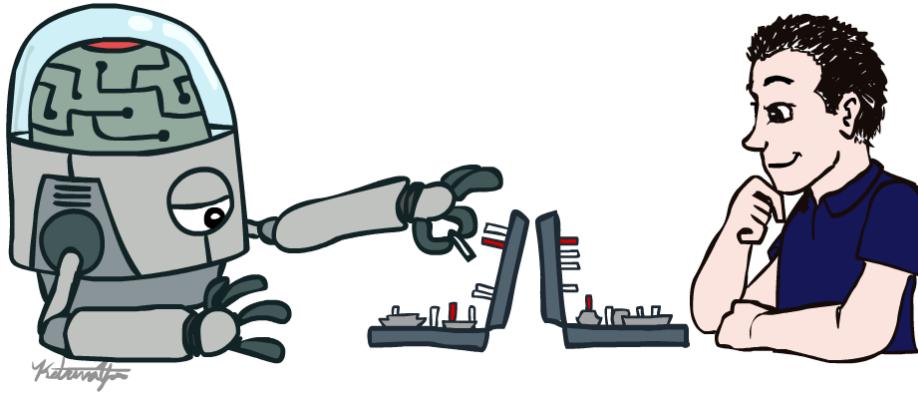


# CS 5522: Artificial Intelligence II

## Introduction



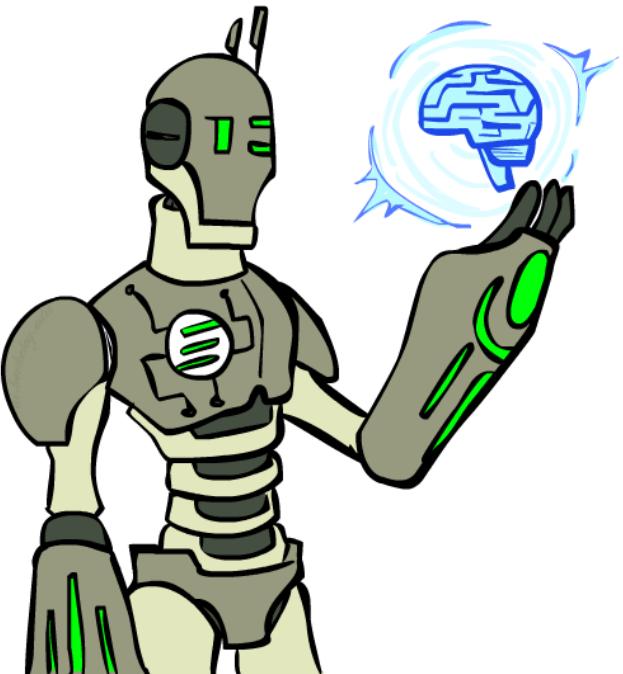
Instructor: Wei Xu  
Ohio State University

[These slides were adapted from CS188 Intro to AI at UC Berkeley.]

# Today

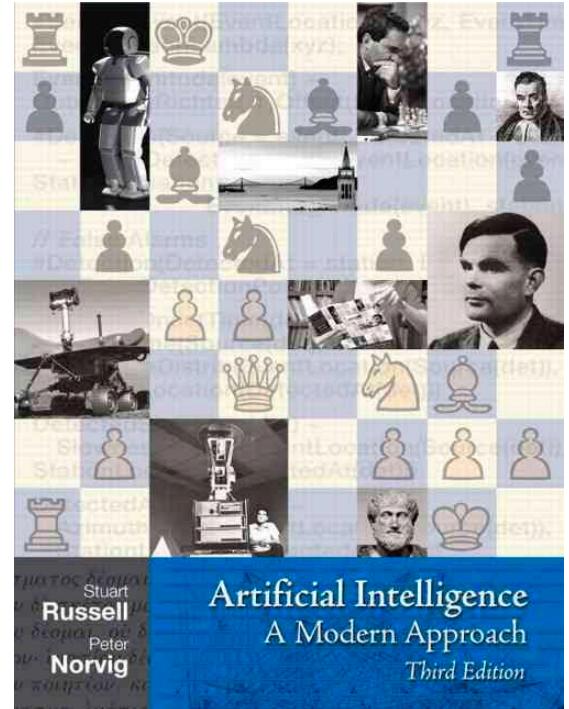
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- What is artificial intelligence?
- What can AI do?
- What is this course?



# Textbook

- Russell & Norvig, AI: A Modern Approach, 3rd Ed.

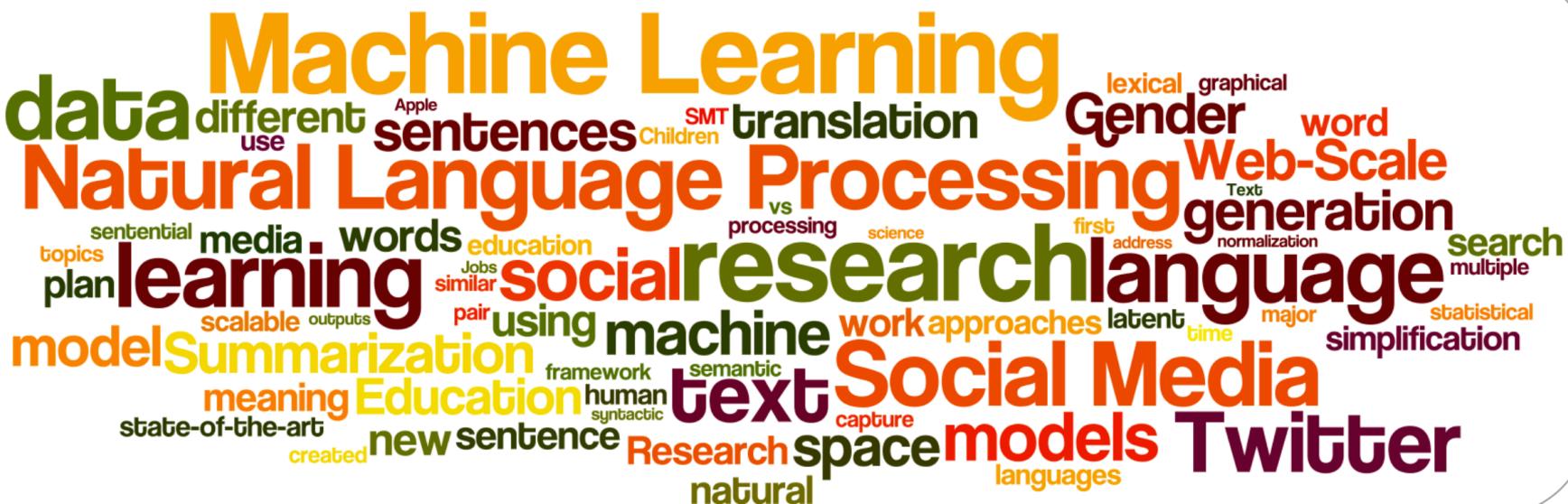


# Who am I?

Assistant Professor **Wei Xu**

Department of Computer Science and Engineering  
Ohio State University

[What I Normally Do]



# Course Webpage

## Grading

Grading will be based on:

### **Participation (10%)**

You will receive credit for asking and answering questions related to the homework on Piazza and engaging in class discussion.

### **Homeworks (50%)**

The homeworks will include both written and programming assignments. Homework should be submitted to the Dropbox folder in [Carmen](#) by 11:59pm on the day it is due (unless otherwise instructed). Each student will have 3 flexible days to turn in late homework throughout the semester. As an example, you could turn in the first homework 2 days late and the second homework 1 day late without any penalty. After that you will lose 20% for each day the homework is late. Please email your homework to the instructor in case there are any technical issues with submission.

### **Midterm (20%)**

### **Final Exam (20%)**

# Course Webpage

## Homework Assignments

- Homework 0 [written part](#) and [programming part](#) (due 1/12, hand in a paper copy of both parts at the beginning of class)
- [Homework 1](#) (due TBA)
- [Homework 2](#) (due TBA)
- [Homework 3](#) (due TBA)
- [Homework 5](#) (due TBA, follow instructions for submission at the bottom of the assignment)

## Resources

- [Piazza](#) (discussion, announcements and restricted resources)
- [Carmen](#) (homework submission)

# Prerequisites

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- Probability
- Calculus
- Linear Algebra
- Python

# Prerequisites

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- Probability
  - Calculus
  - Linear Algebra
  - Python
- 
- Lots of Math and Programming!

# Prerequisites

---

- CSE 3521 or CSE 5521 or CSE 630 or grad standing
  - Probability
  - Calculus
  - Linear Algebra
  - Python
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- Lots of Math and Programming!

# Sci-Fi AI?

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# Sci-Fi AI?



