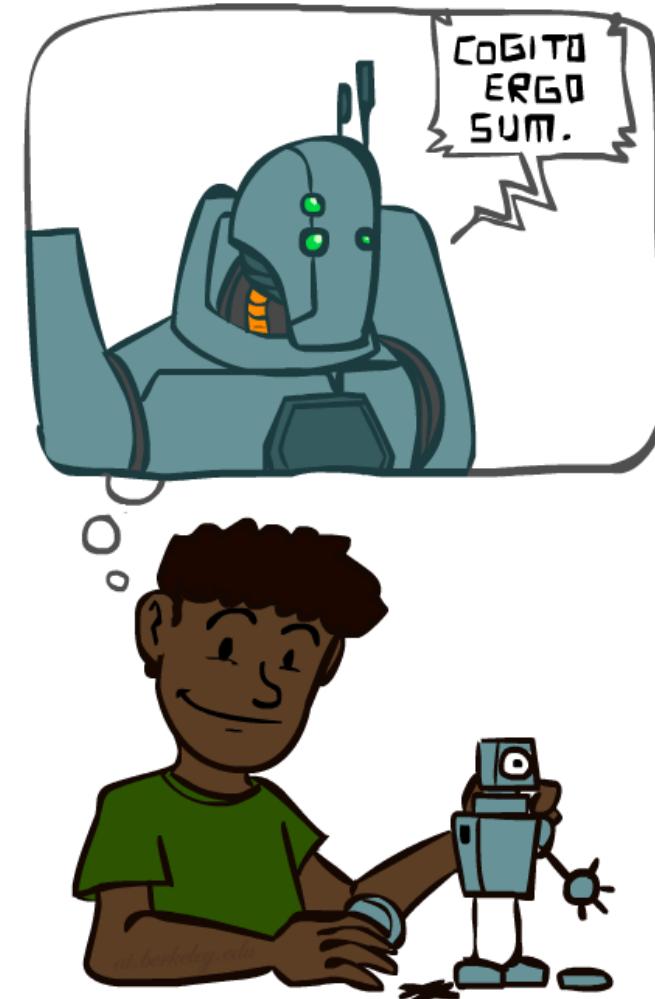
# A (Short) History of AI



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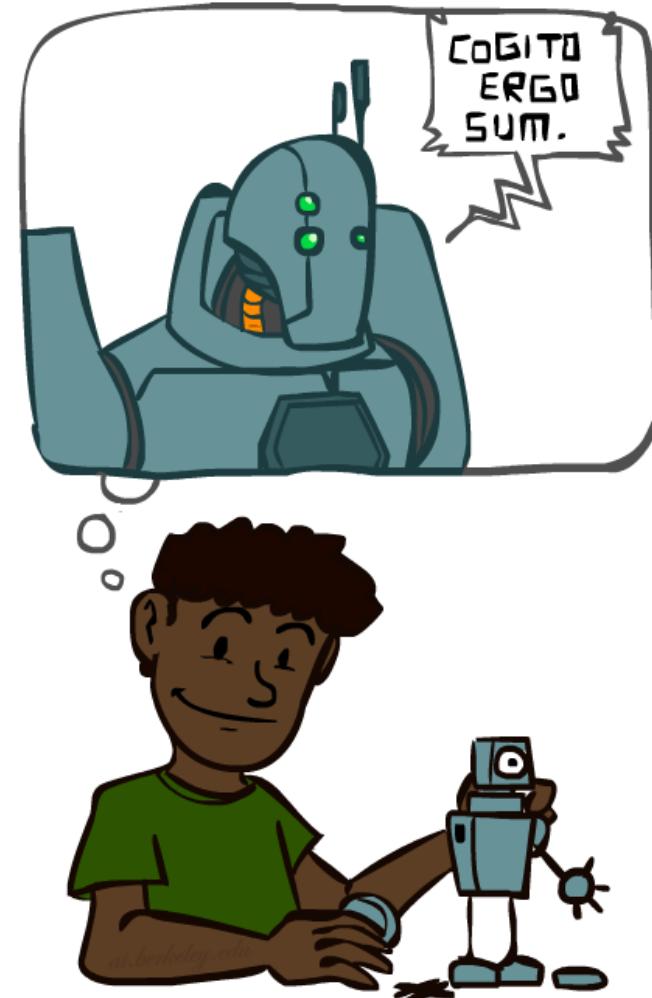
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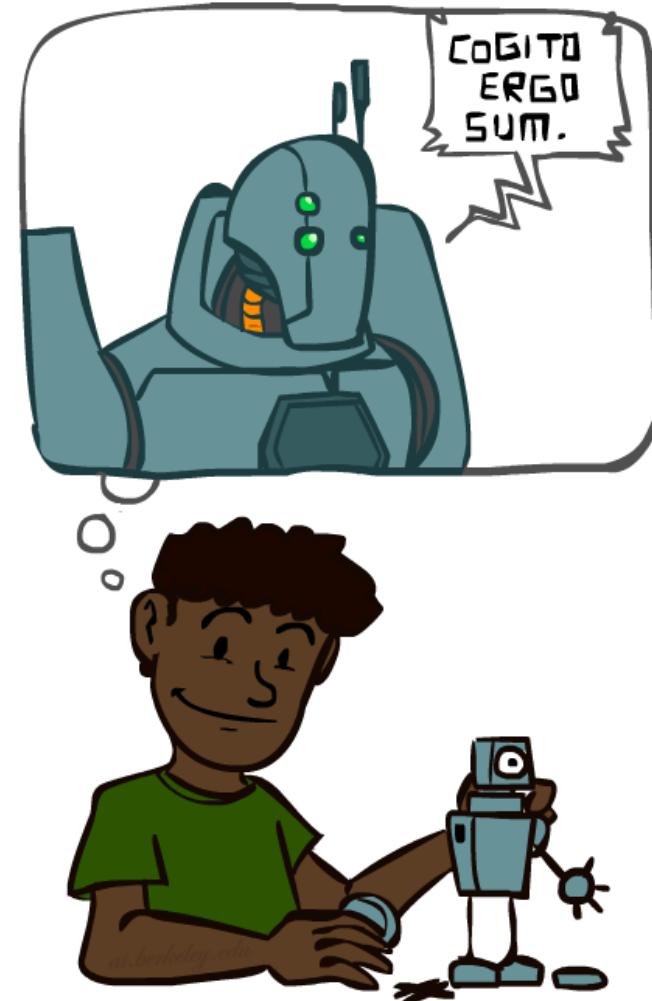
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  - 1950s: Early AI programs, including Samuel's checkers program, Newell & Simon's Logic Theorist, Gelernter's Geometry Engine
  - **1956: Dartmouth meeting: “Artificial Intelligence” adopted**
  - 1965: Robinson's complete algorithm for logical reasoning



