

CMSC 471  
Intro to Artificial Intelligence  
Fall 2023

KMA Solaiman

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

# Instructor: KMA Solaiman (Salvi)

ITE 201C/Remote

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

Wednesday: 1-2 pm

Monday: 1-2pm (if needed)

by appointment

Multimodal Information  
Retrieval

Vision & language processing

Learning with low-to-no  
supervision

Novelties in Learning Models

TA

**Prasanna Bollineni**

[LinkedIn](#)

[lakshmb1@umbc.edu](mailto:lakshmb1@umbc.edu)

**Office hours:**

Mon 11:30-12:30pm,  
and by appointment

**Location:** ITE 334

**Shashank Sacheti**

[LinkedIn](#)

[ssachet1@umbc.edu](mailto:ssachet1@umbc.edu)

**Office hours:**

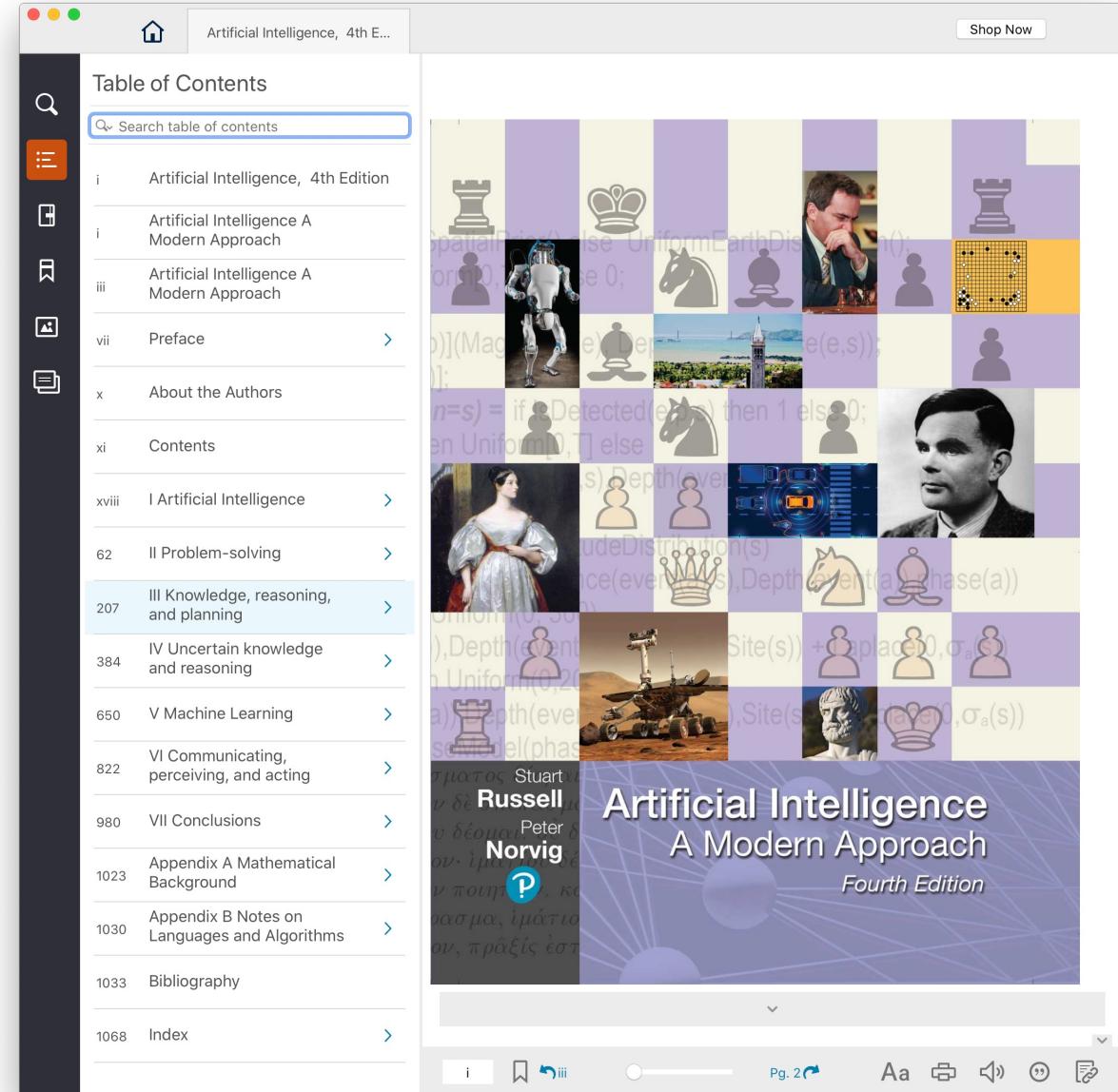
Wed 12-1pm,  
and by appointment

**Location:** ITE 334

# 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/fall2023-public/>



<https://campuswire.com/c/G38B2595B/feed>



**campuswire**

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

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This Week



**campuswire**

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# Course Syallabus (On the Website)

## CMSC 471 – Introduction to Artificial Intelligence

Fall 2023

- [CMSC 471 — Introduction to Artificial Intelligence](#)
  - [Logistics](#)
  - [Course Description](#)
    - [CMI Text Book](#)
    - [Prerequisites](#)
  - [Course Schedule](#)
  - [Assignments](#)
  - [Midterm and Final Exams](#)
  - [Course Evaluation](#)
  - [Policies](#)
    - [Due Dates](#)
    - [Extensions and Late Policy](#)
    - [Academic Honesty](#)
  - [Accomodations](#)
    - [Students with Accommodation Needs](#)
    - [Sexual Assault, Sexual Harassment, and Gender-based Violence and Discrimination](#)
    - [Hate, Bias, Discrimination, and Harassment](#)
  - [Acknowledgements](#)

# 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)

# Course Evaluation

Components	Percentage
Quiz (?)	10%
Assignments	45%
Exams (Midterm + Final)	40%
Course Engagement	5%

# Course Evaluation

On Blackboard if we have them, mostly to motivate you to keep up with the reading and classes

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What is engagement?

# Final Grades

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

# 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

# Late Policy

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Use them as needed throughout the course

They're meant for personal reasons and **emergencies**

Do not procrastinate

# Late Policy

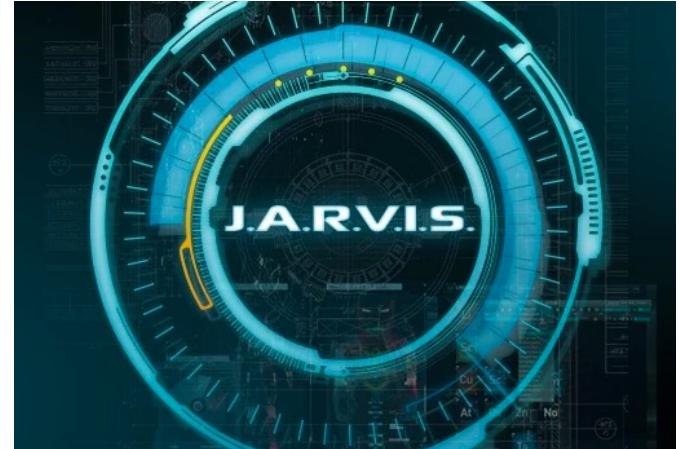
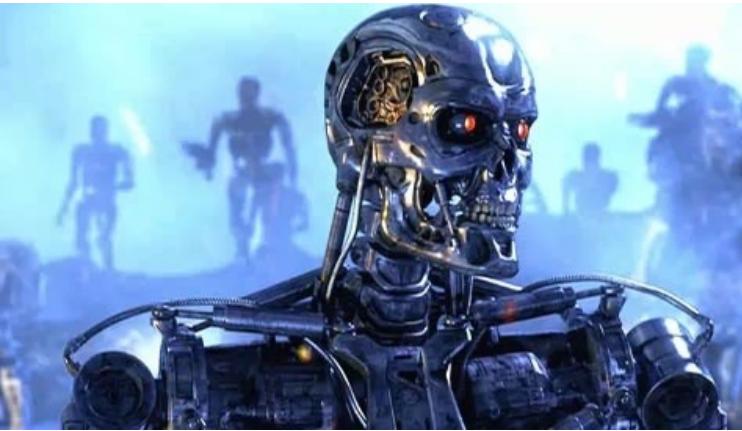
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Contact me privately if an extended absence will occur

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

Q: What is AI  
(artificial intelligence)?