# Sci-Fi AI?



# Sci-Fi AI?



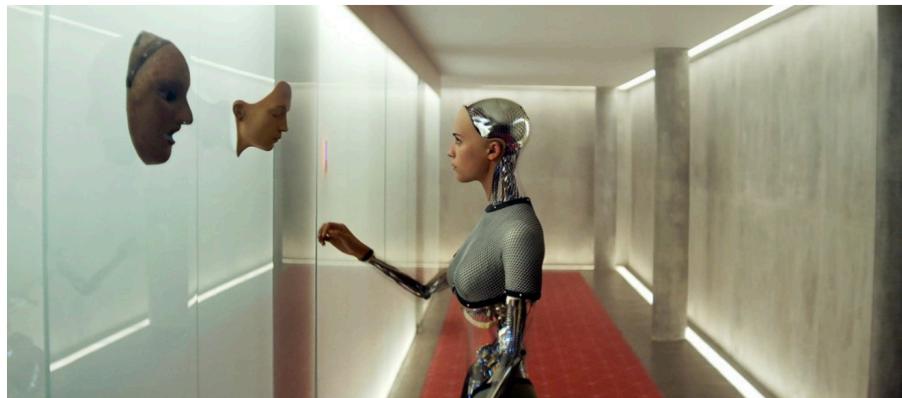
MOVIES

Alex Garland of 'Ex Machina' Talks About Artificial Intelligence



## Alex Garland of 'Ex Machina' Talks About Artificial Intelligence

By ALEX GARLAND APRIL 22, 2015



Alicia Vikander as Ava in "Ex Machina," a film directed by Alex Garland. A24

### RELATED COVERAGE



'Ex Machina' Features a New Robot for the Screen APRIL 2, 2015



Review: In 'Ex Machina,' a Mogul Fashions the Droid of His Dreams APRIL 9, 2015



T MAGAZINE  
Alex Garland's Sci-Fi Faves MARCH 30, 2015

In the last few years, I've become increasingly fascinated by artificial intelligence, and in particular our escalating fear of it. It seemed to me that our increasingly holistic relationship with technology and abstract clouds of information was compounding this fear and perhaps edging it

# What is AI?

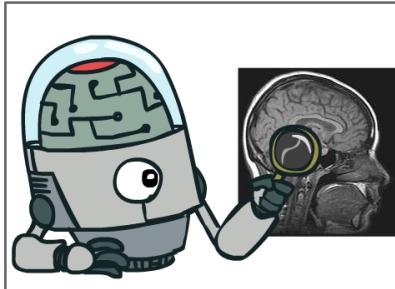
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The science of making machines that:

# What is AI?

The science of making machines that:

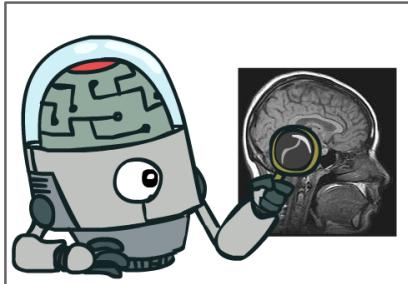
Think like people



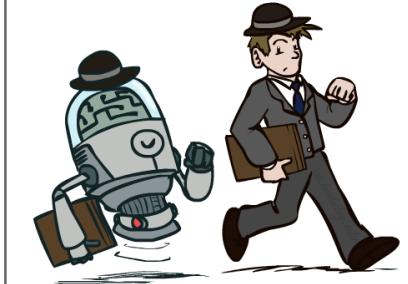
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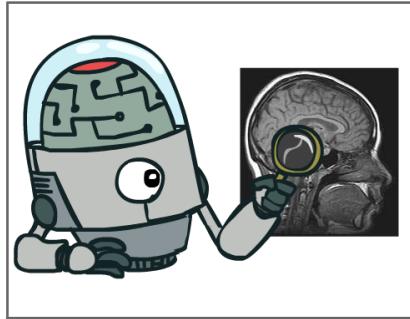
Act like people



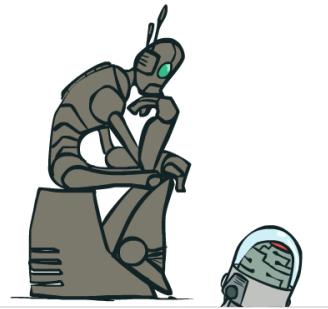
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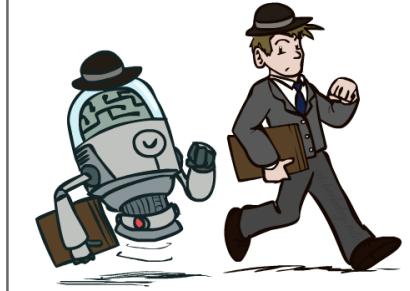
Think like people



Think rationally



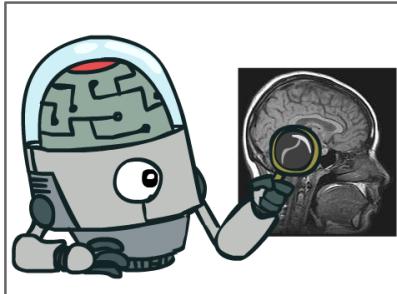
Act like people



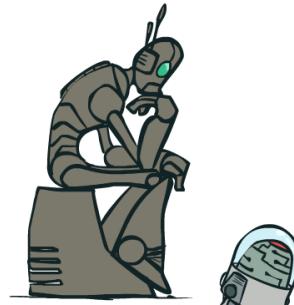
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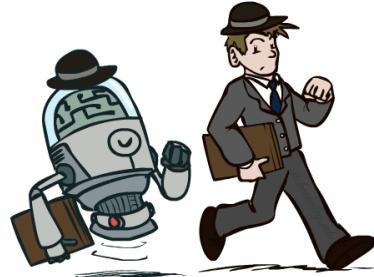
Think like people



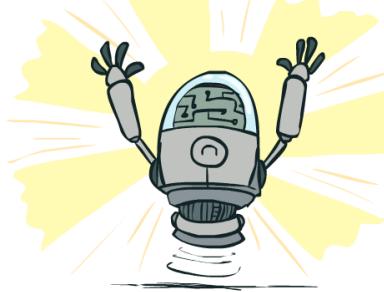
Think rationally



Act like people



Act rationally



# Rational Decisions

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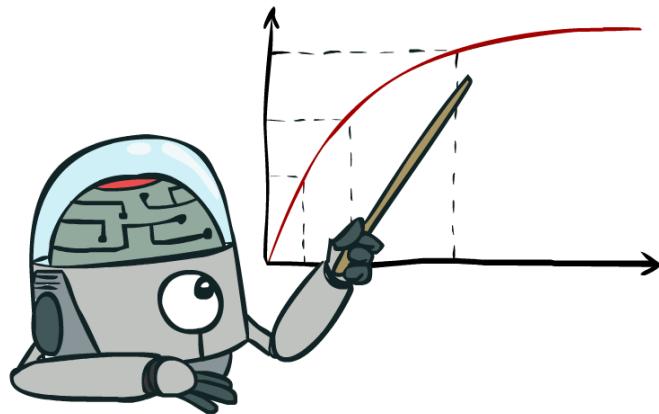
We'll use the term **rational** in a very specific, technical way:

- 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**



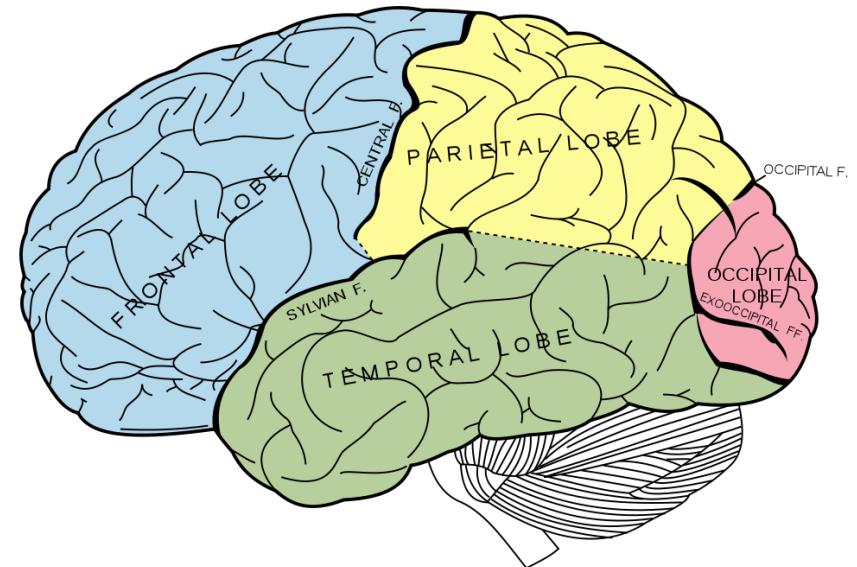
# Maximize Your Expected Utility

# Maximize Your Expected Utility



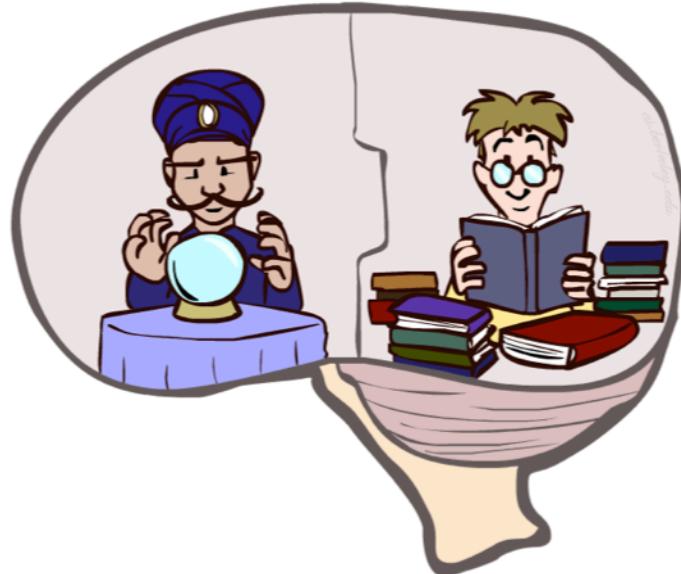
# What About the Brain?

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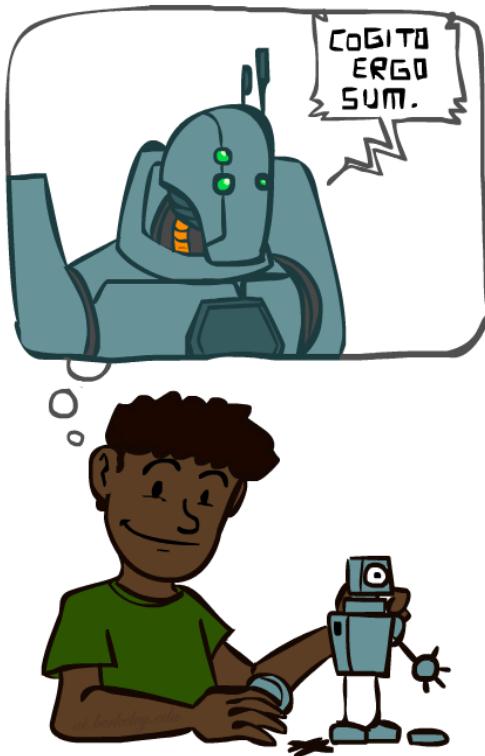
# What About the Brain?