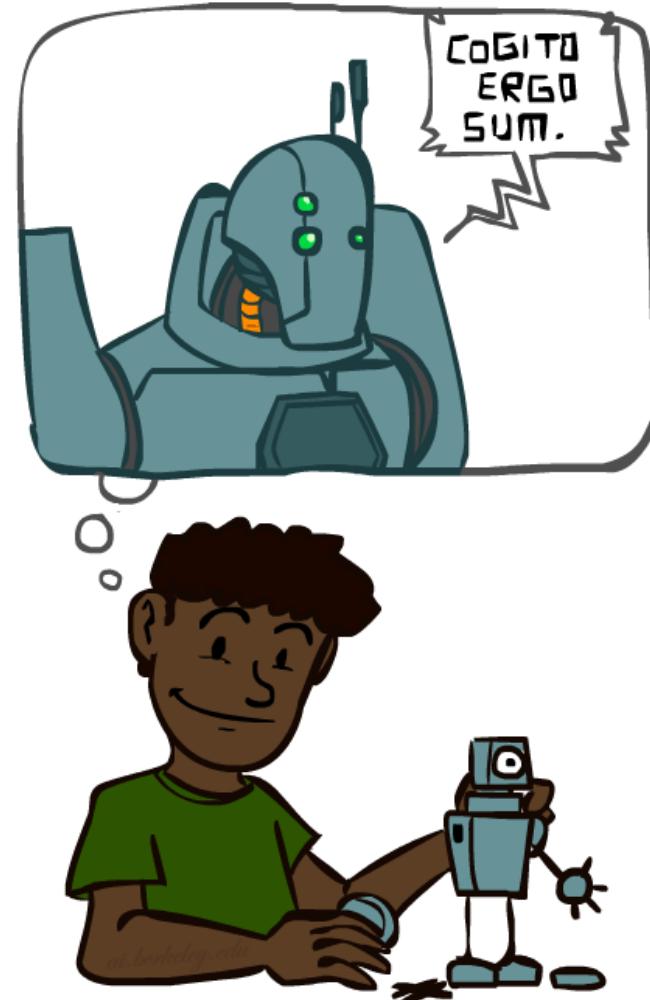
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  - 1969–79: Early development of knowledge-based systems
  - 1980–88: Expert systems industry booms
  - 1988–93: Expert systems industry busts: "AI Winter"



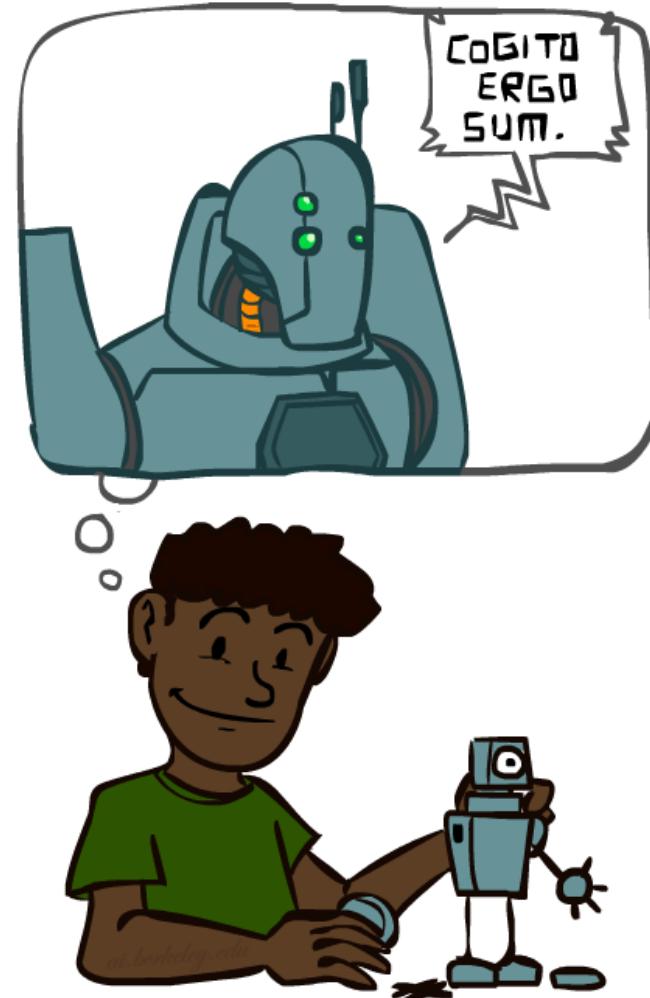
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  - General increase in technical depth
  - Agents and learning systems... "AI Spring"?