# Sci-Fi AI?



Partially Adapted from: Pieter Abbeel

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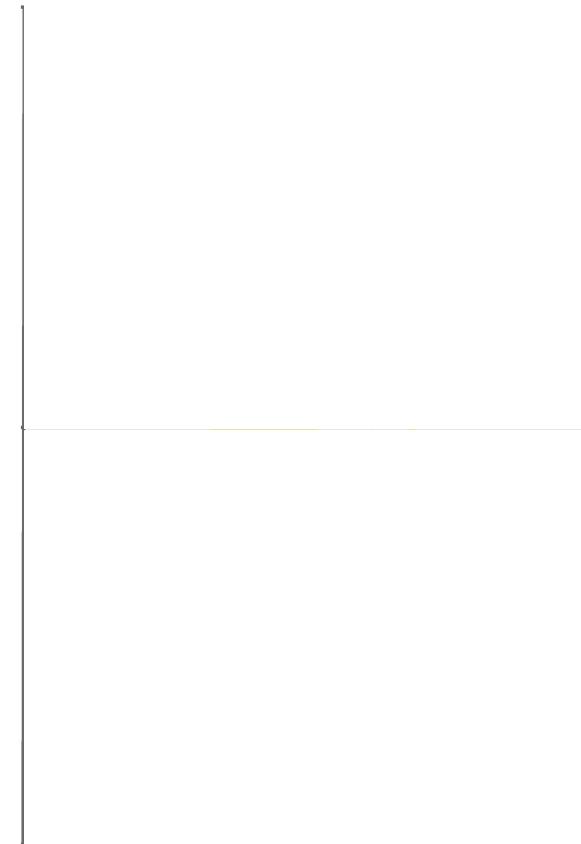
A. Intelligence is the computational part of the ability to achieve goals in the world. Varying kinds and degrees of intelligence occur in people, many animals and some machines

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Courtesy: Tim Finin

# Possible Approaches

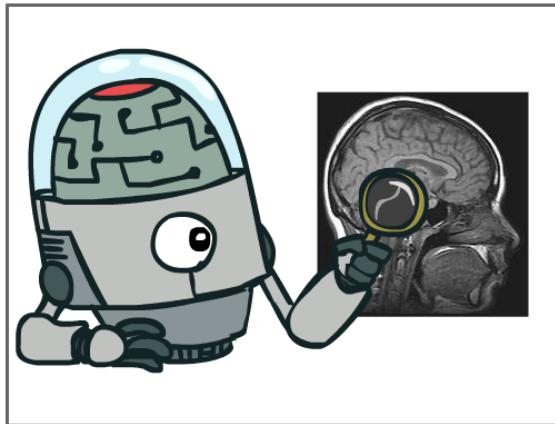
The science of making machines that:



# Possible Approaches

The science of making machines that:

Think like people

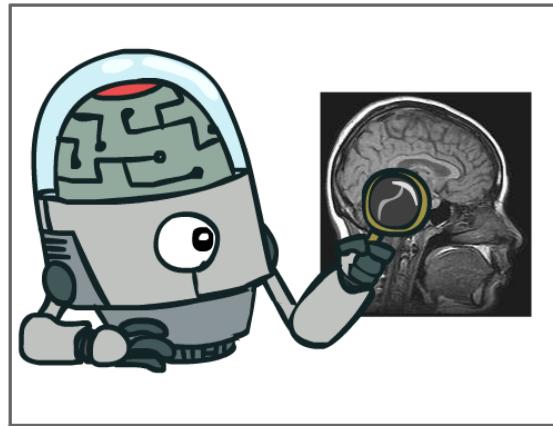


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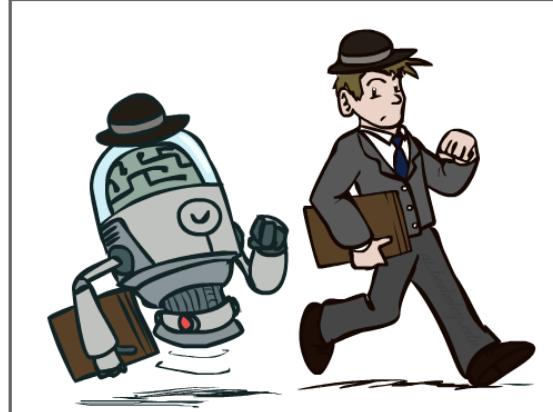
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The science of making machines that:

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Act like people

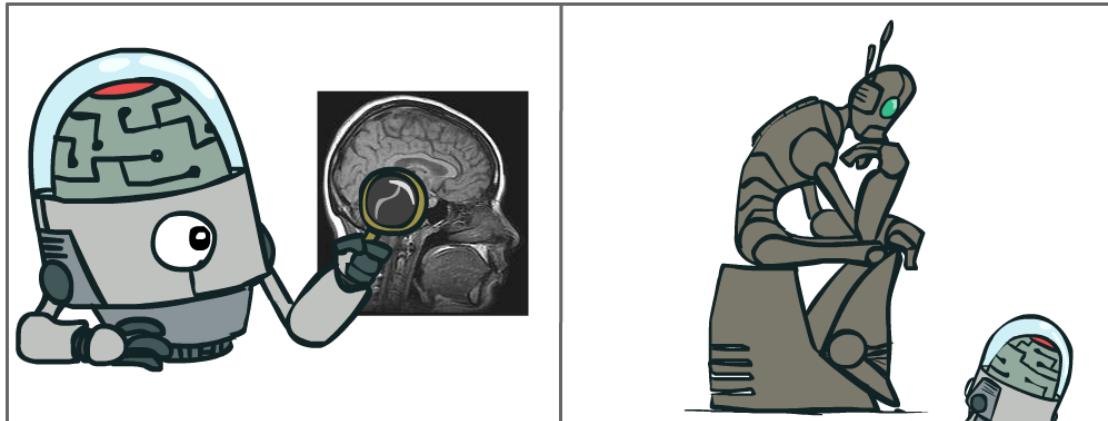


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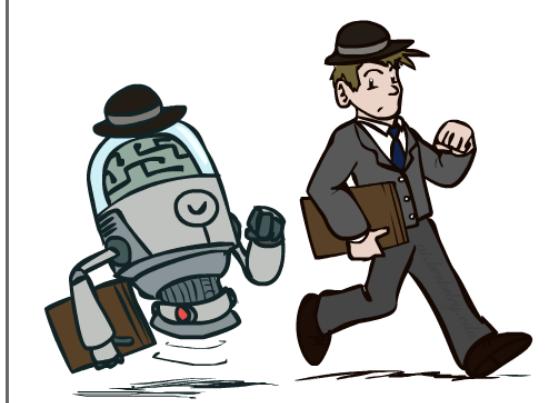
The science of making machines that:

Think like people



Think rationally

Act like people

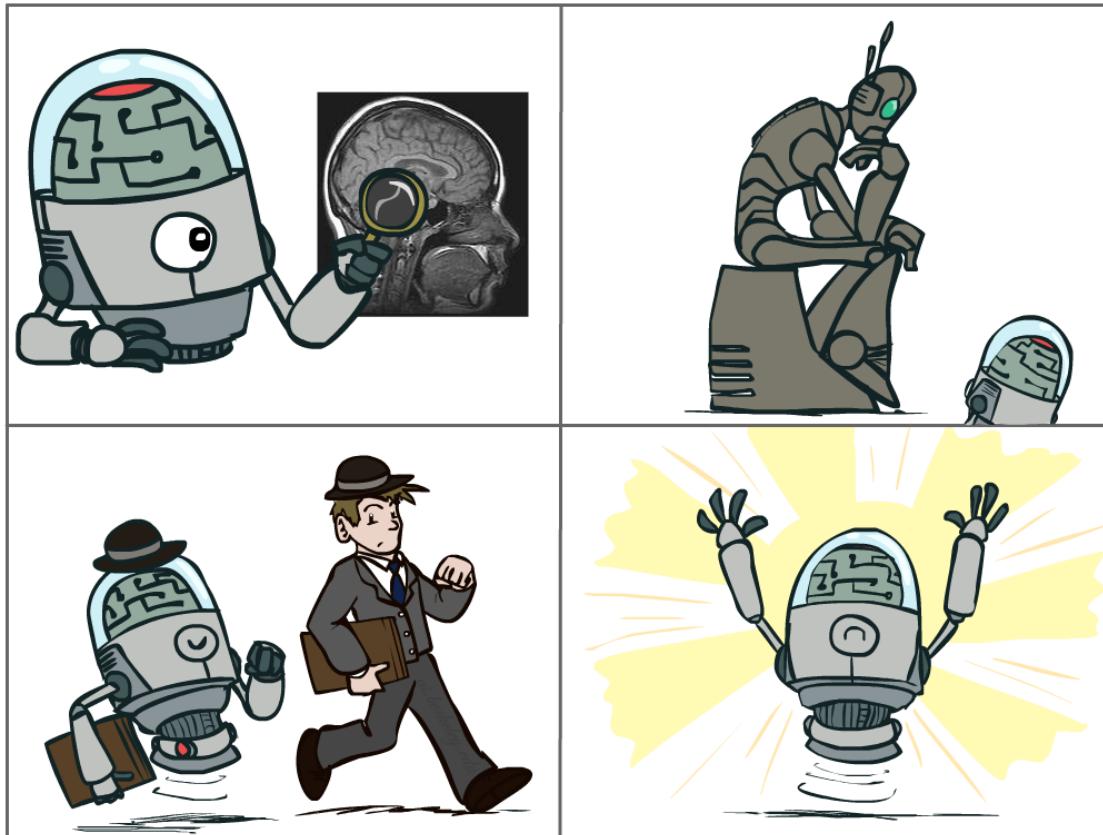


Courtesy: Pieter Abbeel

# Possible Approaches

The science of making machines that:

Think like people



Think rationally

Act like people

# Rational Decisions

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

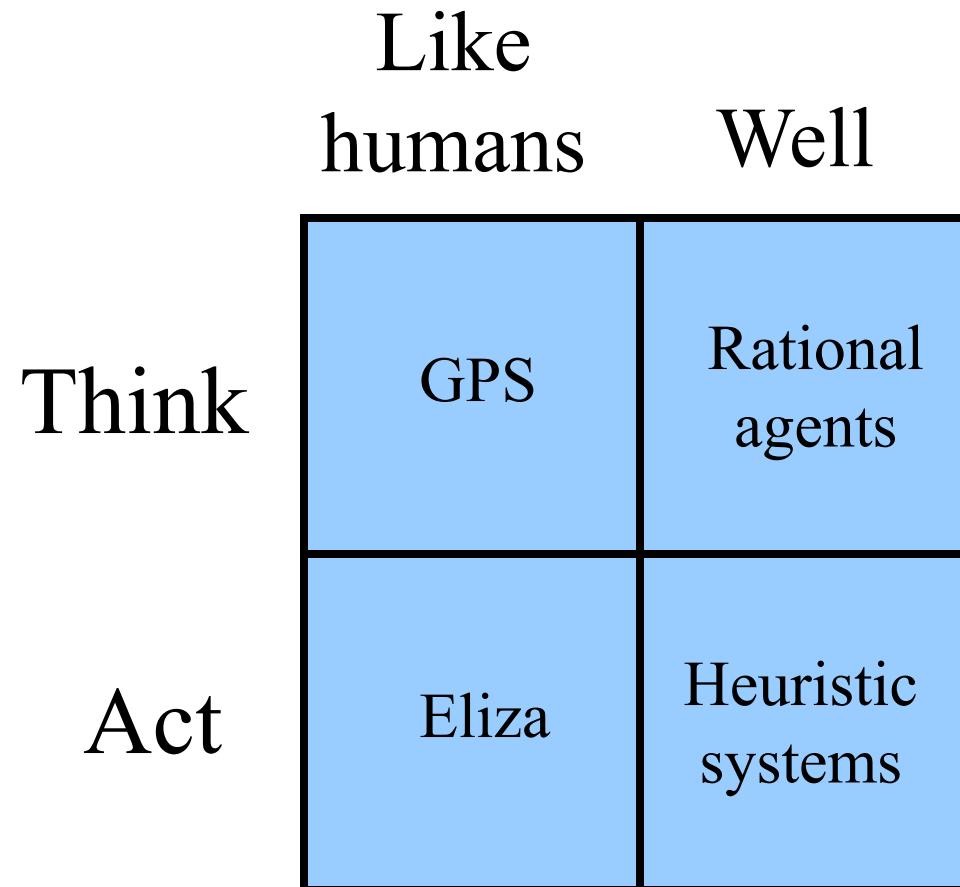
- Rational: maximally achieving pre-defined goals
- Rationality only concerns what decisions are made  
(not the thought process behind them)
- Goals are expressed in terms of the **utility** of outcomes
- Being rational means **maximizing your expected utility**

# Rational Decisions

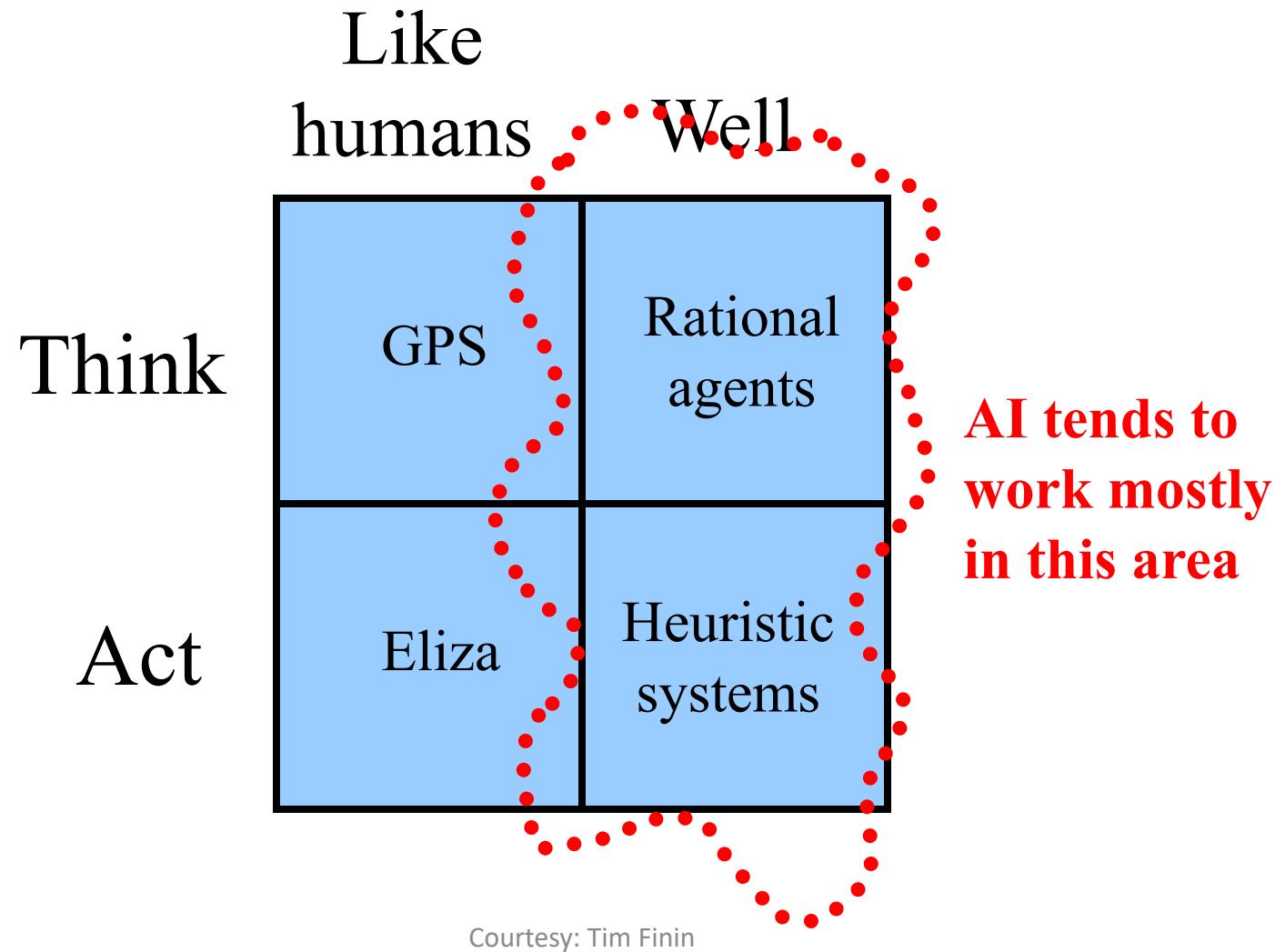
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# Possible Approaches



# Possible Approaches



# 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, ...

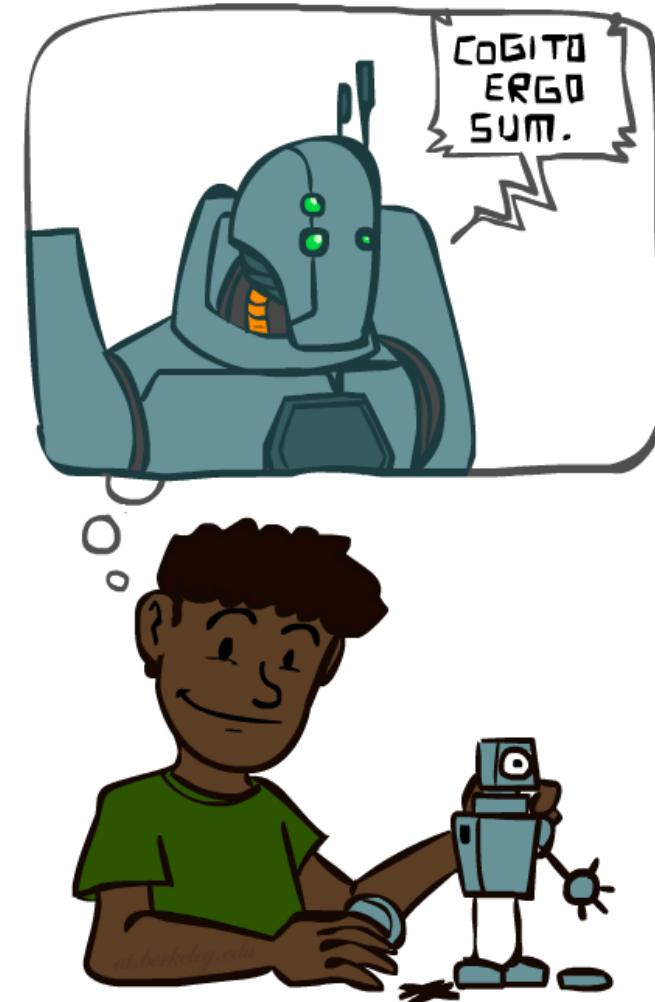
## **2 Cognitive Science:** model and understand how natural minds and mental phenomena work

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, ...