- 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 and simulation are key to decision making

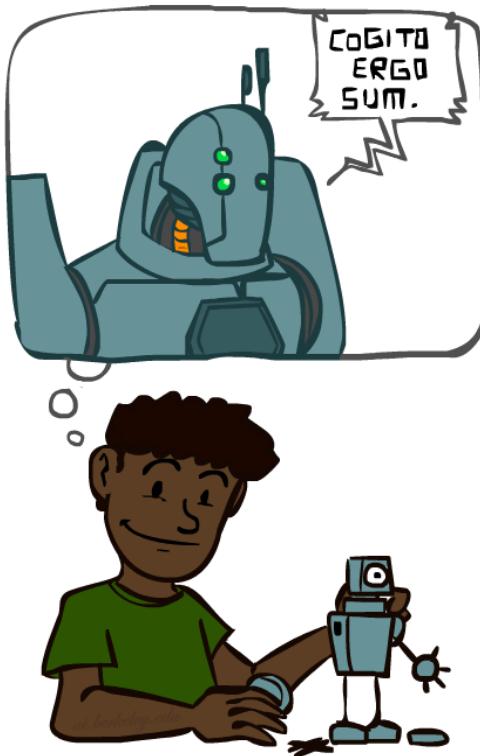


# A (Short) History of AI

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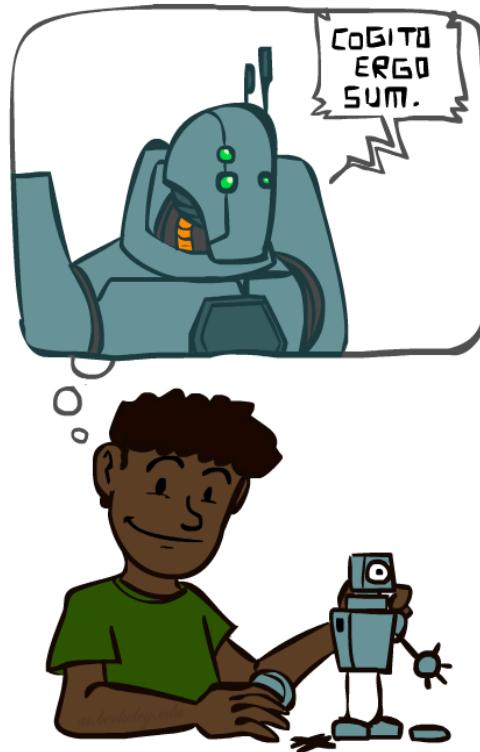


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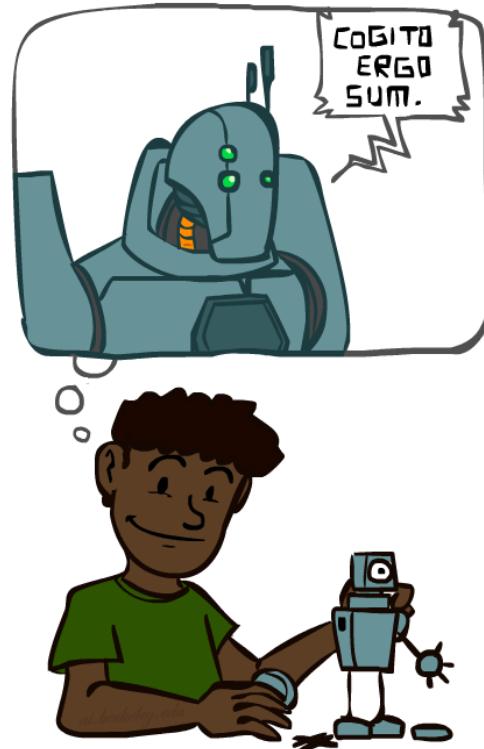
<https://www.youtube.com/watch?v=aygSMgK3BEM>

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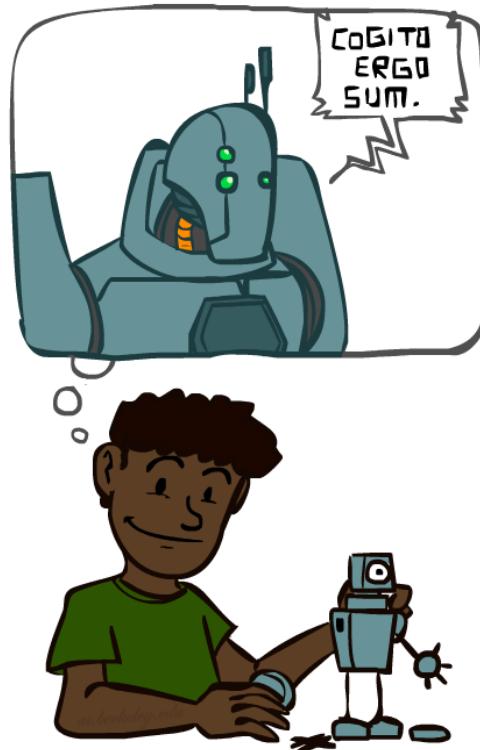
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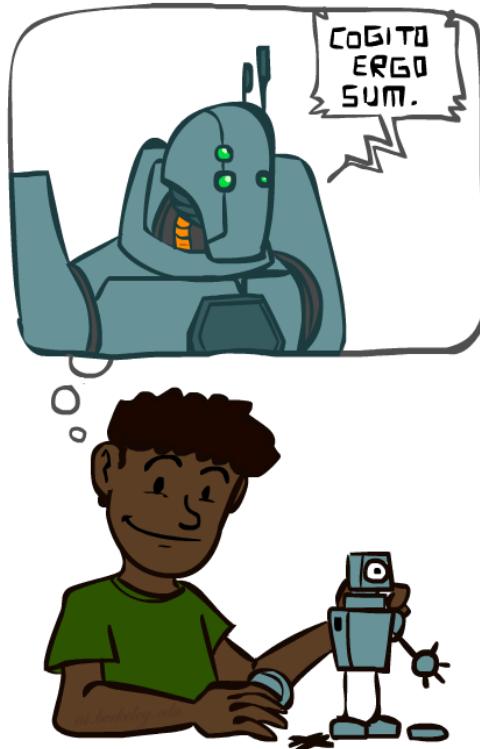
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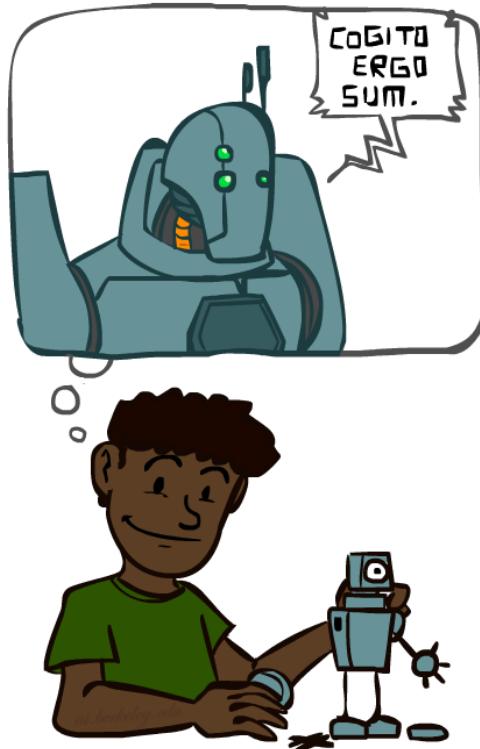
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  - 1969–79: Early development of knowledge-based systems
  - 1980–88: Expert systems industry booms
  - 1988–93: Expert systems industry busts: "AI Winter"
- 1990–: Statistical approaches
  - Resurgence of probability, focus on uncertainty
  - General increase in technical depth
  - Agents and learning systems... "AI Spring"?



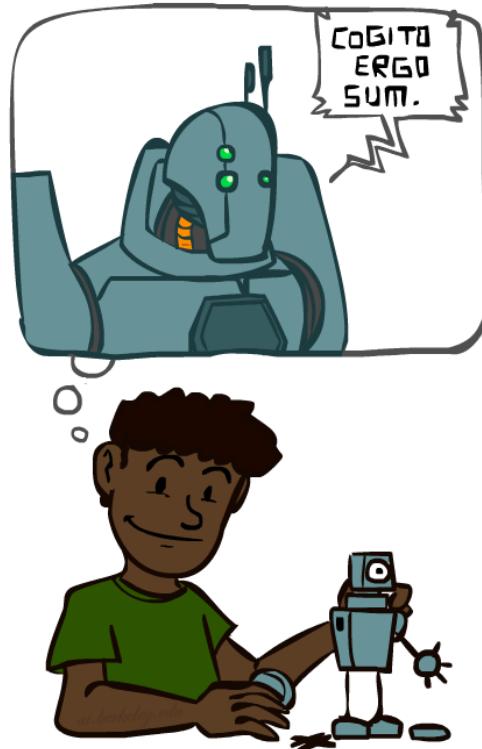
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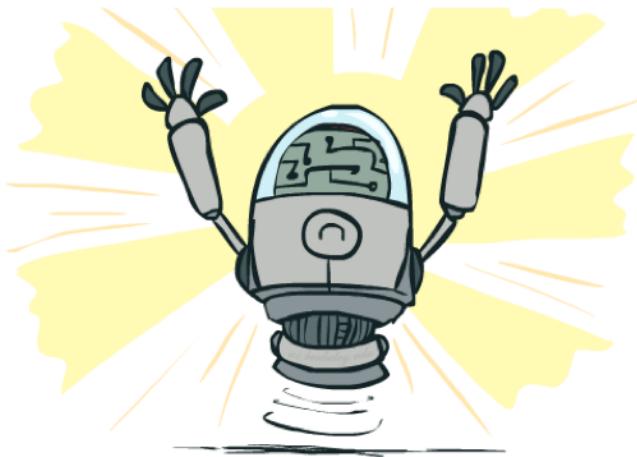


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- 2000–: Where are we now?