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- 1990–2012: Statistical approaches
  - Resurgence of probability, focus on uncertainty
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- 2012–: Where are we now?



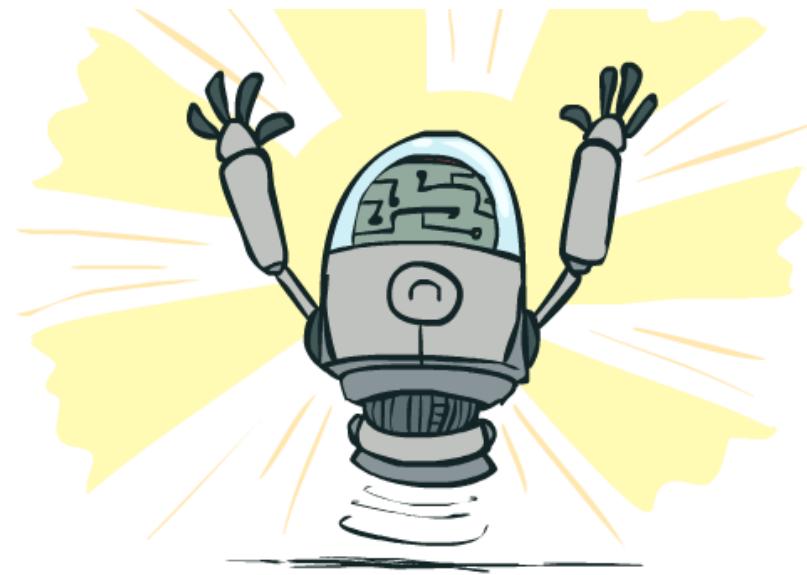
# Hot Topics Today

- 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?

