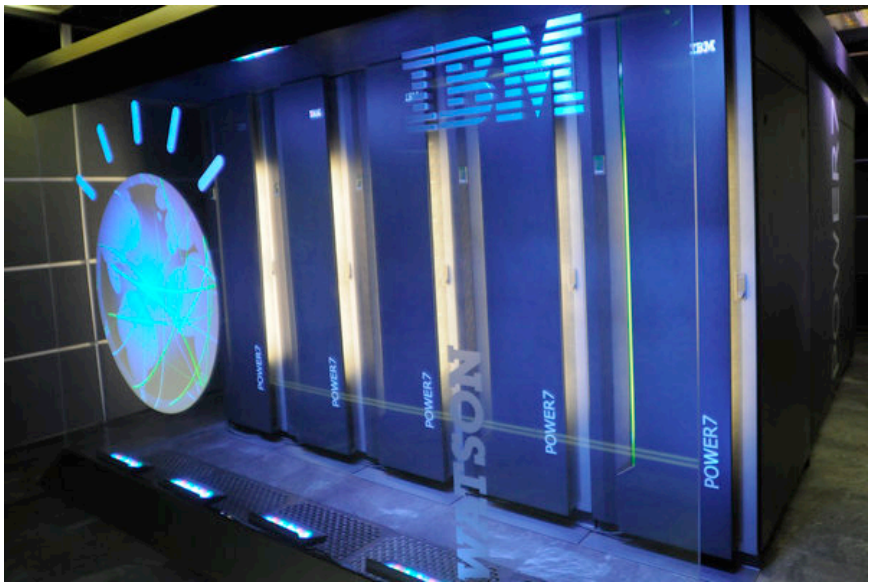
# CS10: The Beauty and Joy of Computing

## Artificial Intelligence

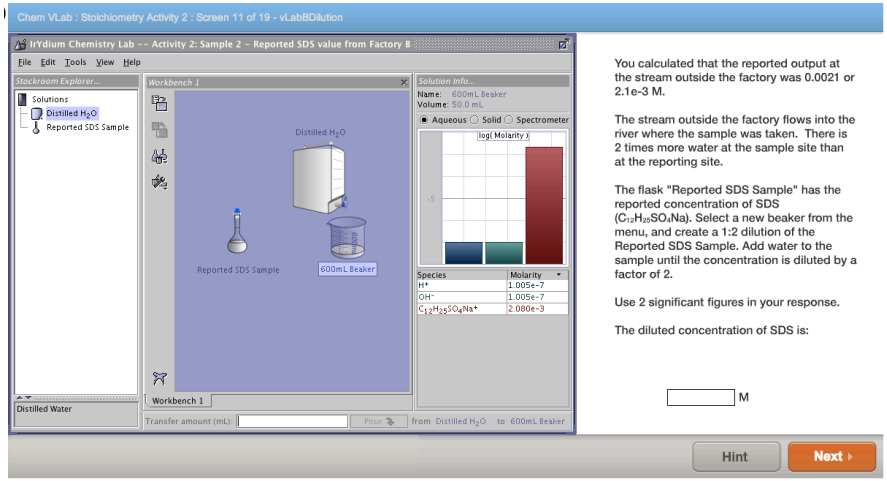



Anna Rafferty

(Slides adapted from Dan Garcia)