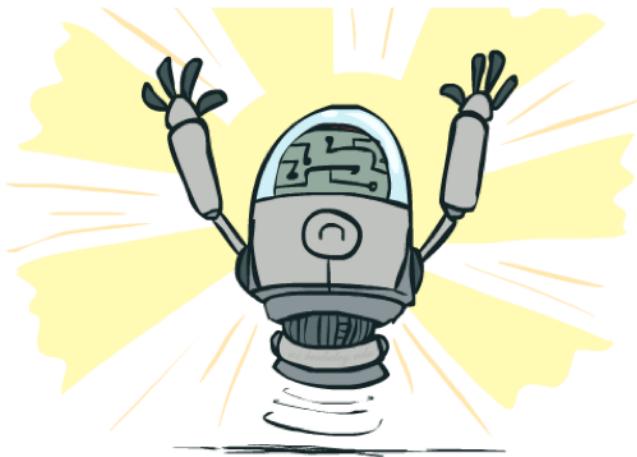


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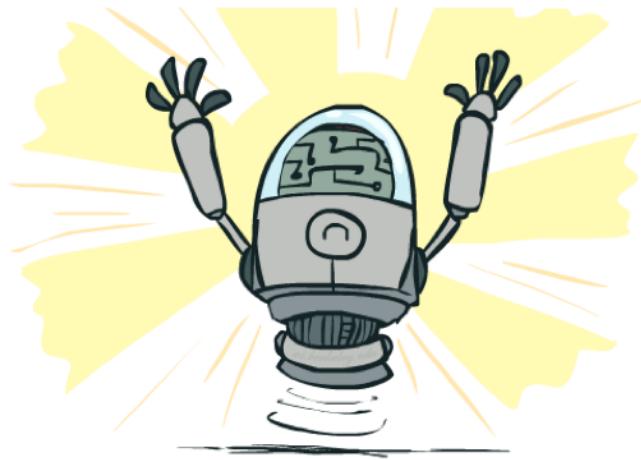
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- Play a decent game of table tennis?



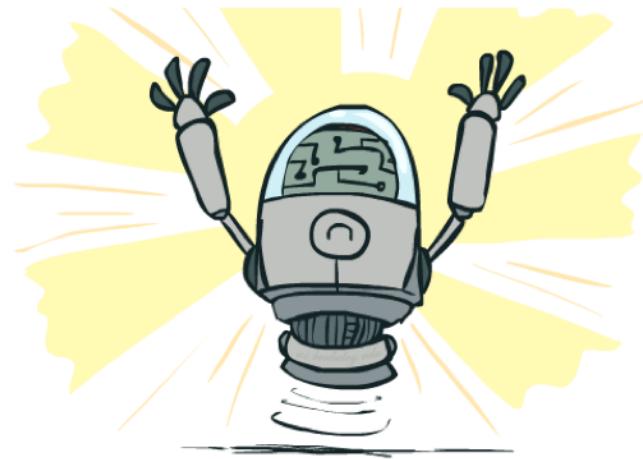
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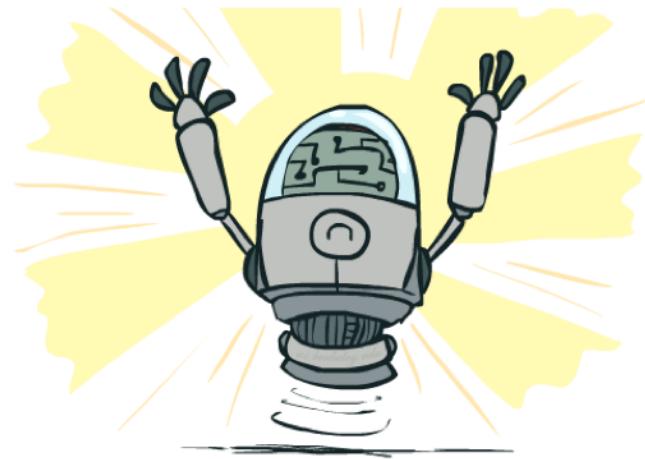
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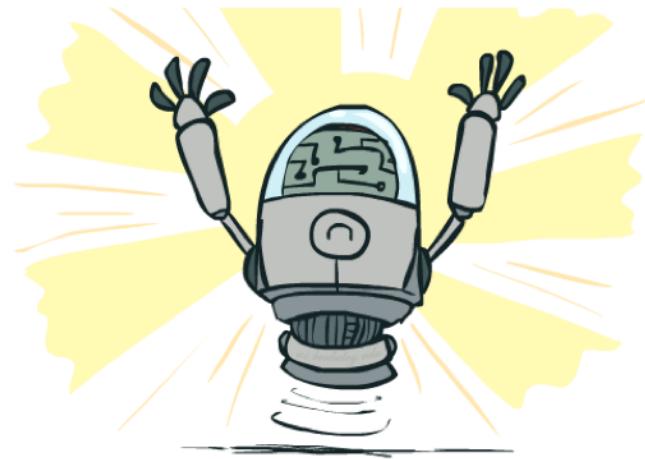
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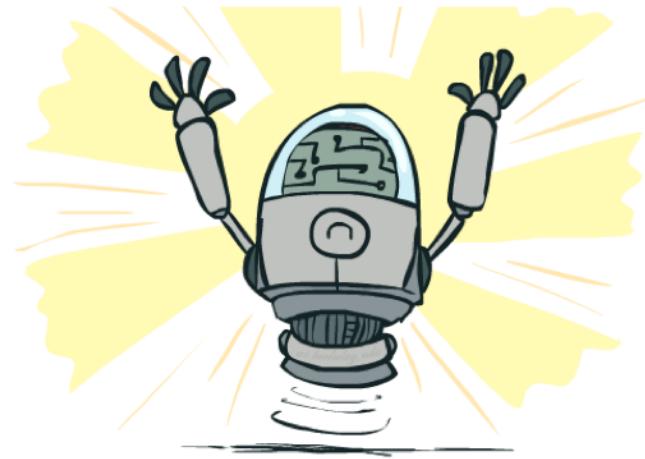
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- Drive safely along a curving mountain road?



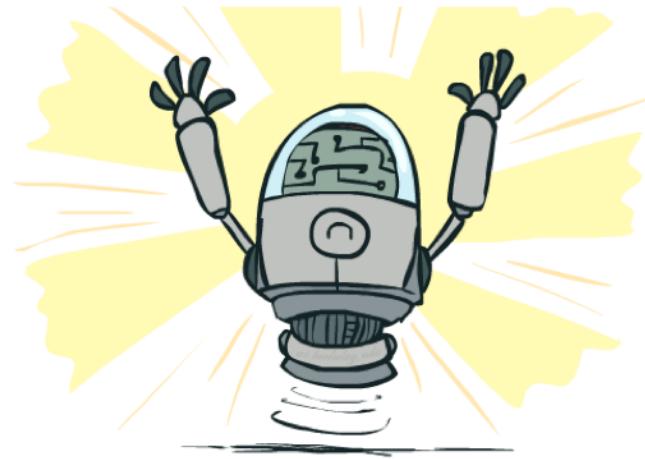
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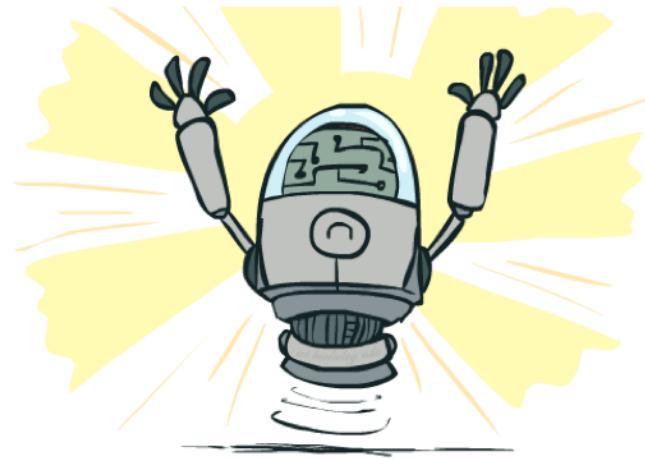
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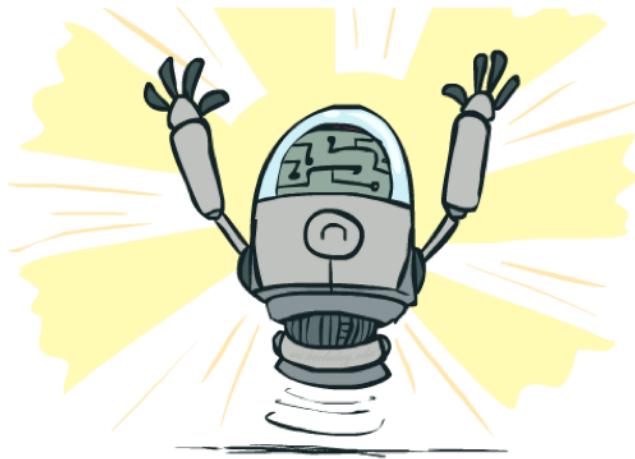
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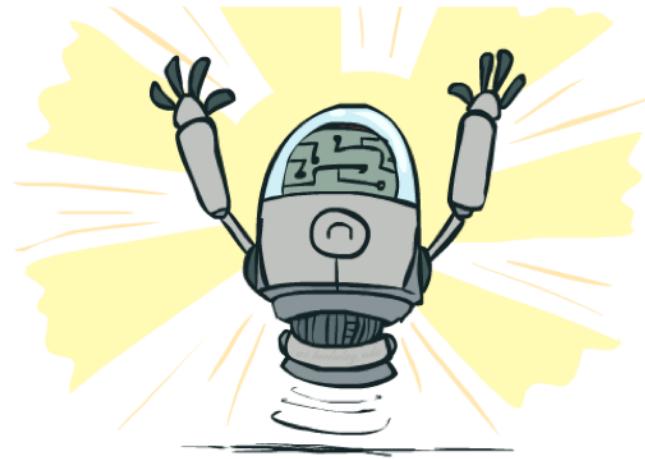
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- Buy a week's worth of groceries on the web?