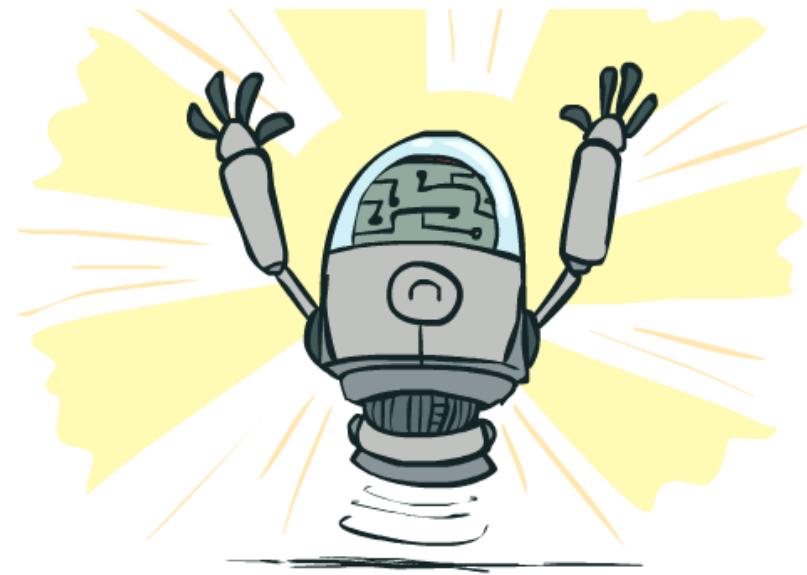
- Play a decent game of Jeopardy?
- Win against any human at chess?
- Win against the best humans at Go?
- Play a decent game of tennis?
- Grab a particular cup and put it on a shelf?
- Unload any dishwasher in any home?
- Drive safely along the highway?
- Drive safely along the streets of Pennsylvania?
- 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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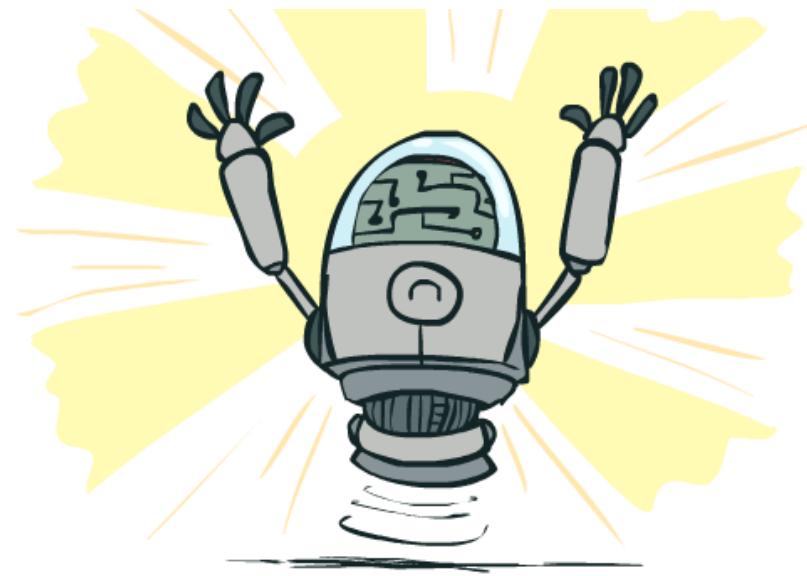
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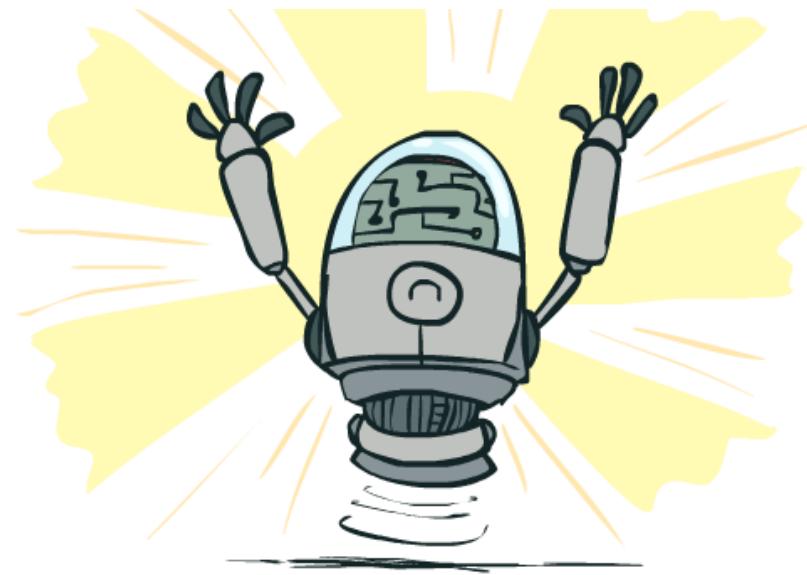
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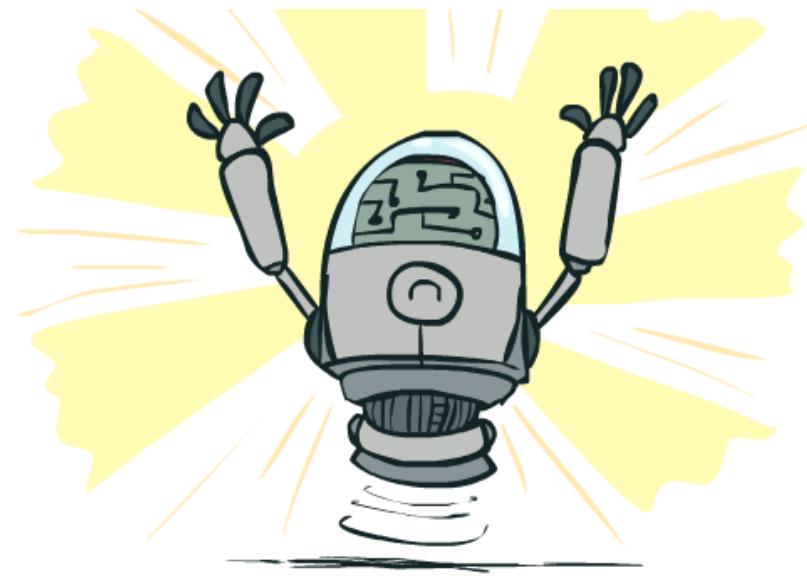
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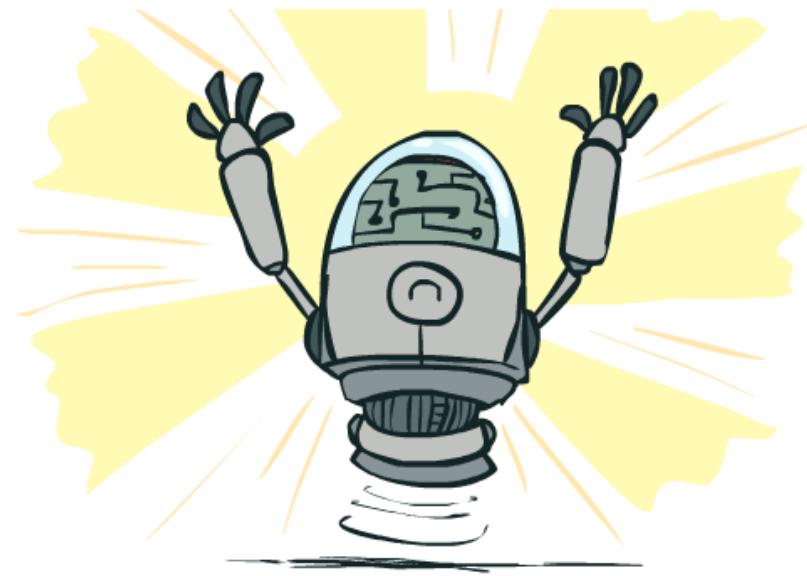
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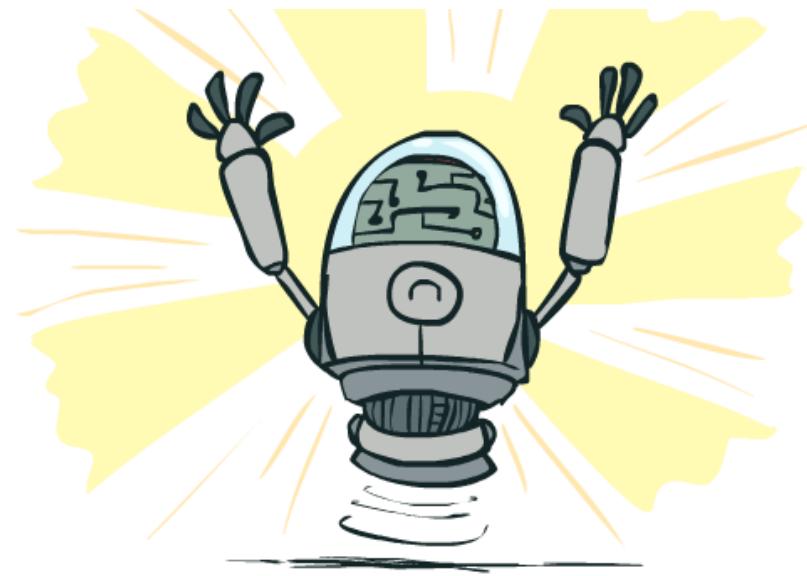
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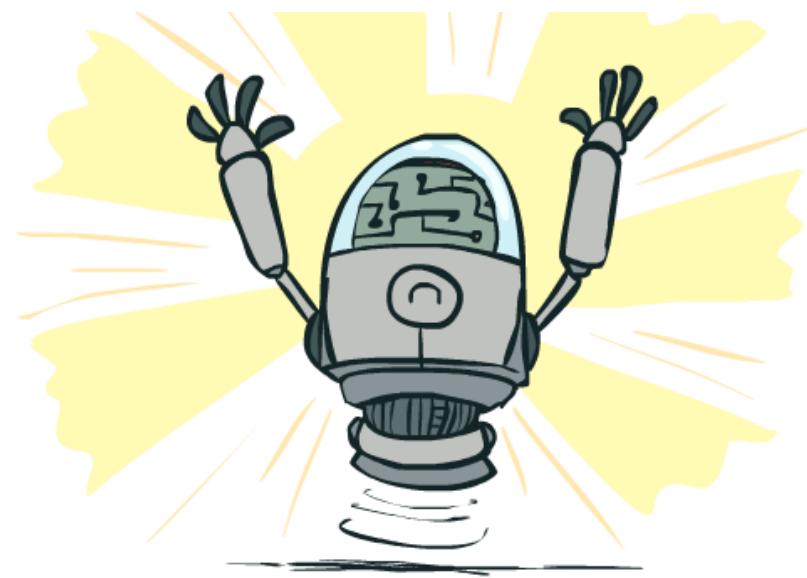
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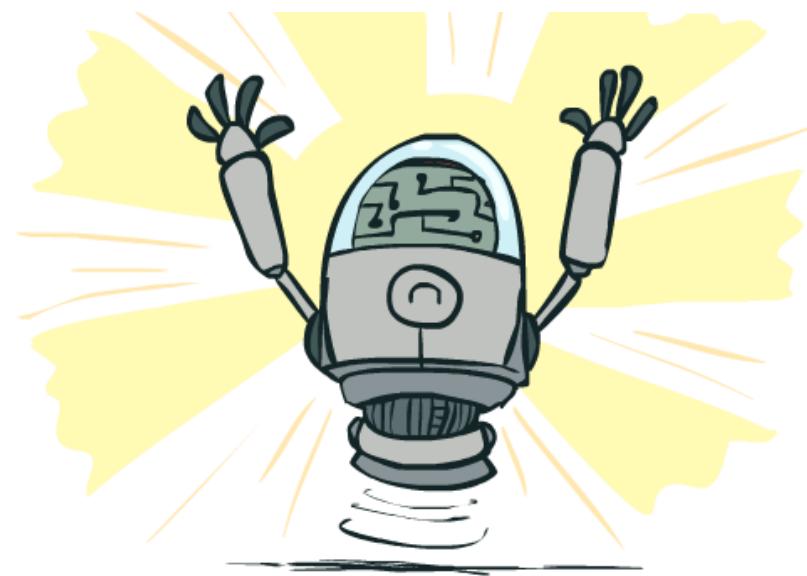
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Mon 21 Aug 2023 : 14:28 UTC