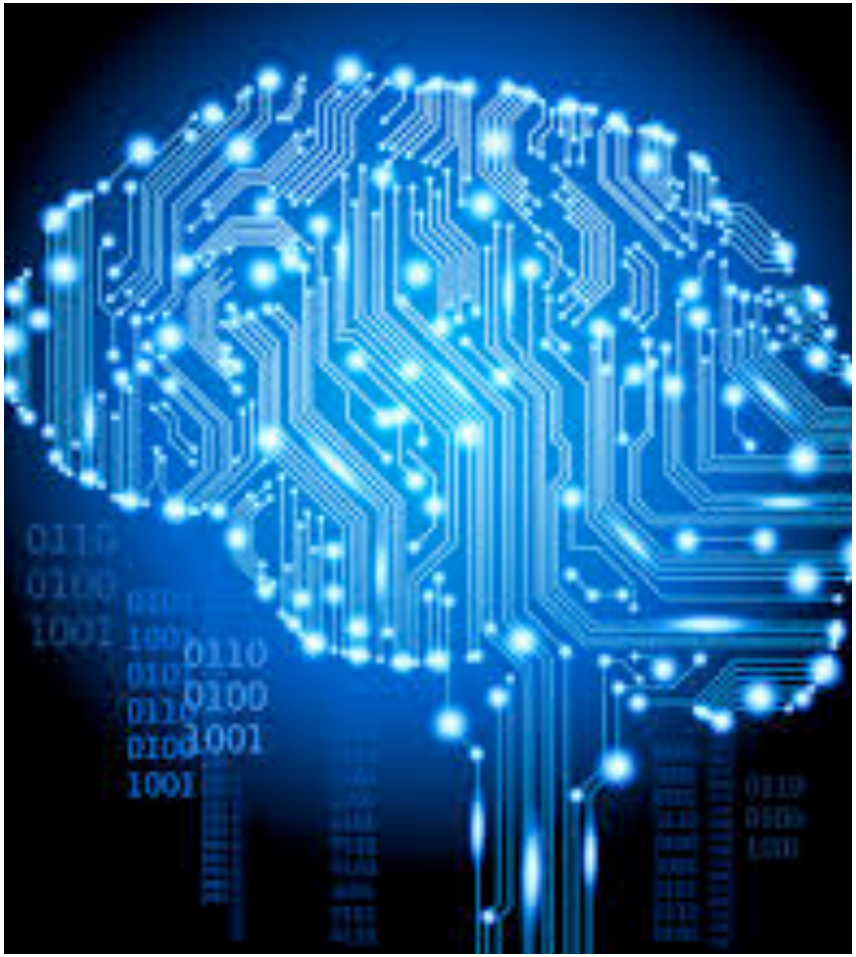
# What I Do…

- Model human learning using machine learning
- Adaptive instruction and feedback in computer-based educational environments
- E.g., diagnose a student's knowledge by watching her play a game




# Lecture Overview

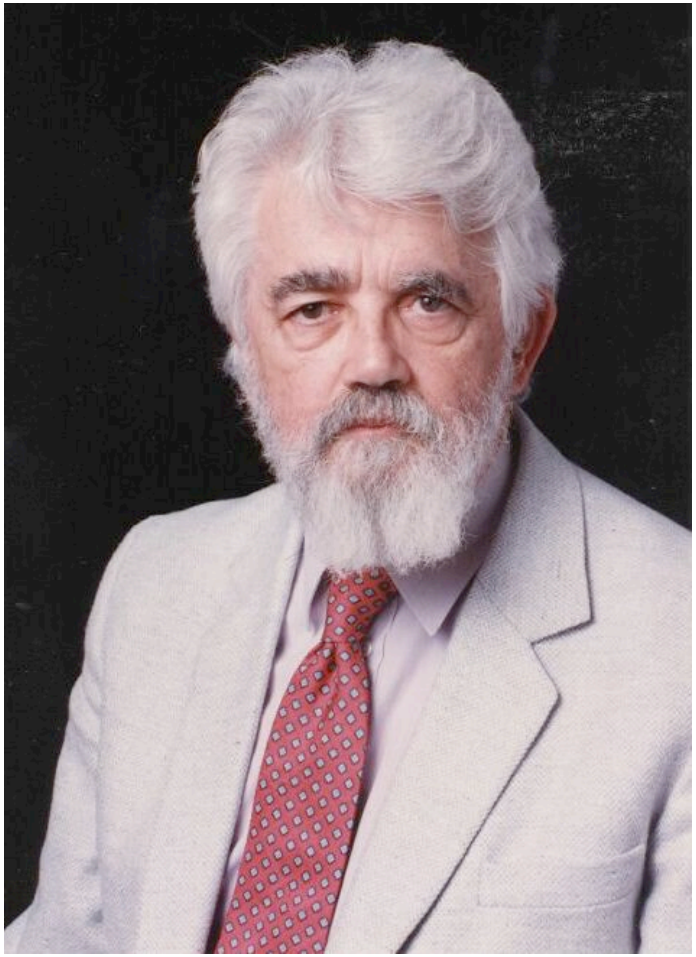
- What is AI?
- Some AI history: AI winter and the resurgence!
- Tour of areas of AI
- Philosophy: What would it mean for a program to be intelligent?



# AI Definition by John McCarthy

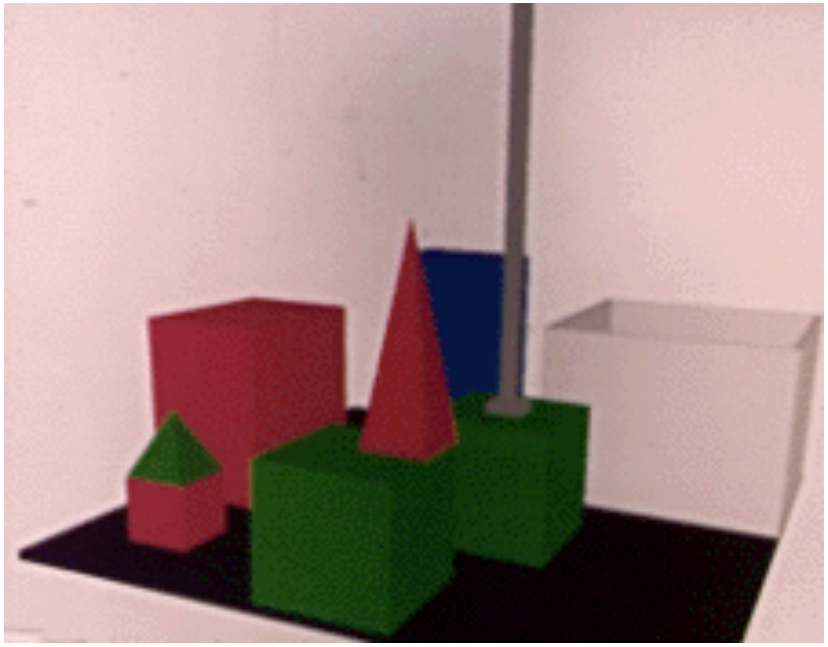
- "Getting a computer to do things which, when done by people, are said to involve intelligence"

- Finesses the idea of whether a computer has consciousness, whether they have rights, etc.