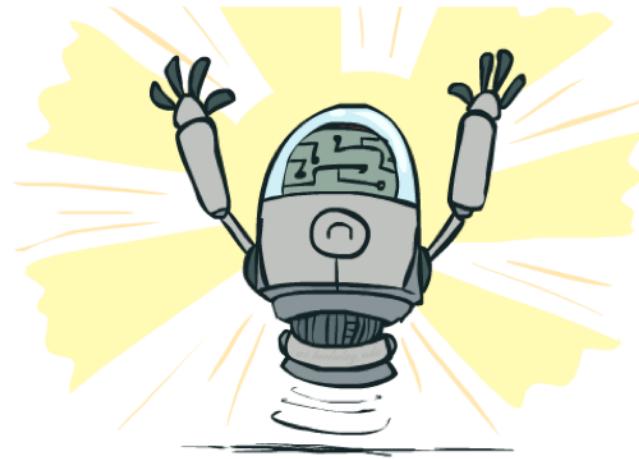
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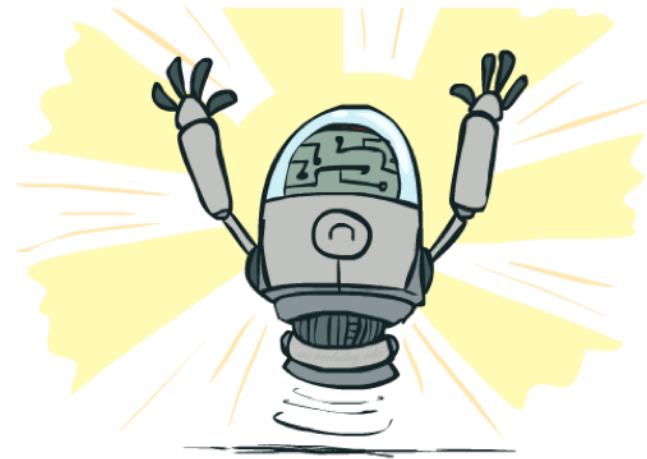
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- Buy a week's worth of groceries at North Market?



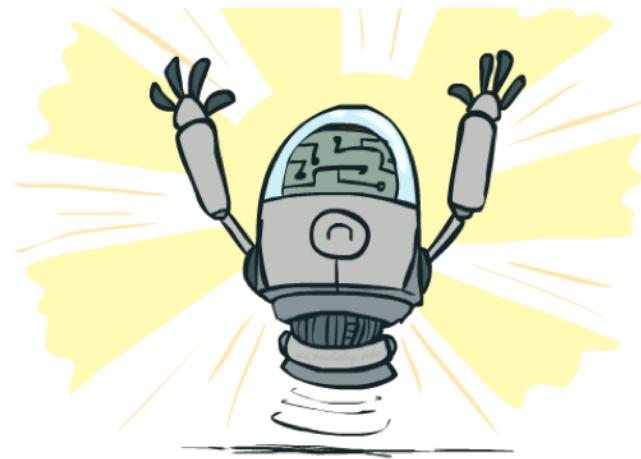
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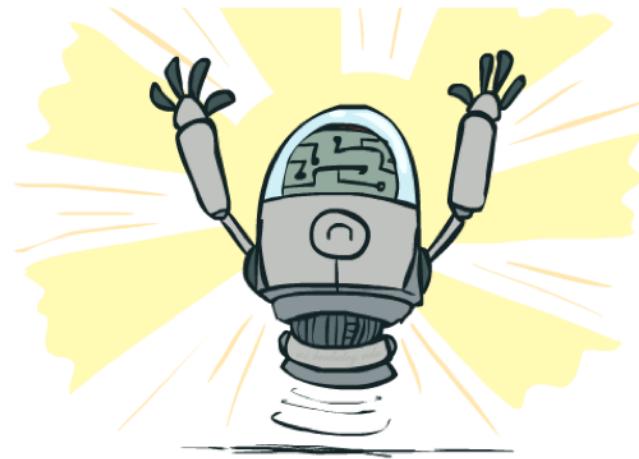
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- Discover and prove a new mathematical theorem?



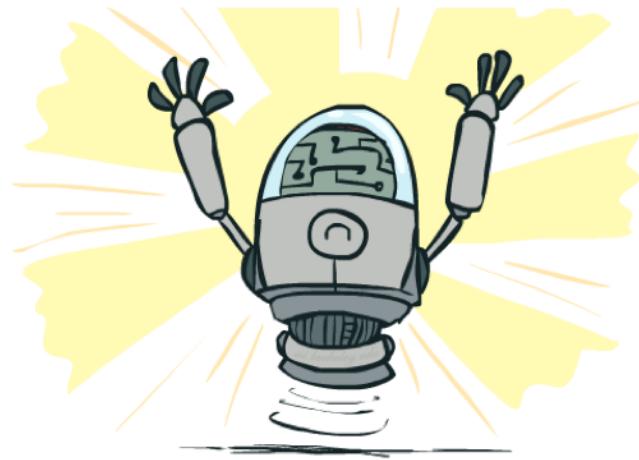
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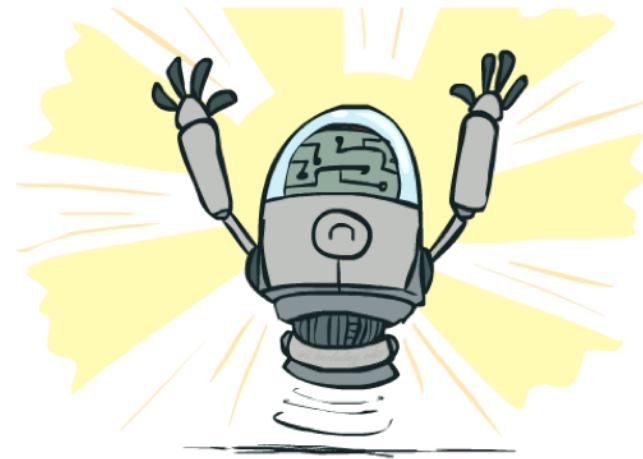
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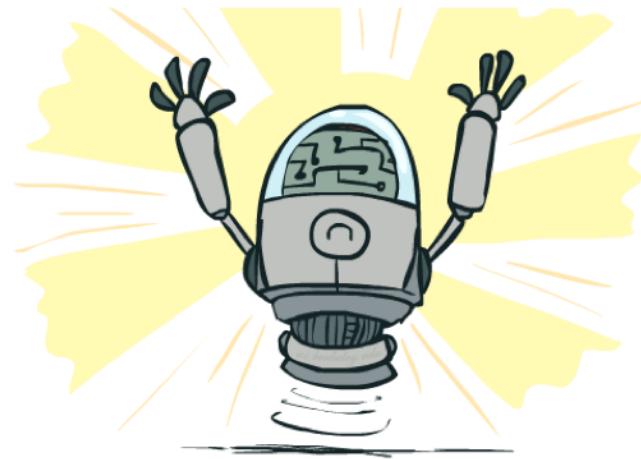
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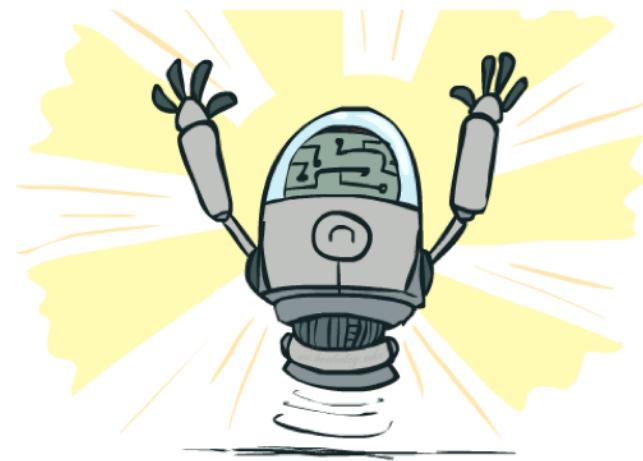
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- Perform a surgical operation?



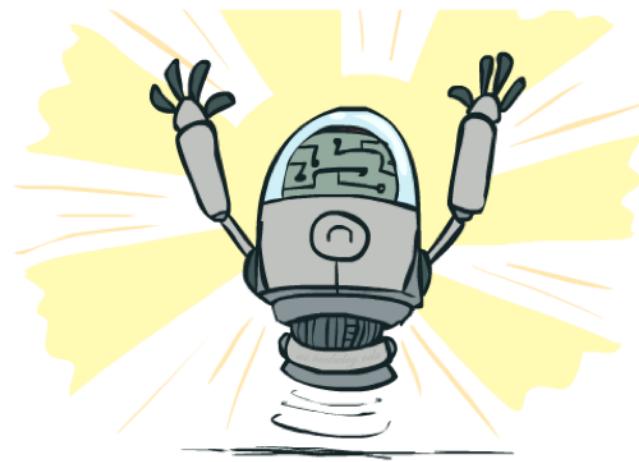
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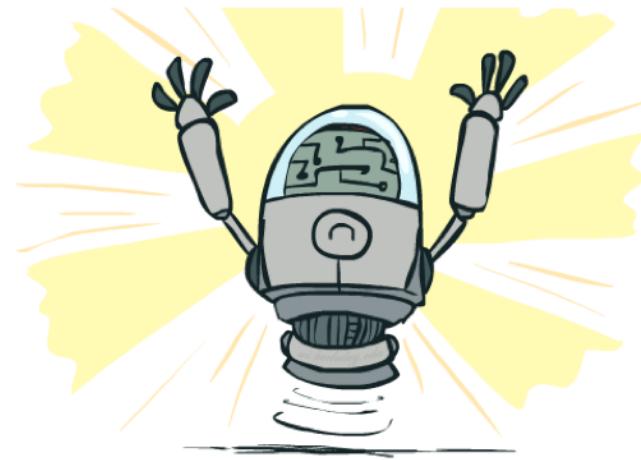
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- ✗ Perform a surgical operation?
- Put away the dishes and fold the laundry?