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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 dalaï-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"**

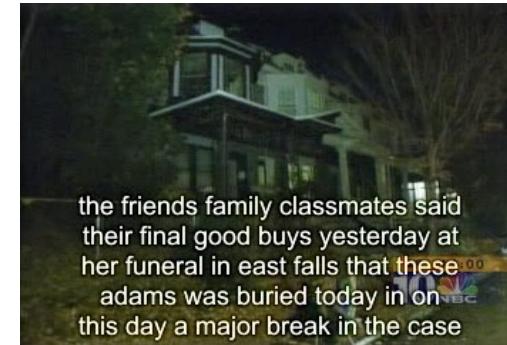
Philip Bruno, correspondent for "World" in China, said that journalists of the AFP who have been deported from the Tibetan province of Qinghai "were not illegal."

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

**Video** Anniversary of the Tibetan rebellion: China on guard

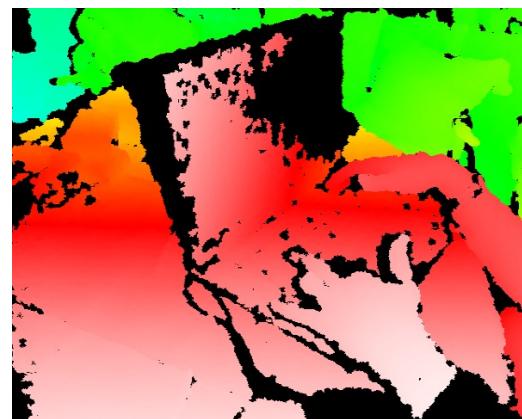
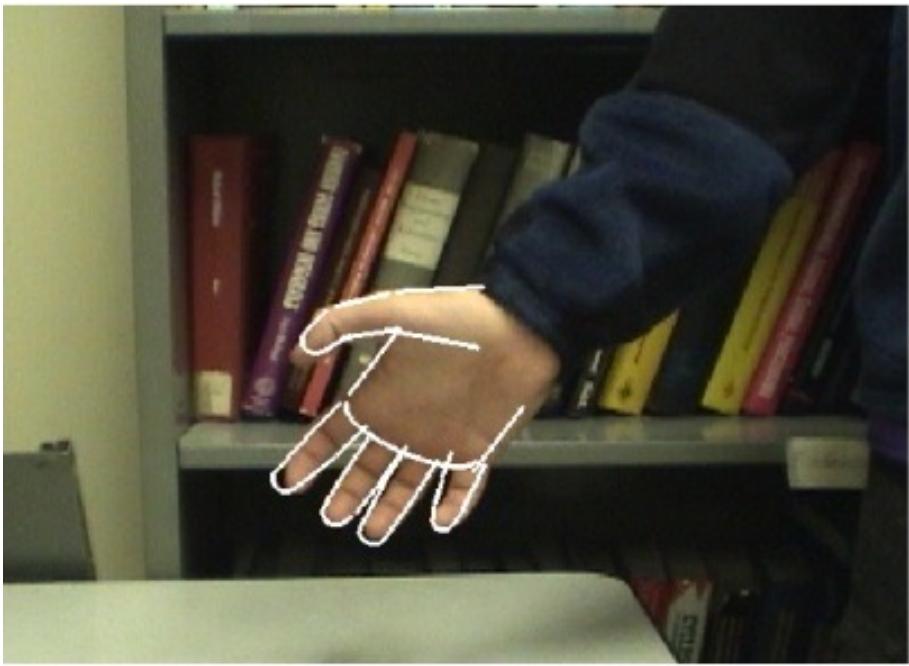