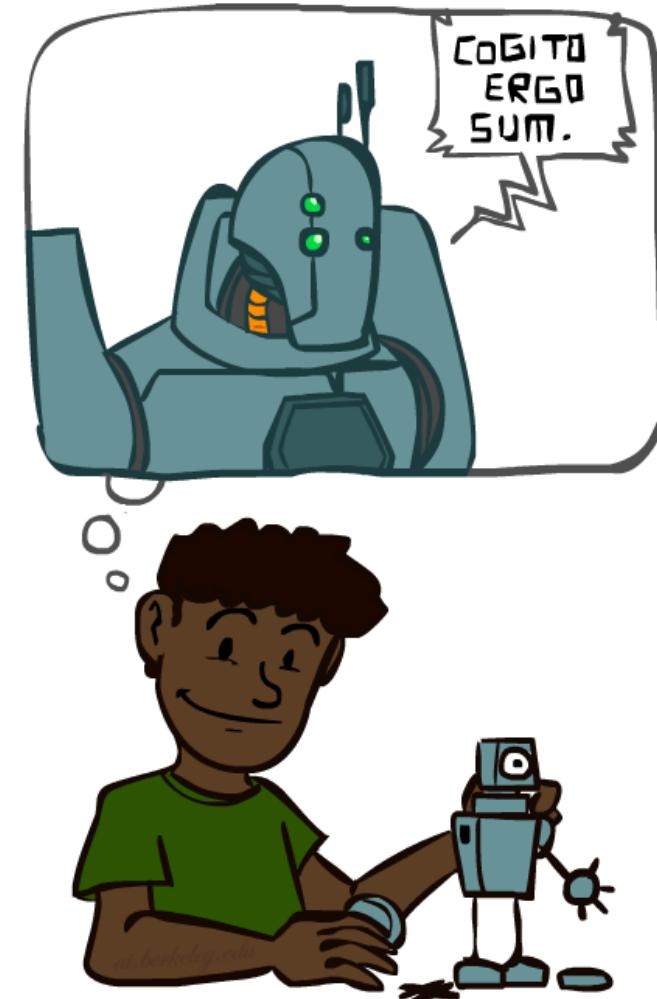
# A (Short) History of AI



Courtesy: Pieter Abbeel

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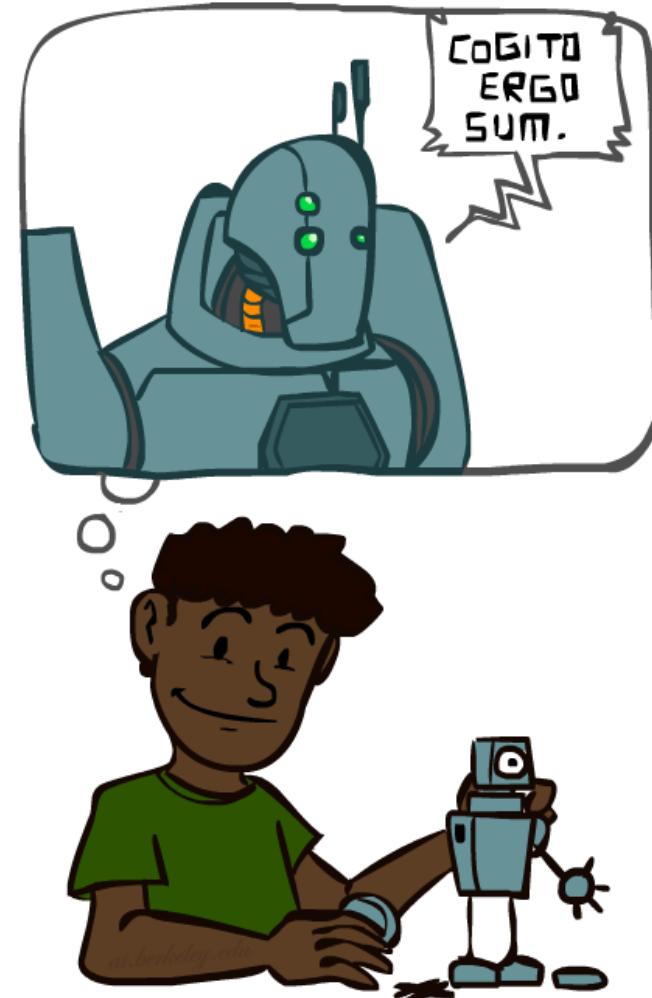
- 1940-1950: Early days
  - 1943: McCulloch & Pitts: Boolean circuit model of brain
  - 1950: Turing's "Computing Machinery and Intelligence"



Courtesy: Pieter Abbeel

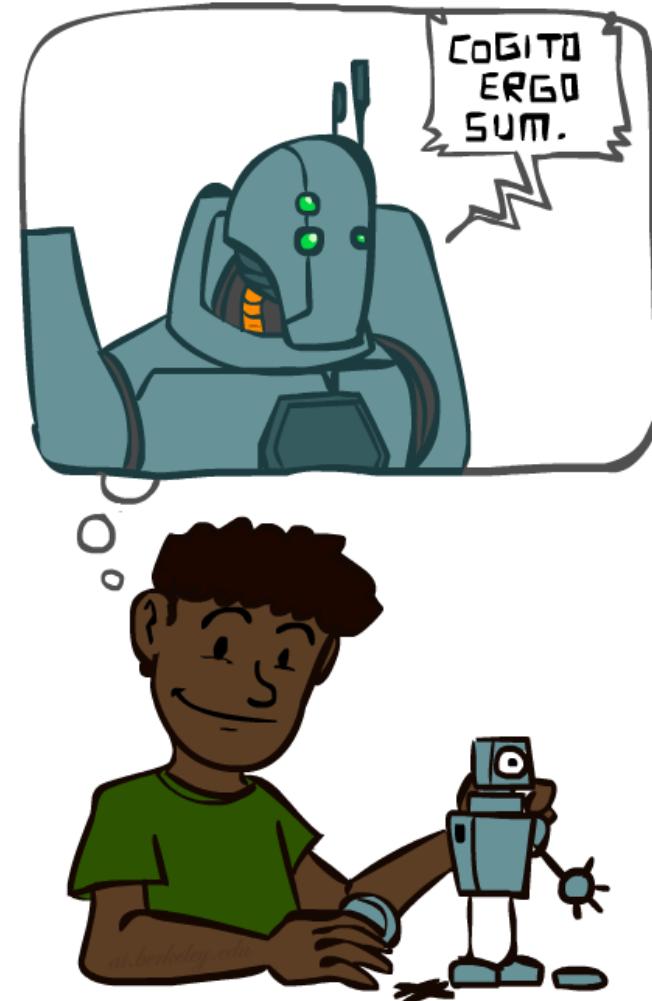
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- 1950—70: Excitement: Look, Ma, no hands!
  - 1950s: Early AI programs, including Samuel's checkers program, Newell & Simon's Logic Theorist, Gelernter's Geometry Engine
  - **1956: Dartmouth meeting: “Artificial Intelligence” adopted**
  - 1965: Robinson's complete algorithm for logical reasoning



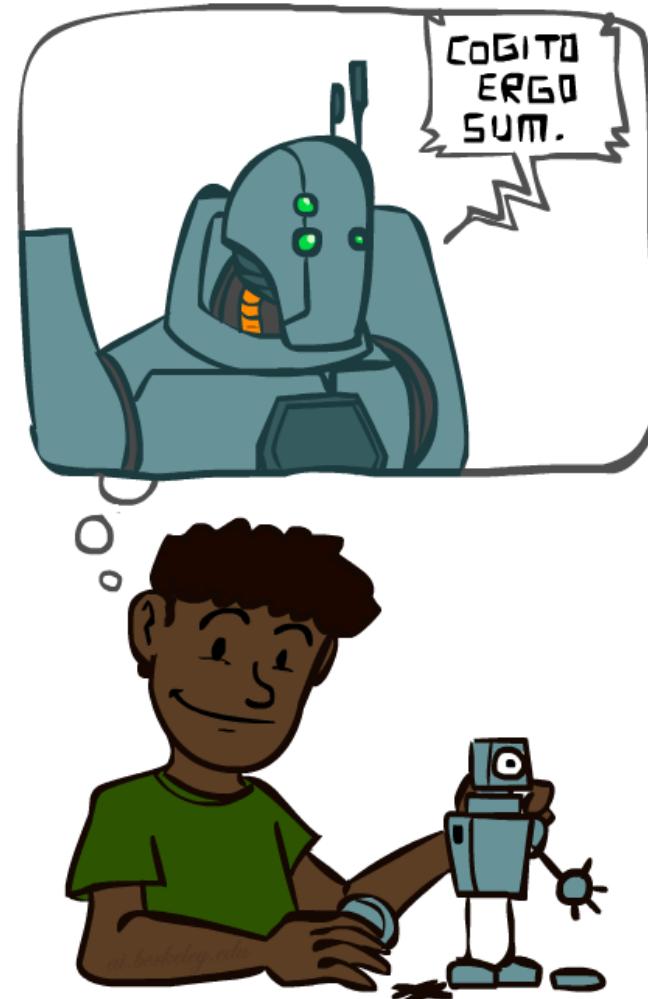
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  - 1980–88: Expert systems industry booms
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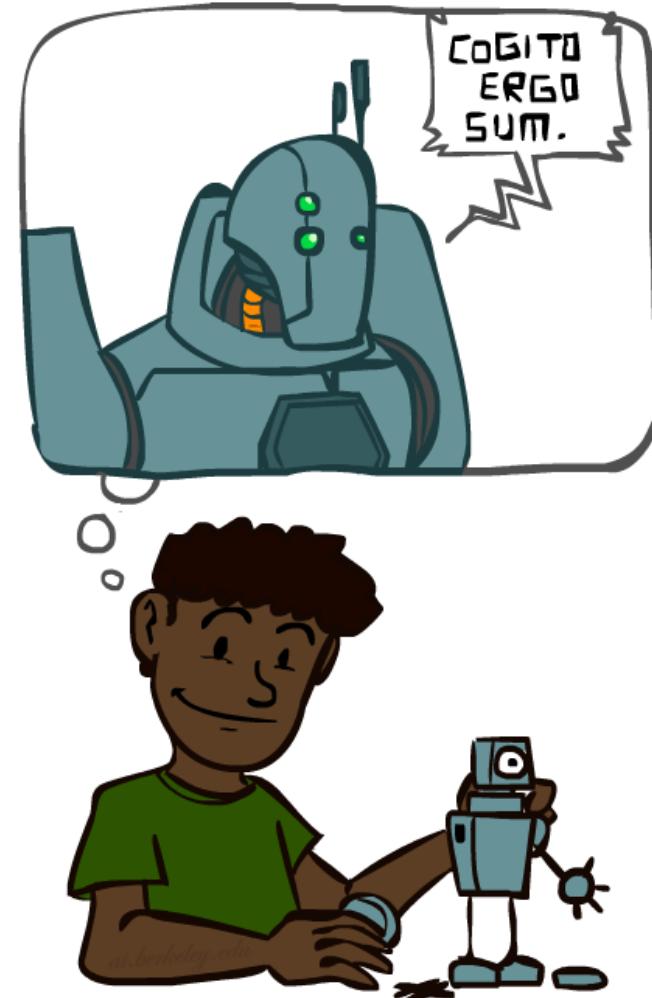
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  - General increase in technical depth
  - Agents and learning systems... "AI Spring"?