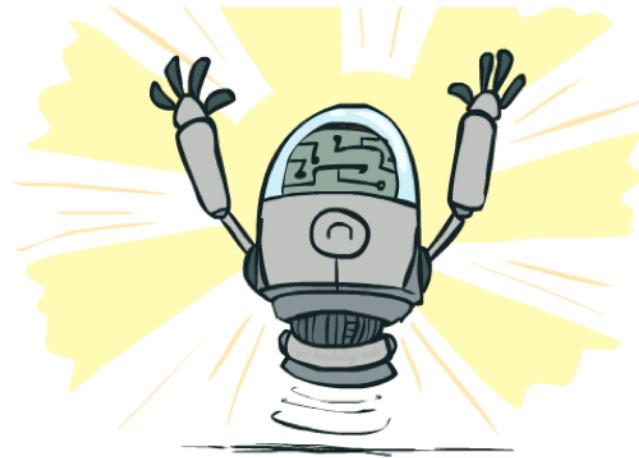
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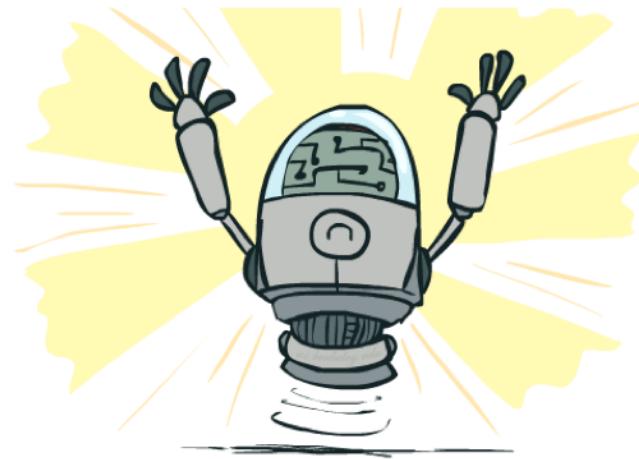
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- ✓ Put away the dishes and fold the laundry?
- Translate spoken Chinese into spoken English in real time?



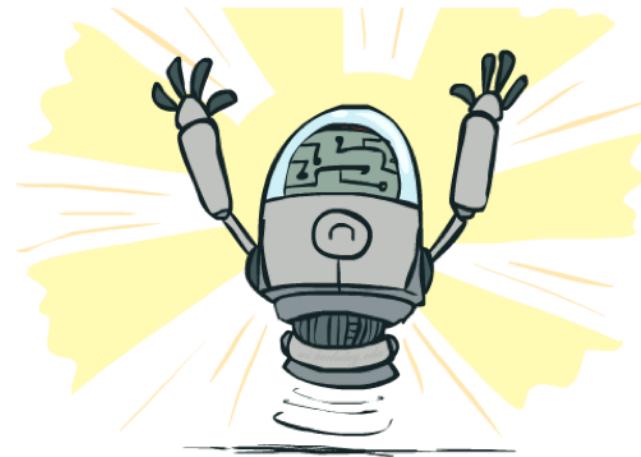
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- Play a decent game of table tennis?
- Play a decent game of Jeopardy?
- Drive safely along a curving mountain road?
- ? Drive safely across campus during the Michigan Game?
- Buy a week's worth of groceries on the web?
- X Buy a week's worth of groceries at North Market?
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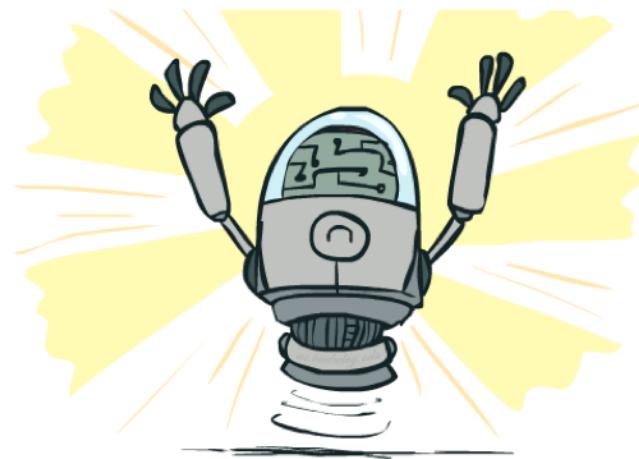
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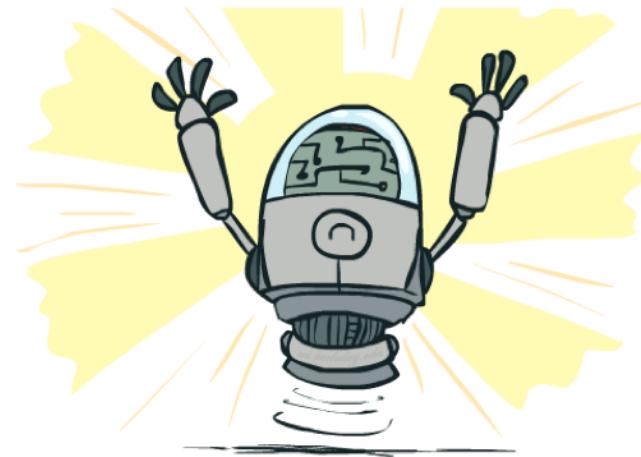
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<https://www.youtube.com/watch?v=ive4sKkpCqs>

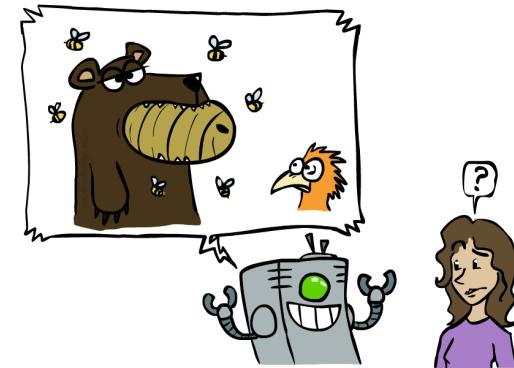
# Unintentionally Funny Stories

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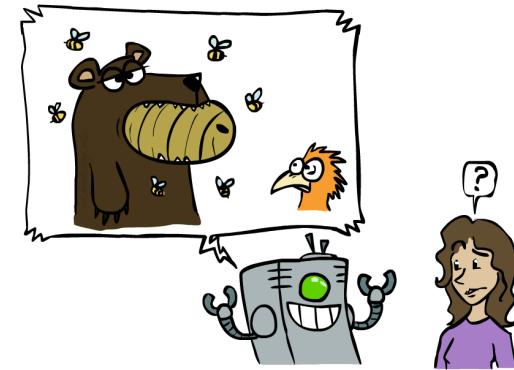
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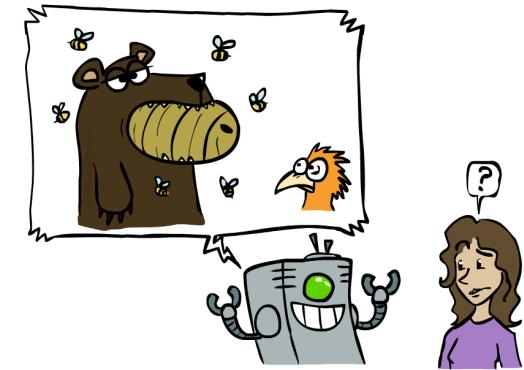
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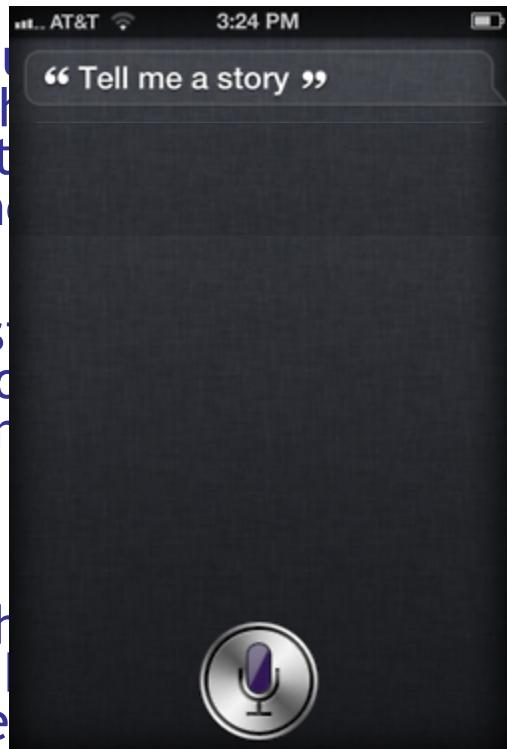
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- Once upon a time there was a dishonest fox and a vain crow. One day the crow was sitting in his tree, holding a piece of cheese in his mouth. He noticed that he was holding the piece of cheese. He became hungry, and swallowed the cheese. The fox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



# Unintentionally Funny Stories

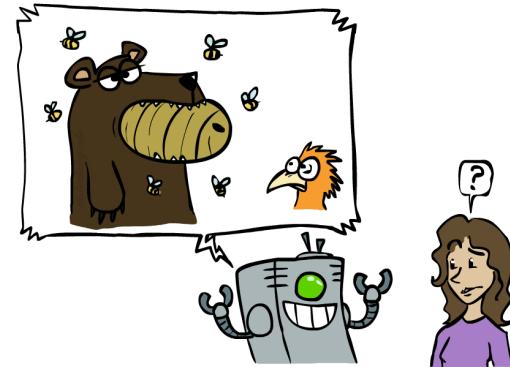
- One day Joe Bear was hunting for acorns. He heard Irving Bird where some birds were singing. Joe saw that there was a beehive in the oak tree. He ate the acorns and fell asleep.
- Henry Squirrel was thirsty. He was walking along the river bank where his good friend Irving Bird was singing. Henry slipped and fell into the water. He was drowned.
- Once upon a time there was a crow who was very vain. The crow was sitting in a tree. He noticed that he was very ugly. He swallowed a piece of cheese and became very full. He became very hungry and crawled over to the crow. The End.