- Web search
- Text classification, spam filtering, etc...



# Vision (Perception)

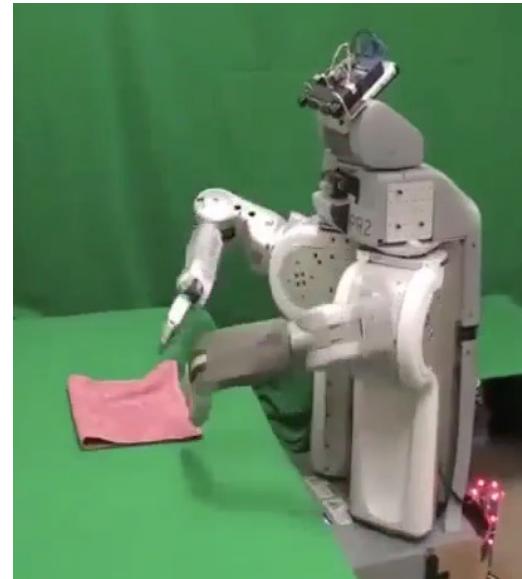
- Object and face recognition
- Scene segmentation
- Image classification



Demo: [YOLO obj-detect](#)

# Robotics

- 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

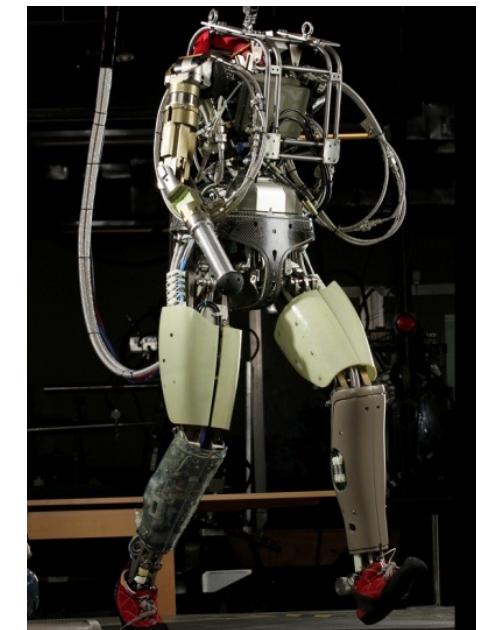


Demo 1: [ROBOTICS – soccer.avi](#)

Demo 3: [ROBOTICS – gcar.avi](#)

Demo 4: [ROBOTICS – laundry.avi](#)

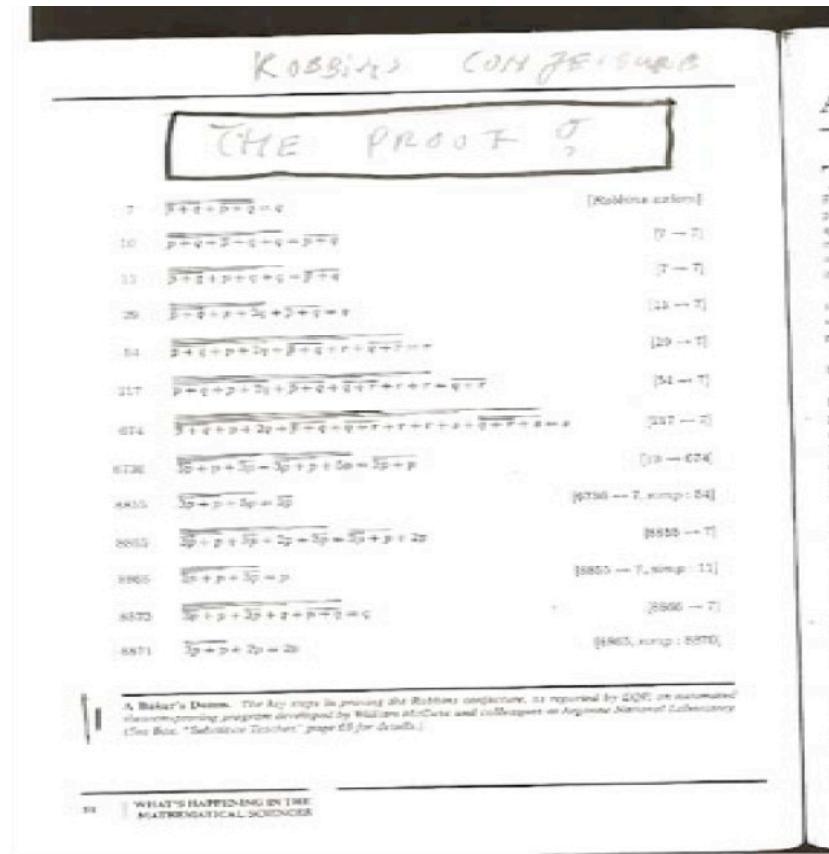
Demo 5: [ROBOTICS – petman.avi](#)



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!)