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- 2000–: Where are we now?



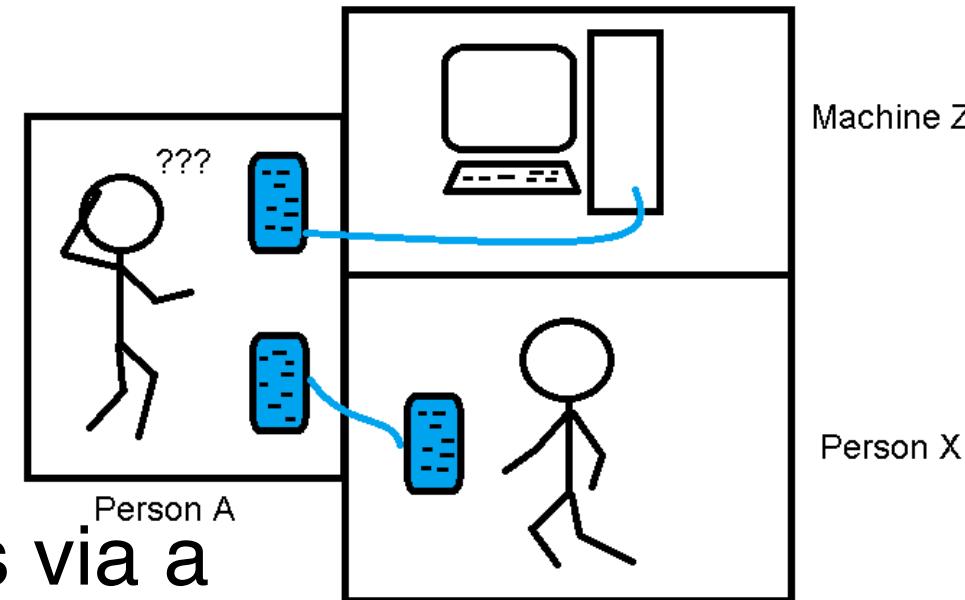
# 1956 Dartmouth Project

“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/dartmouth.html>

# Turing Test<sup>1</sup>

- Three rooms: person, computer, interrogator
- Interrogator communicates with others via a ‘teleprinter’
- Interrogator tries to distinguish person and machine
- Machine tries to fool interrogator into believing it is the person
- Person acts naturally
- If machine succeeds, we conclude it can think



<sup>1</sup> [Turing, Alan](#) (October 1950), "Computing Machinery and Intelligence", *Mind*. (236): 433–460.

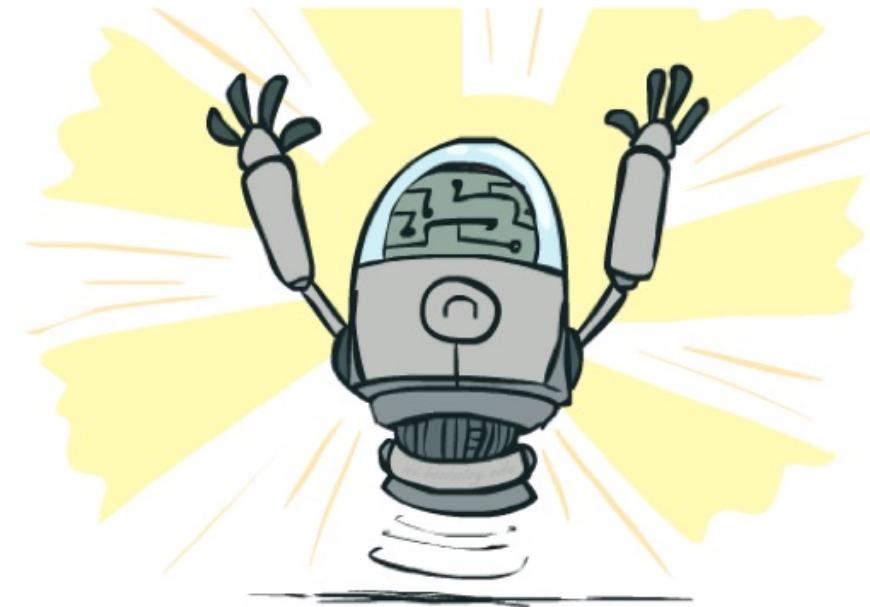
# Hot Topics Today

- 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 table tennis?
- ✓ Play a decent game of Jeopardy?
- ✓ Drive safely along a curving mountain road?
- ? Drive safely along Telegraph Avenue?
- ✓ Buy a week's worth of groceries on the web?
- ✗ Buy a week's worth of groceries at Walmart?
- ✗ Discover and prove a new mathematical theorem?
- ✗ Converse successfully with another person **for an hour**?
- ✓ Perform a surgical operation?
- ✓ Put away the dishes and fold the laundry?
- ✗ Translate spoken Chinese into spoken English in real time?
- Write an intentionally funny story?



# Unintentionally Funny Stories

Courtesy: Pieter Abbeel

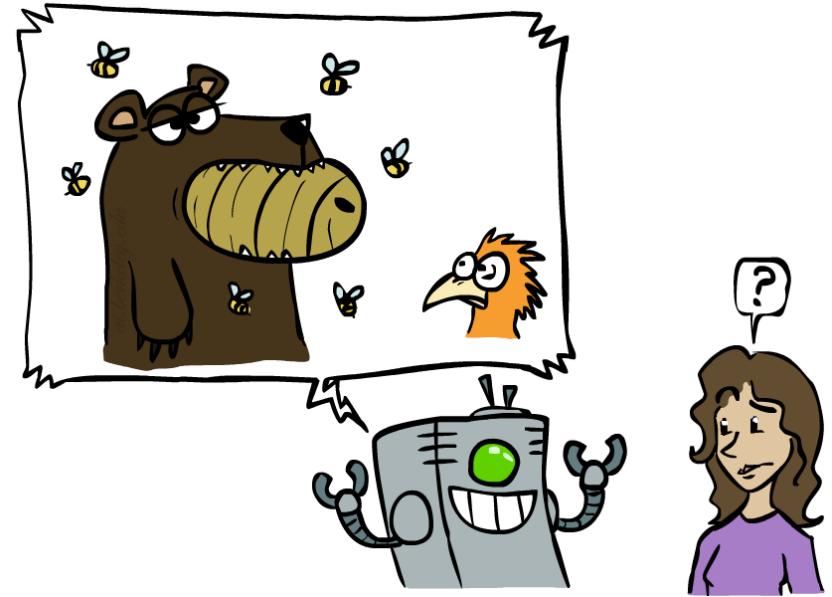
[Shank, Tale-Spin System, 1984]

# Unintentionally Funny Stories

- One day Joe Bear was hungry. He asked his friend Irving Bird where some honey was. Irving told him there was a beehive in the oak tree. Joe walked to the oak tree. He ate the beehive. The End.