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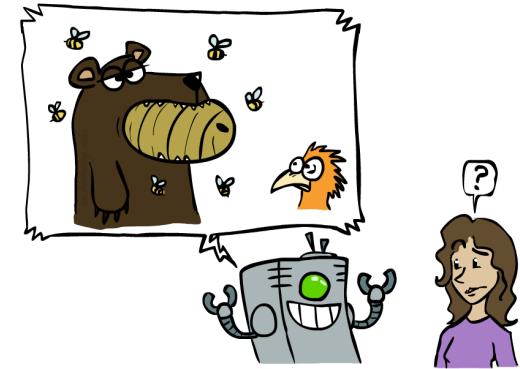
- One day Joe Bear was hunting for acorns. Irving Bird was nearby. There was a beehive in the oak tree. He ate the honey and got stung. His friend Henry Squirrel heard him and walked to help him. Henry Squirrel was thirsty and stopped at the river bank where his good friend Irving Bird was sitting. Henry slipped and fell in the water. He was drowning. The End.
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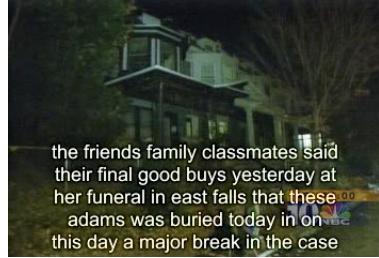
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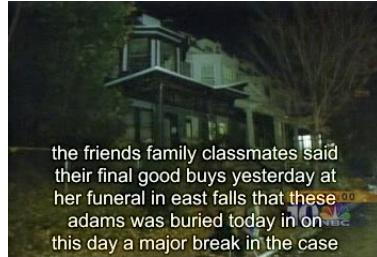
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- Speech technologies (e.g. Siri)
  - Automatic speech recognition (ASR)
  - Text-to-speech synthesis (TTS)
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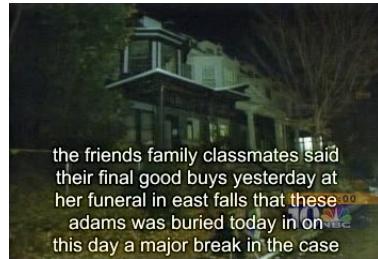
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## "Il est impossible aux journalistes de rentrer dans les régions tibétaines"

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'ilégalité".

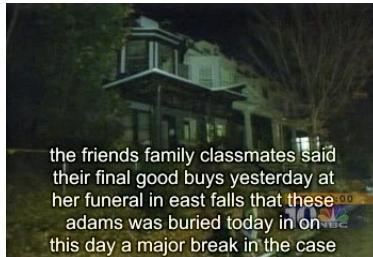
**Les faits** Le dalaï-lama dénonce l'"enfer" imposé au Tibet depuis sa fuite, en 1959  
**Vidéo** Anniversaire de la rébellion



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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



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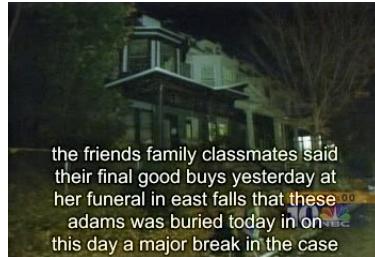
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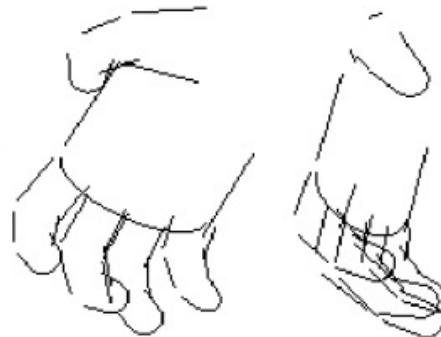
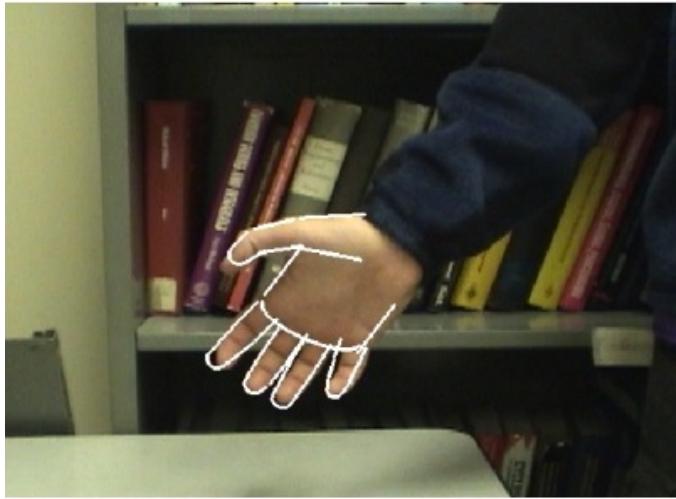
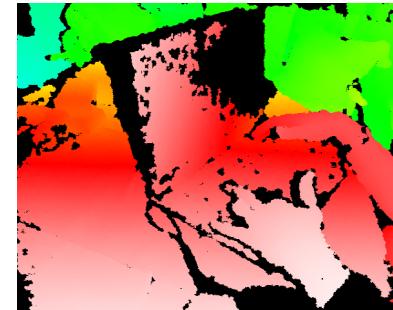
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- Web search
- Text classification, spam filtering, etc...

# Vision (Perception)

- Object and face recognition
- Scene segmentation
- Image classification



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

Demo1: VISION - lec\_1\_t2\_video.flv

Demo2: VISION - lec\_1\_obj\_rec\_0.mpg

# Robotics

Demo 1: ROBOTICS - soccer.avi Demo 4: ROBOTICS - laundry.avi  
Demo 2: ROBOTICS - soccer2.avi Demo 5: ROBOTICS - petman.avi  
Demo 3: ROBOTICS - gcar.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!)

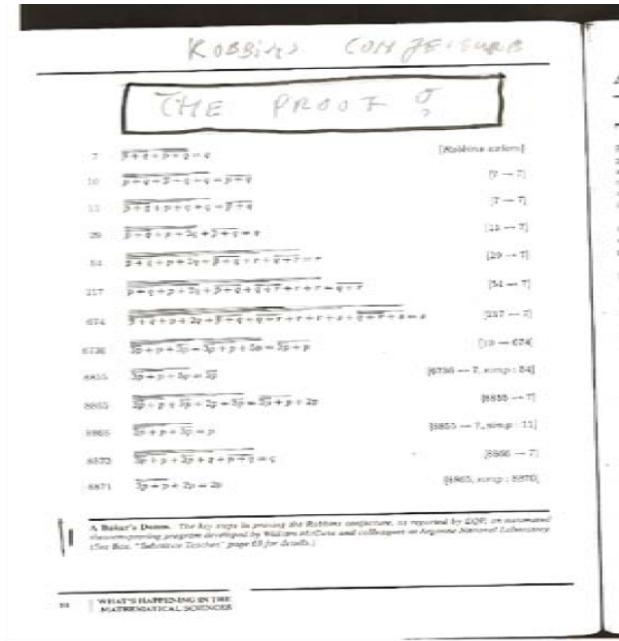


Image from Bart Selman

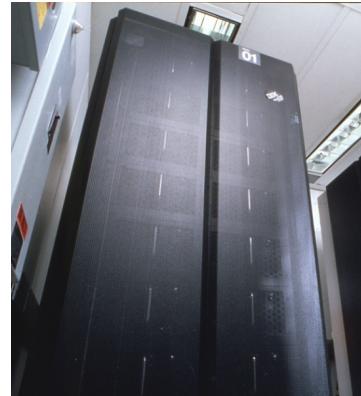
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  - First match won against world champion
  - “Intelligent creative” play
  - 200 million board positions per second
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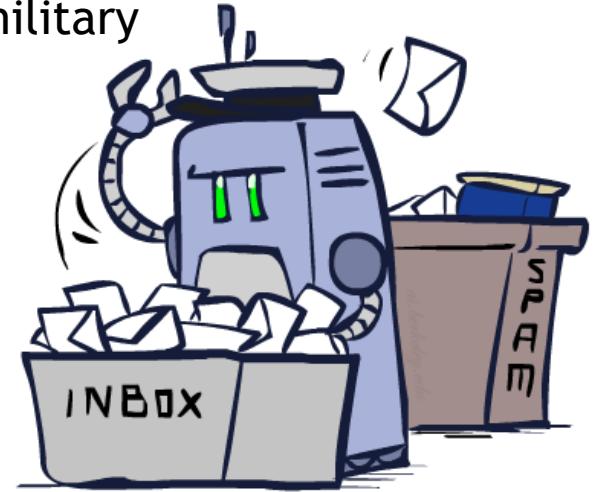
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- **1997: Deep Blue Beats Kasparov**

“Deep Blue hasn't proven anything.”
- Huge game-playing advances recently, e.g. in Go!



# 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!



# Designing Rational Agents

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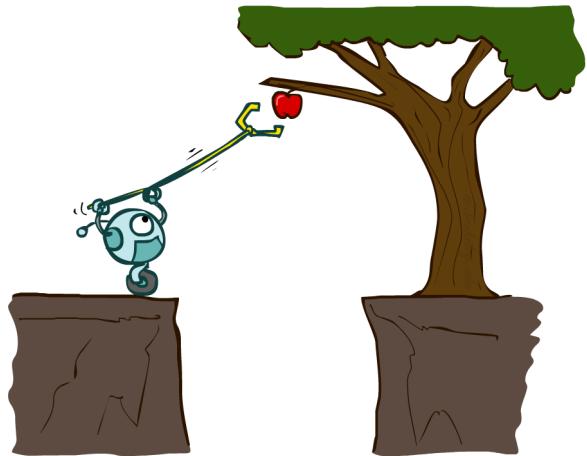
# Designing Rational Agents

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- An **agent** is an entity that *perceives* and *acts*.