Courtesy: Pieter Abbeel

Image from Bart Selman

# 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!

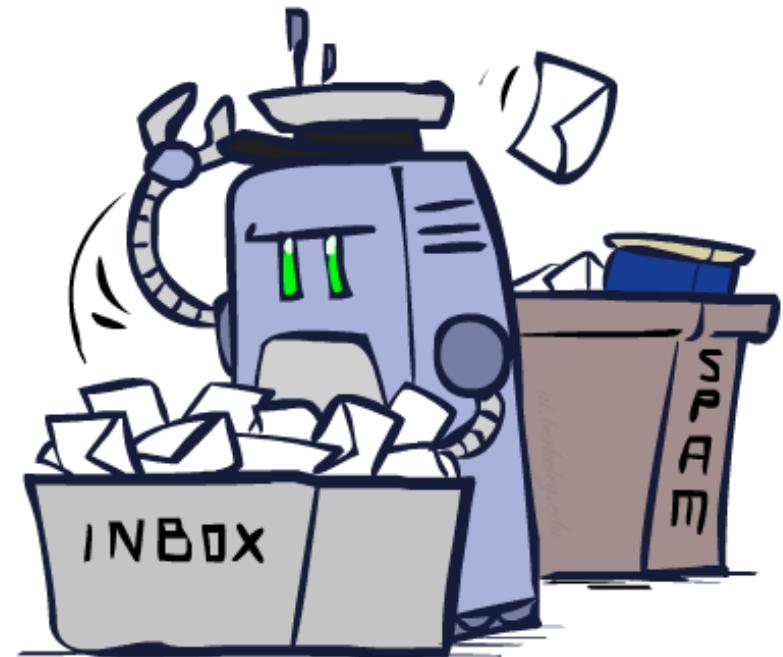
**In March 2016, it beat Lee Sedol in a five-game match, the first time a computer Go program has beaten a 9-dan professional without handicap**



# 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

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

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

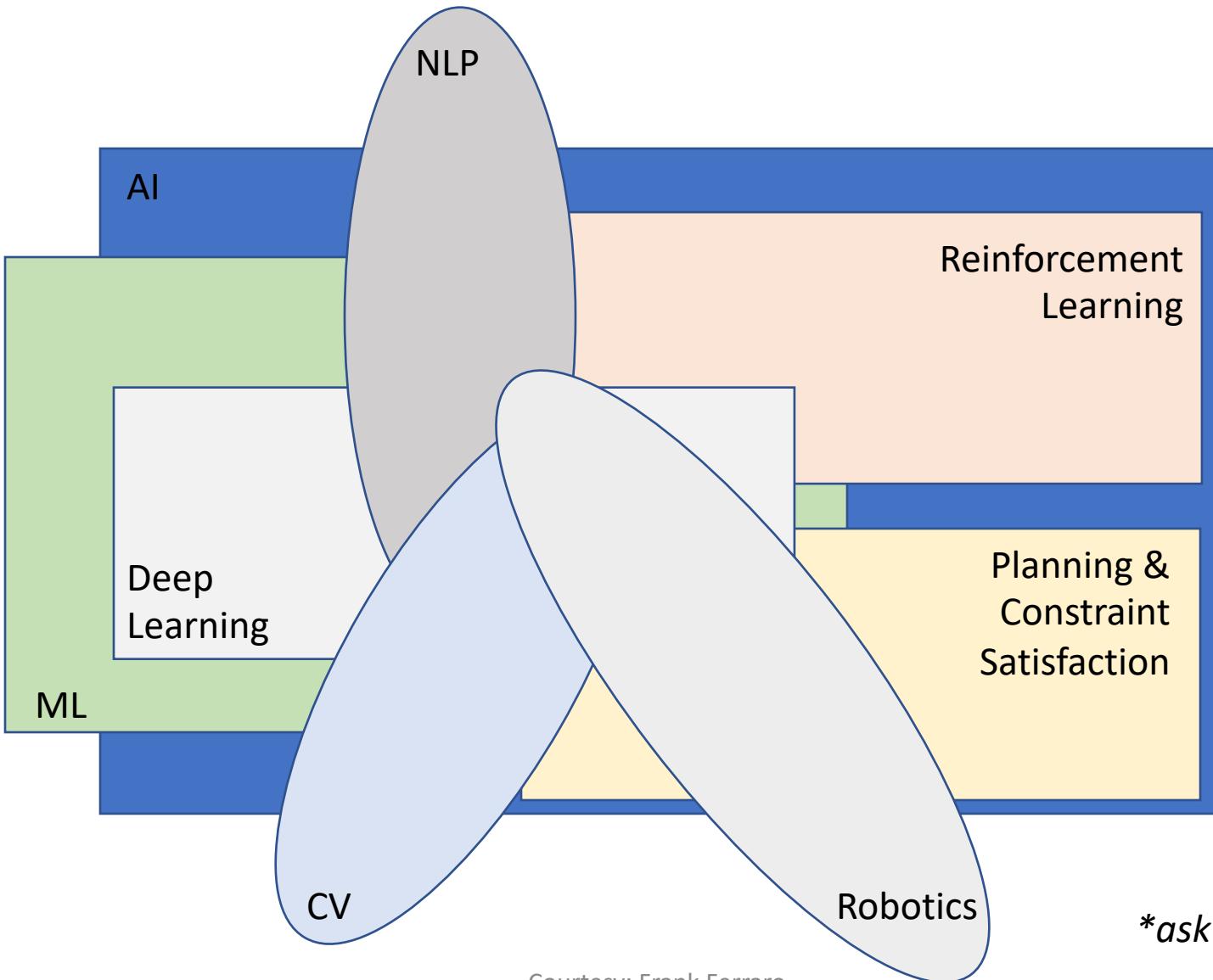
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- ~~Surf the web and find interesting knowledge~~
- ~~Interpret an arbitrary visual scene~~
- ~~Learn a natural language~~
- ~~Play Go well~~
  - Construct plans in dynamic real-time domains
  - Refocus attention in complex environments
  - Perform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