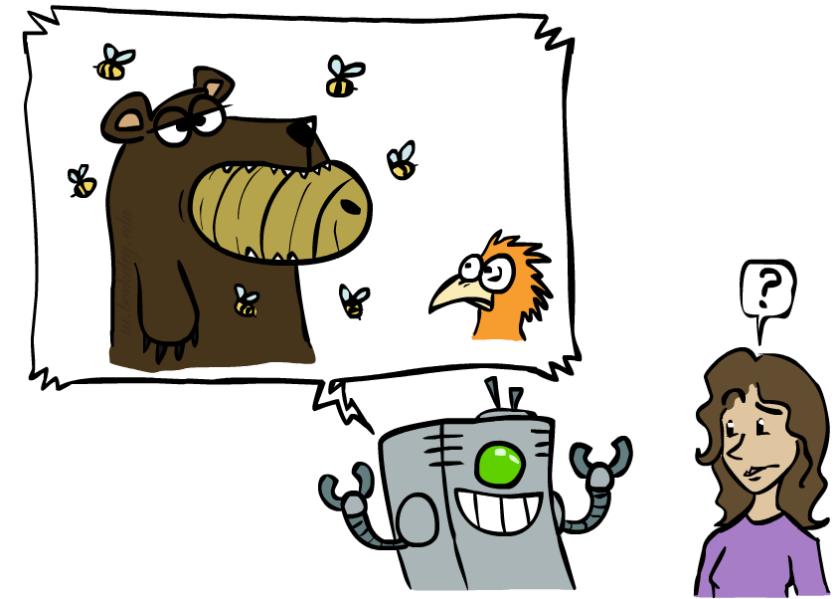
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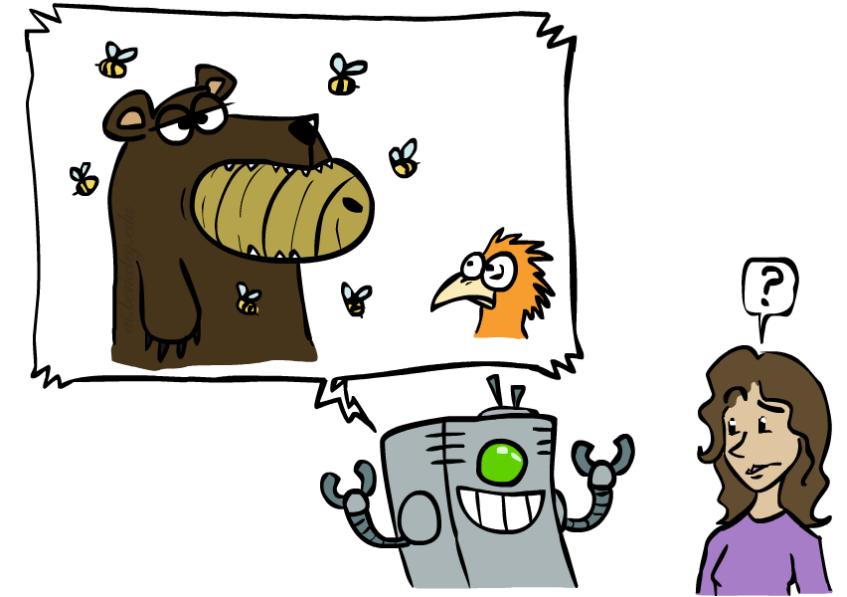
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- Henry Squirrel was thirsty. He walked over to the river bank where his good friend Bill Bird was sitting. Henry slipped and fell in the river. Gravity drowned. The End.



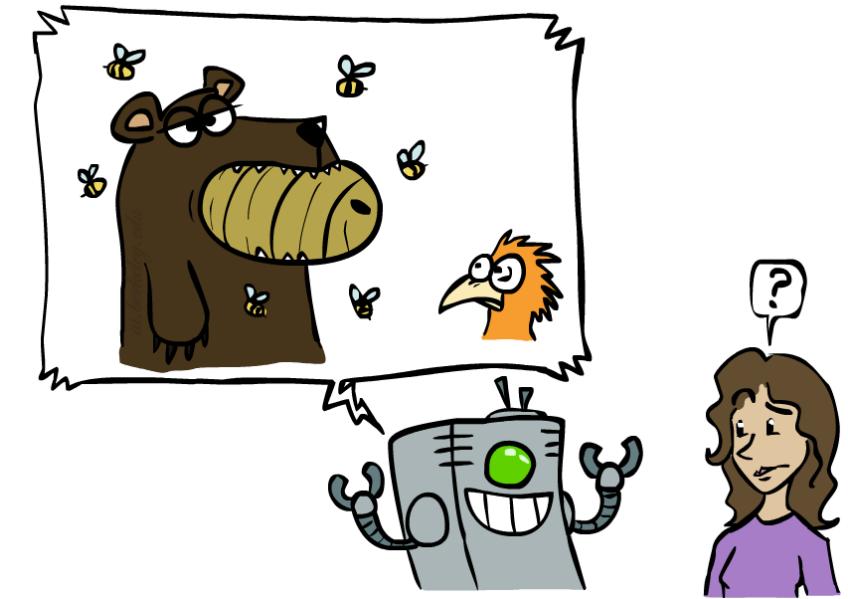
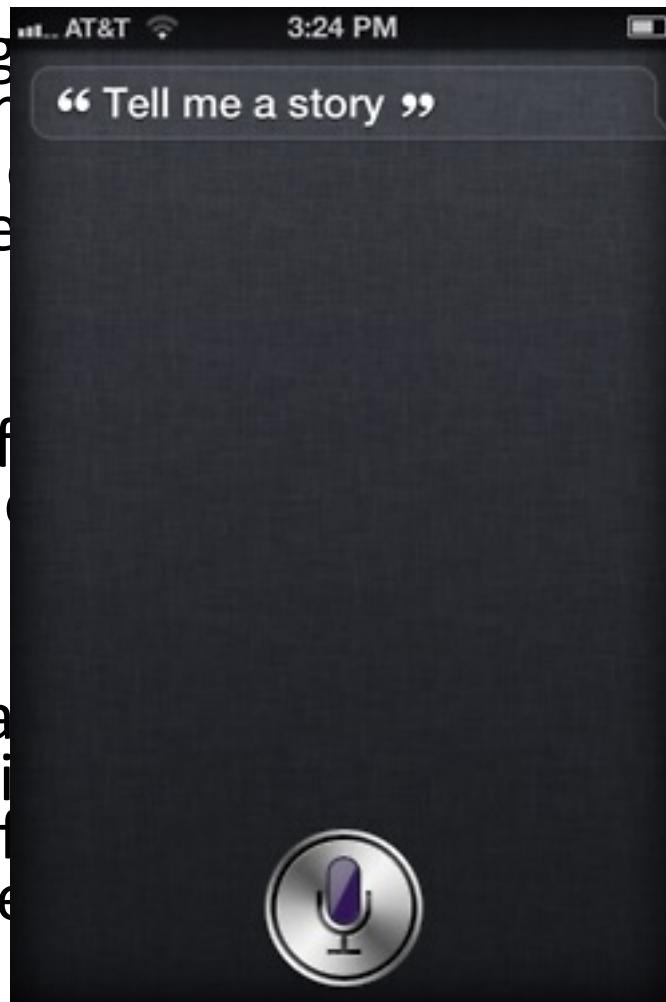
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- Once upon a time there was a dishonest fox and a vain crow. One day the crow was sitting in his tree, holding a piece of cheese in his mouth. He noticed that he was holding the piece of cheese. He became hungry, and swallowed the cheese. The fox walked over to the crow. The End.



# Unintentionally Funny Stories

- One day Joe Bear was hungry. Irving Bird where some honey. There was a beehive in the hollow of the oak tree. He ate the bees.
- Henry Squirrel was thirsty. He was drinking from a stream on the river bank where his good friend Henry was swimming. Henry slipped and fell in the water. The End.
- Once upon a time there was a fox. The fox was sitting in his tree, holding a piece of cheese. He was holding the piece of cheese. The fox walked over to the tree.

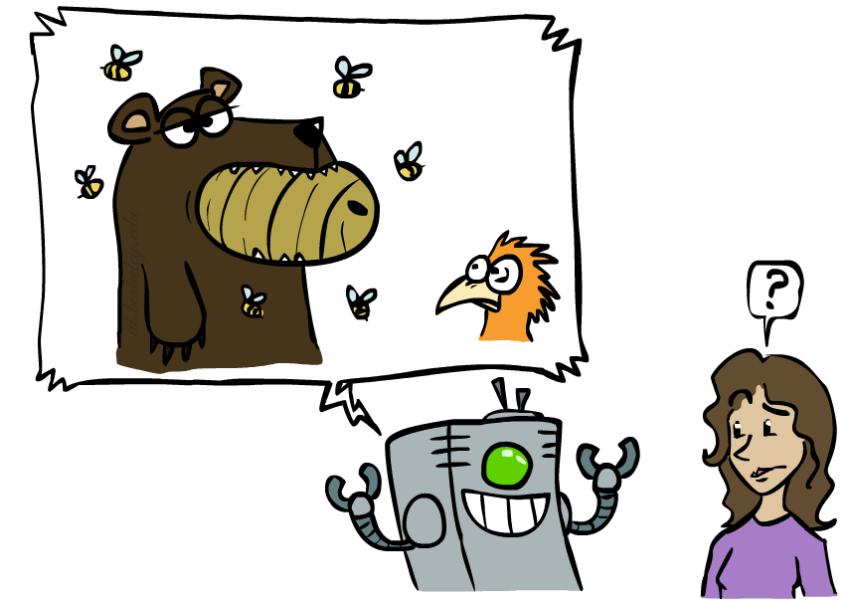


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[Shank, Tale-Spin System, 1984]

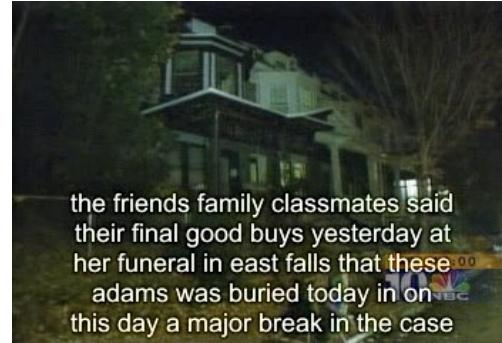
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# Natural Language

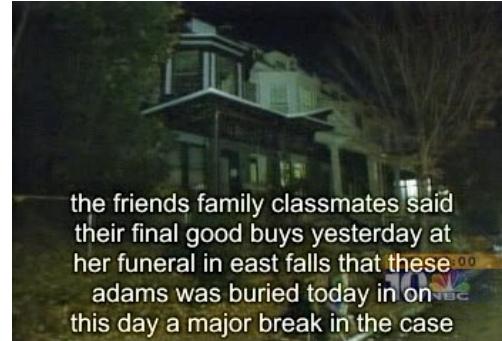
- Speech technologies (e.g. Siri)
  - Automatic speech recognition (ASR)
  - Text-to-speech synthesis (TTS)
  - Dialog systems