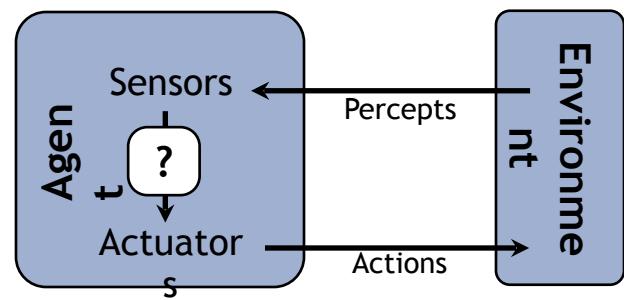
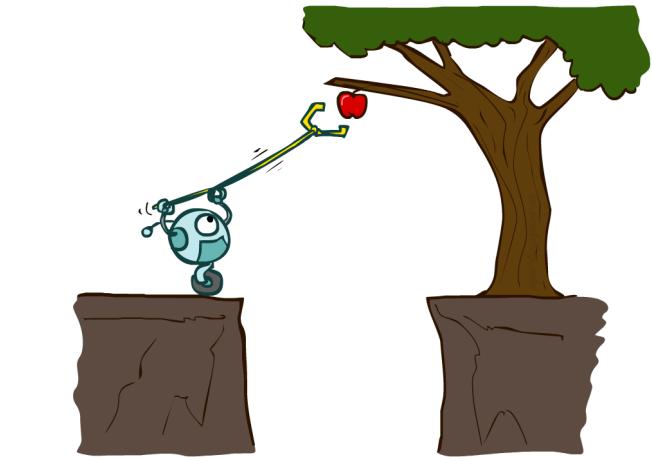
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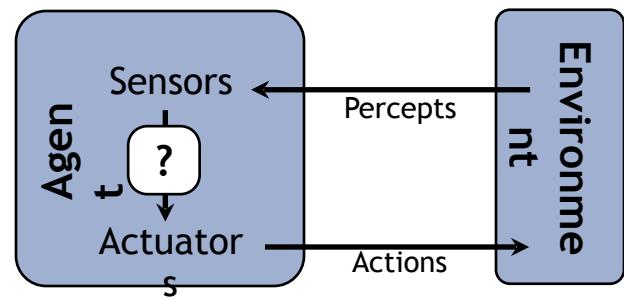
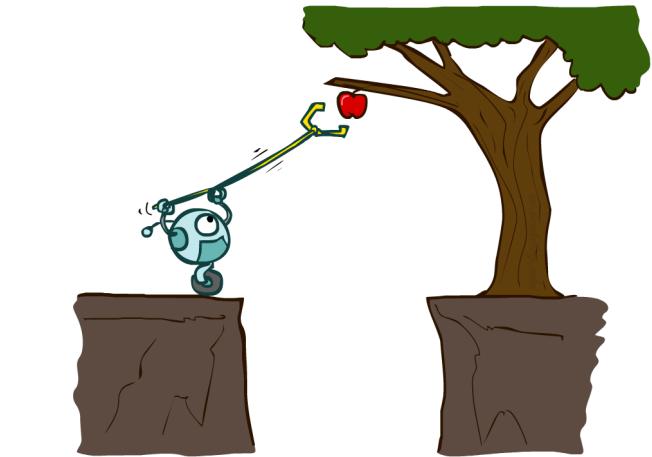
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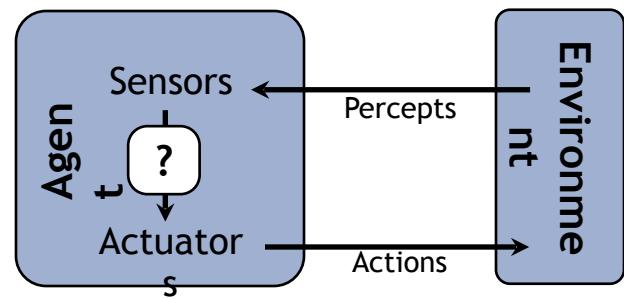
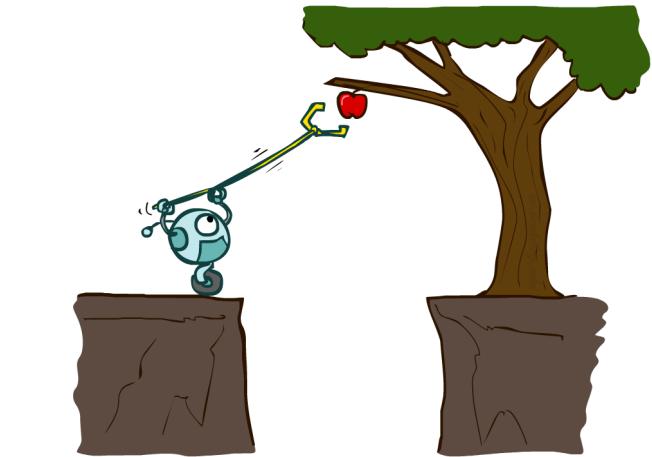
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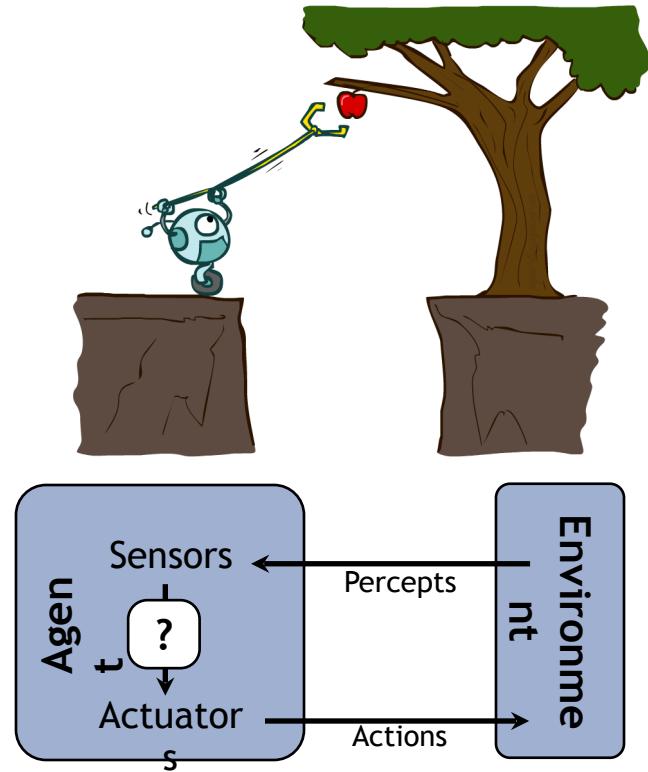
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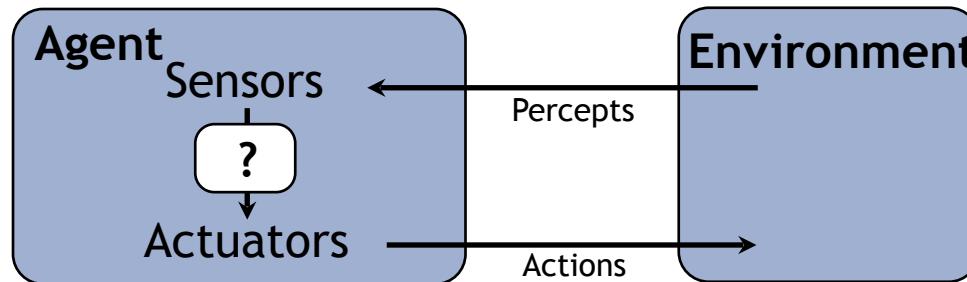
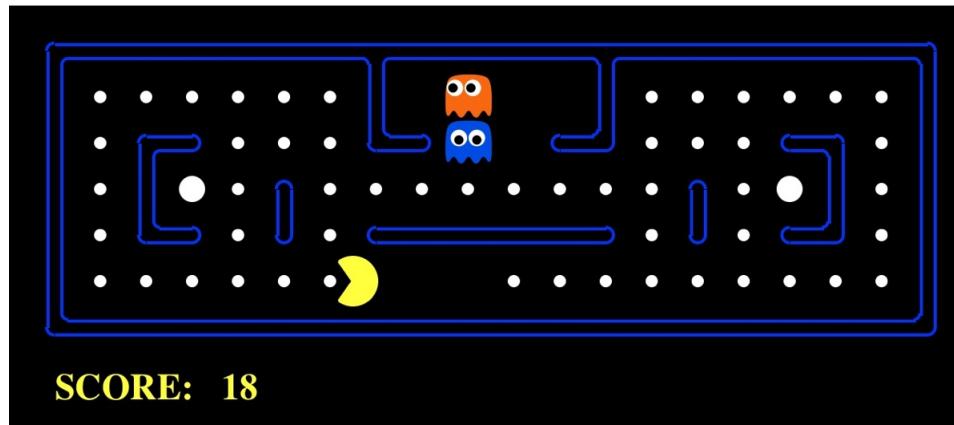


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- A **rational agent** selects actions that maximize its (expected) utility.
- Characteristics of the **percepts**, **environment**, and **action space** dictate techniques for selecting rational actions
- **This course** is about:
  - General AI techniques for a variety of problem types
  - Learning to recognize when and how a new problem can be solved with an existing technique



# Pac-Man as an Agent



# Course Topics

---

- Search
- Adversarial Search (minimax, alpha beta, expectimax)
- Markov Decision Processes
- Reinforcement Learning
- Constraint Satisfaction
- Uncertainty, Bayesian Networks, HMMs
- Supervised Machine Learning
- Applications: Natural Language Processing, Computer Vision

# To Do

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- Homework #0
  - Math Review + Python Tutorial
  - Due on next class (Friday)
  - Hand in paper copy at the beginning of class