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**Exhibit true autonomy  
and intelligence!**

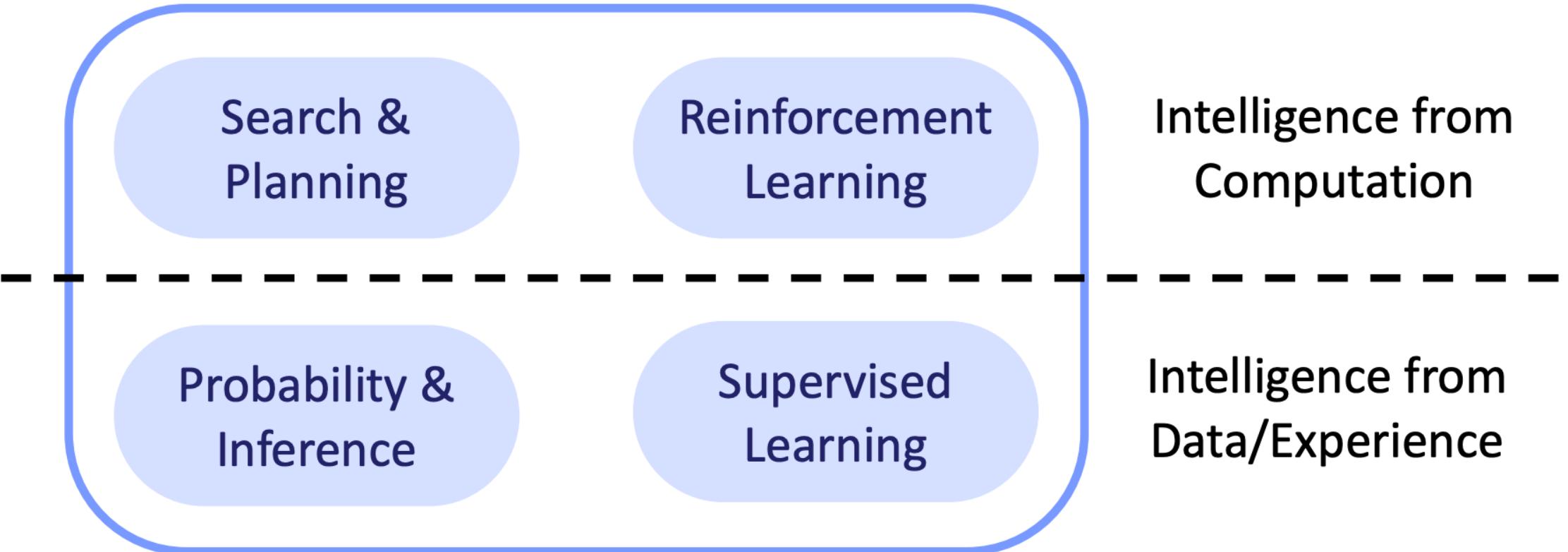
# A Partial, Incomplete View of AI, as a diagram of keywords\*



Courtesy: Frank Ferraro

*\*ask 10 people, get  
11+ opinions*

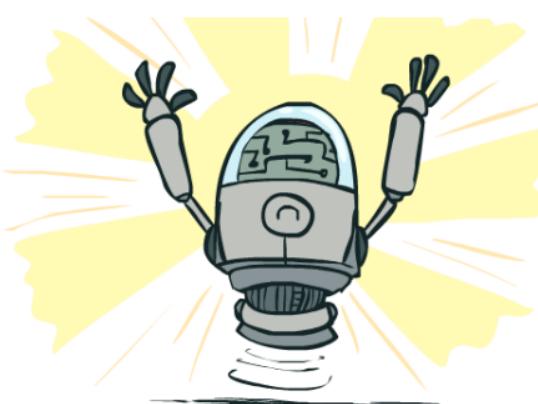
# Course Topics



# By the end of this course you'll:

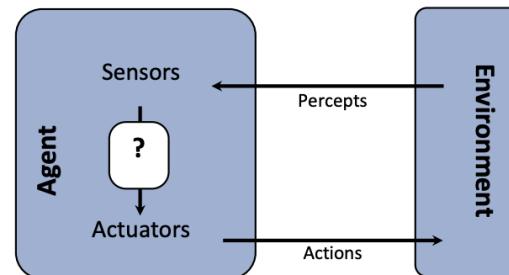
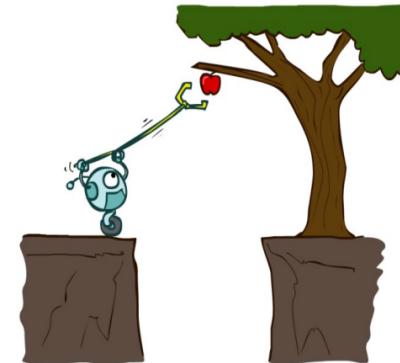
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- Build and understand math of rational, learning agents
- Select and apply the right AI methods for wide range of problems
- Recognize how these methods are used in modern AI systems
- Be prepared to make decisions on how AI is used in society



# 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