Courtesy: Pieter Abbeel

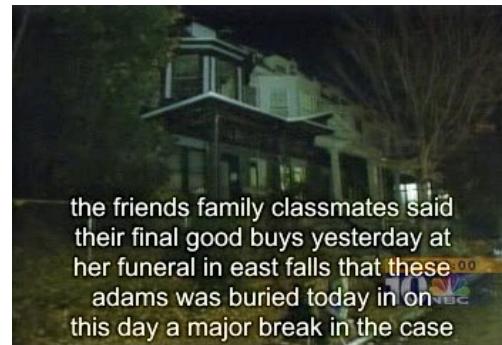
# Natural Language

- Speech technologies (e.g. Siri)
  - Automatic speech recognition (ASR)
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  - Dialog systems
- Language processing technologies



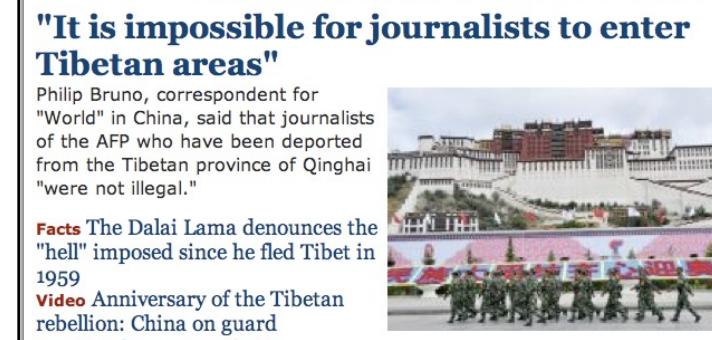
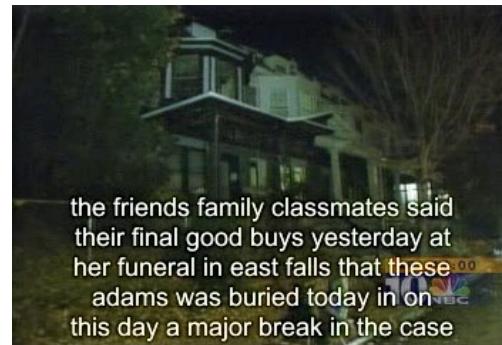
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  - Machine translation



# Natural Language

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- 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 aux coups de canon



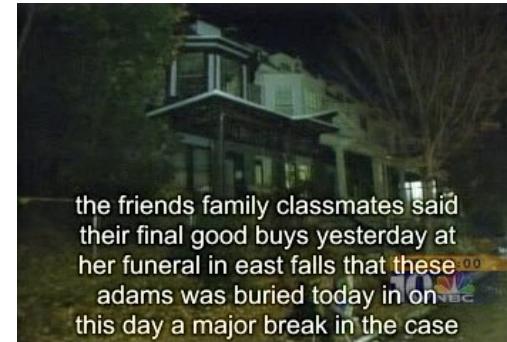
**"It is impossible for journalists to enter Tibetan areas"**

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

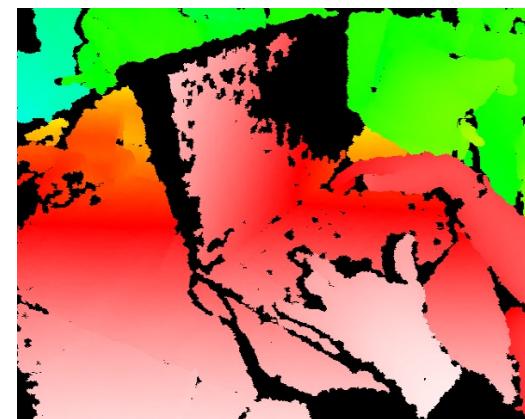
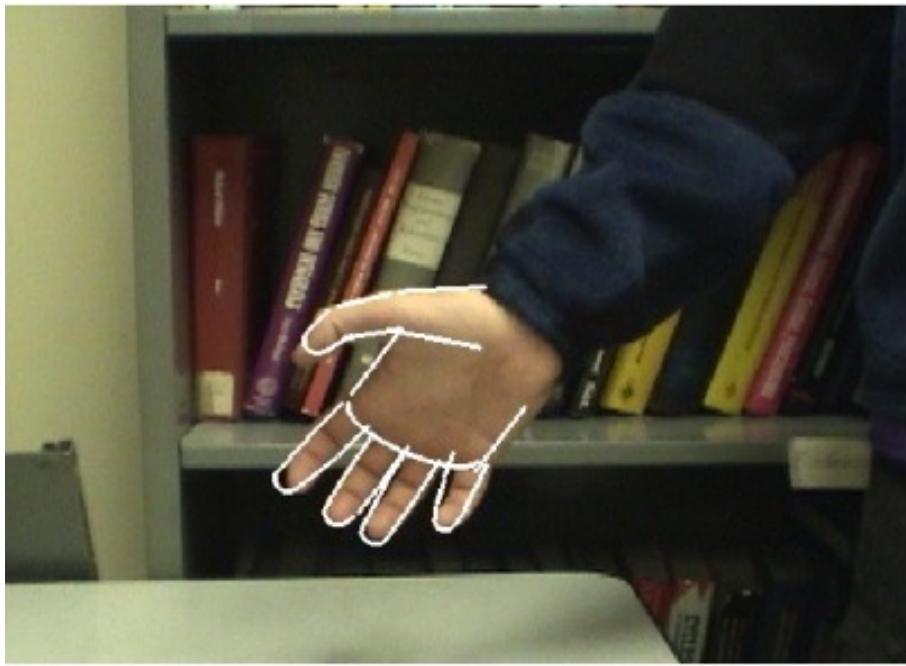


- Web search
- Text classification, spam filtering, etc...



# Vision (Perception)

- Object and face recognition
- Scene segmentation
- Image classification



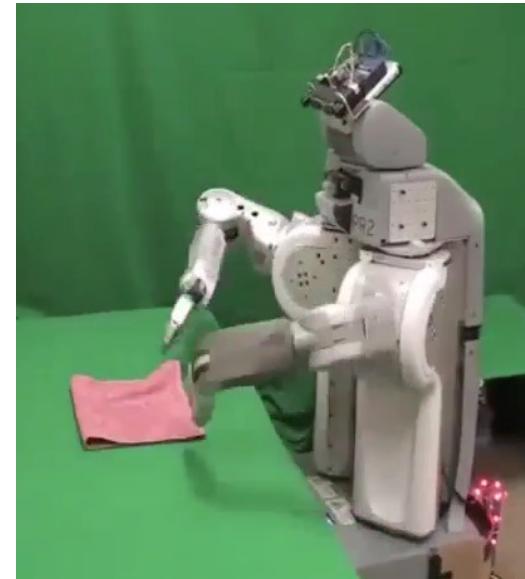
Demo: [YOLO obj-detect](#)

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

Courtesy: Pieter Abbeel

# 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

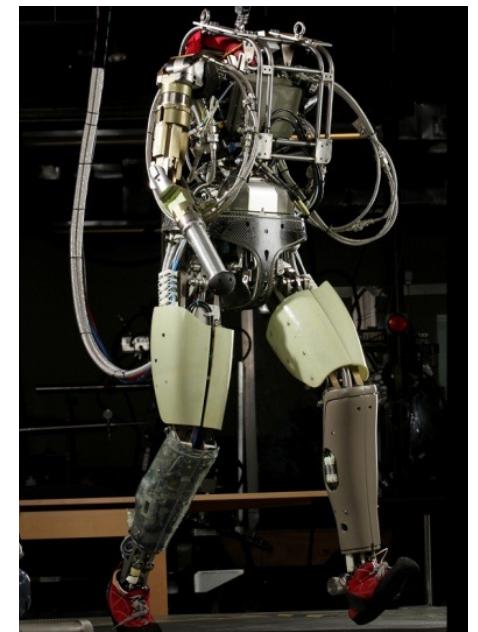


Demo 1: [ROBOTICS – soccer.avi](#)

Demo 3: [ROBOTICS – gcar.avi](#)

Demo 4: [ROBOTICS – laundry.avi](#)

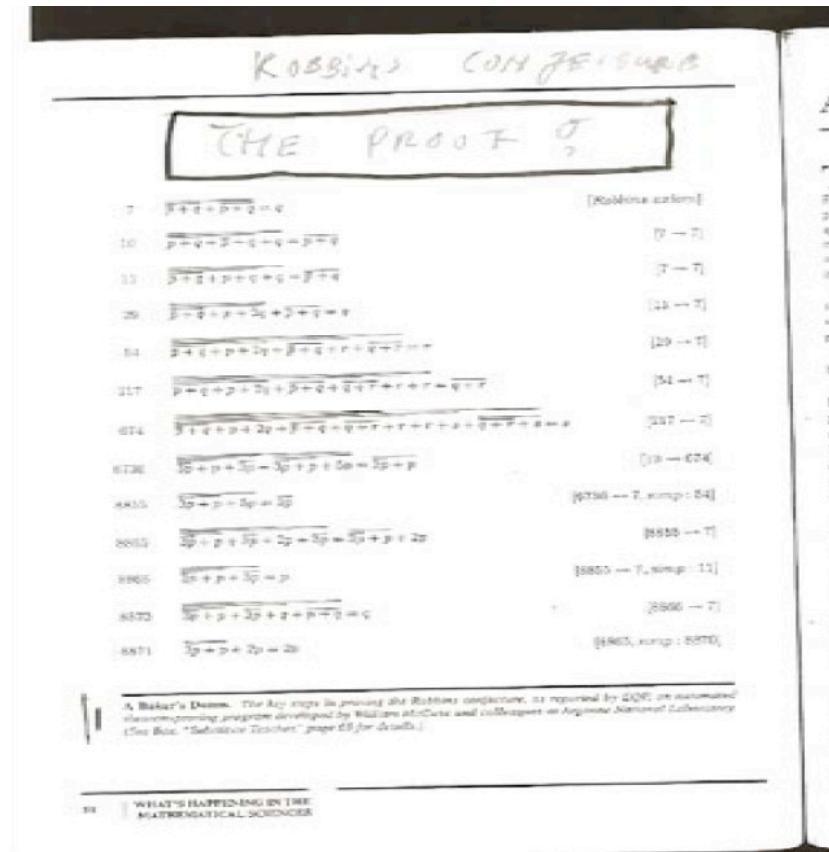
Demo 5: [ROBOTICS – petman.avi](#)



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!)



# 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



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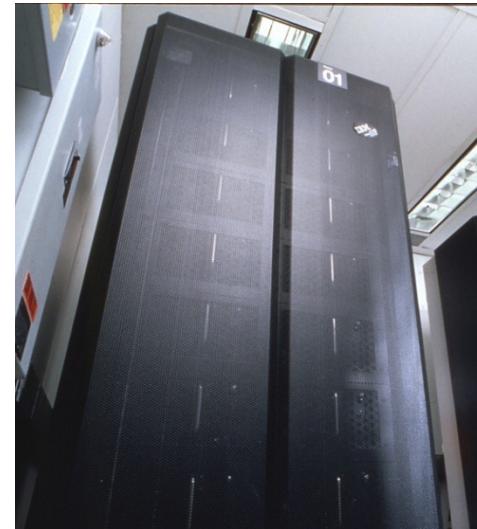


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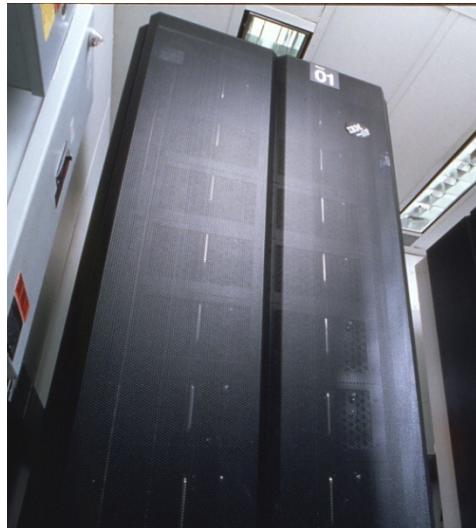
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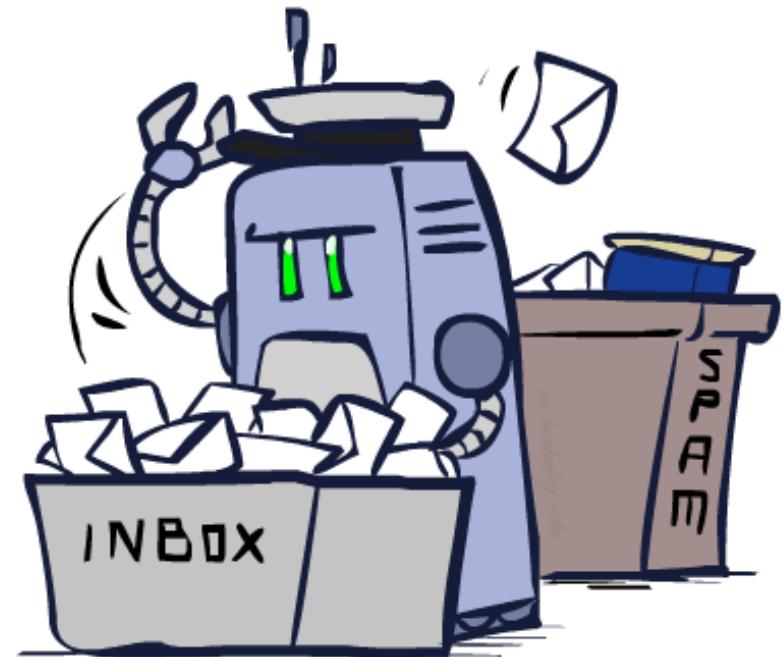


**In March 2016, it beat Lee Sedol in a five-game match, the first time a computer Go program has beaten a 9-dan professional without handicap**

# 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!



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

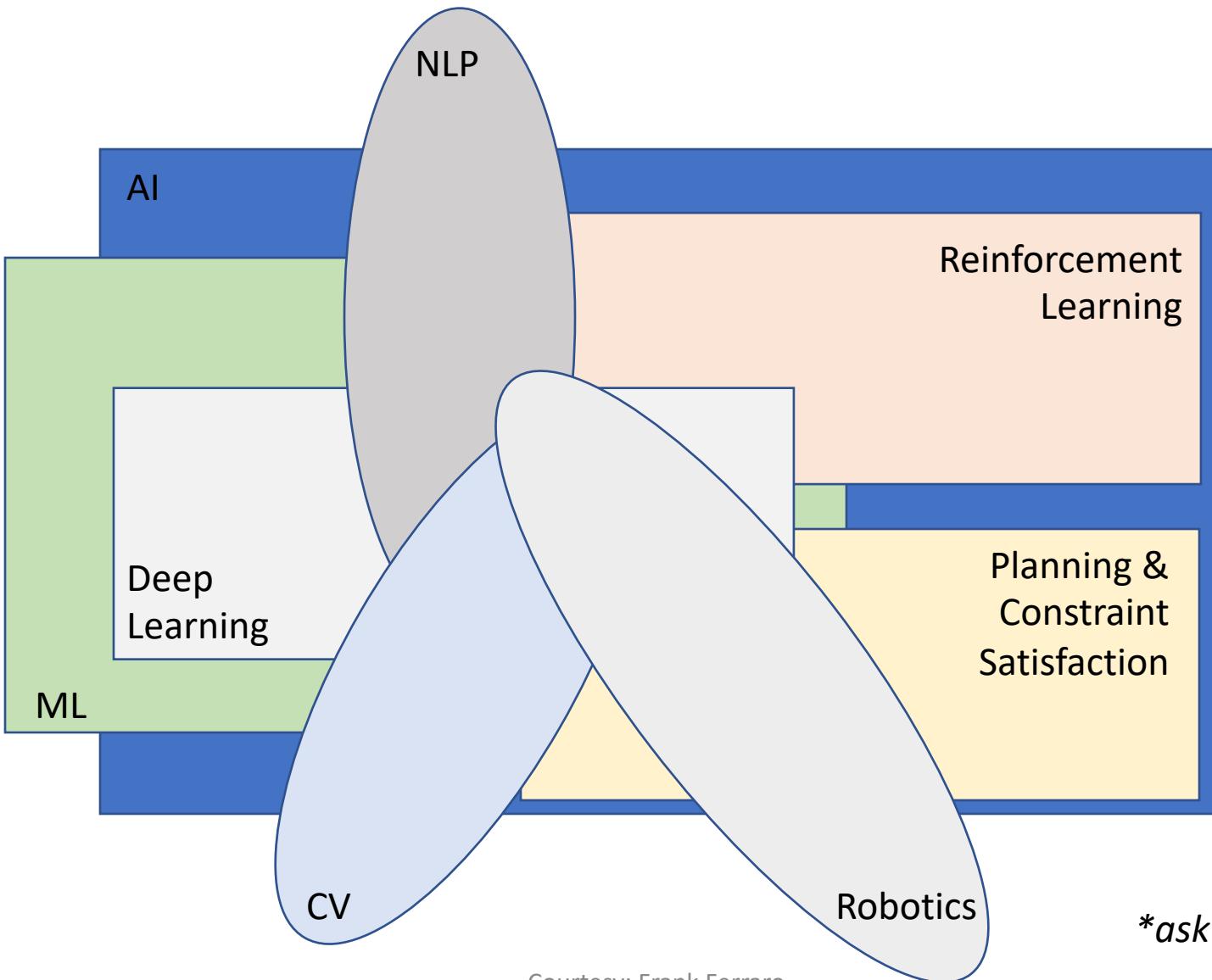
- Understand natural language robustly (e.g., read and understand articles in a newspaper)
- Surf the web and find interesting knowledge
- Interpret an arbitrary visual scene
- Learn a natural language
- ~~Play Go well~~
- Construct plans in dynamic real-time domains
- Refocus attention in complex environments
- Perform life-long learning

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**Exhibit true autonomy  
and intelligence!**

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



# Course Goals

- Be introduced to some of the core problems and solutions of AI (big picture)
- Learn different ways that success and progress can be measured in AI

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- Relate to other CS fields/disciplines
- **Implement AI programs**

# Survey

- There will be a survey posted in Blackboard
- The purpose of this **anonymous survey** is to find what materials we should focus on and how would I design later part of the syllabus
- Sample questions:
  - Why are you taking this course?
  - Have you developed AI/ML projects before?
  - Which courses are you taking from AI and ML this semester?