# A little history…

- Early AI (1956-early 1970s): symbolic reasoning and lots of optimism
- Neural nets (but very simple)



Person: PICK UP A BIG RED BLOCK.
Computer: OK. (does it)
Person: GRASP THE PYRAMID.
Computer: I DON'T UNDERSTAND WHICH PYRAMID YOU MEAN.
Person: FIND A BLOCK WHICH IS TALLER THAN THE ONE YOU ARE HOLDING AND PUT IT INTO THE BOX.
Computer: BY "IT", I ASSUME YOU MEAN THE BLOCK WHICH IS TALLER THAN THE ONE I AM HOLDING.
Computer: OK. (does it)

**http://hci.stanford.edu/winograd/shrdlu/**

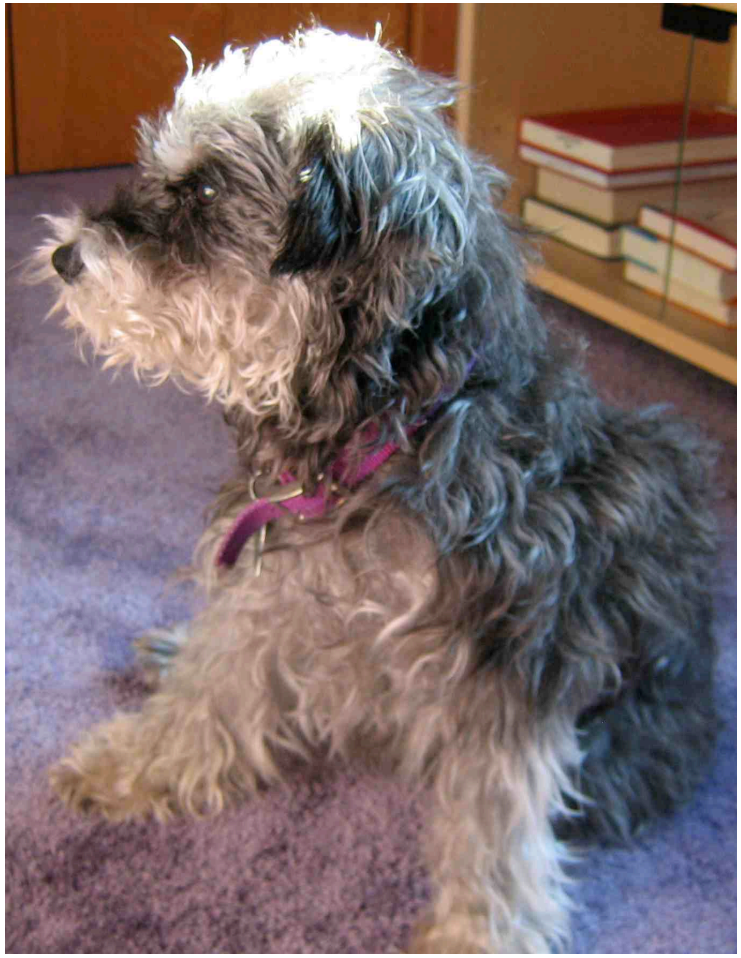
# Clicker Question

- Which of these rules is true for all dogs?
  - (A) Has four legs
  - (B) Has fur
  - (C) Barks
  - (D) None of the above

(Image from: http://vision.stanford.edu/resources_links.html)

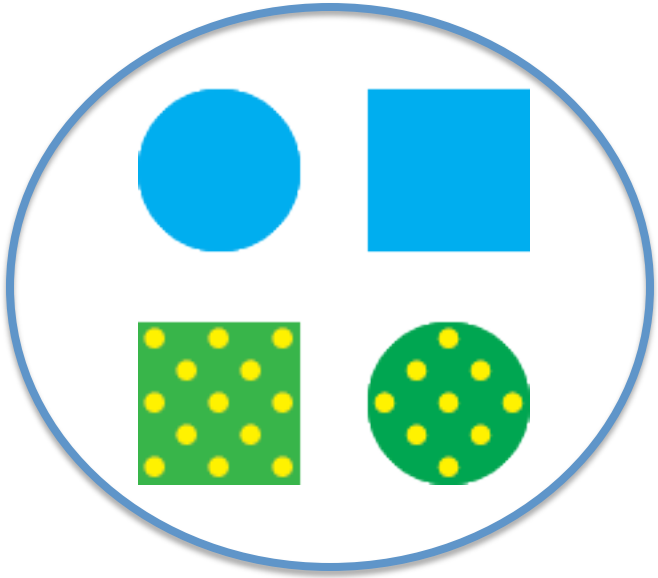
# Revival of AI: Big Ideas

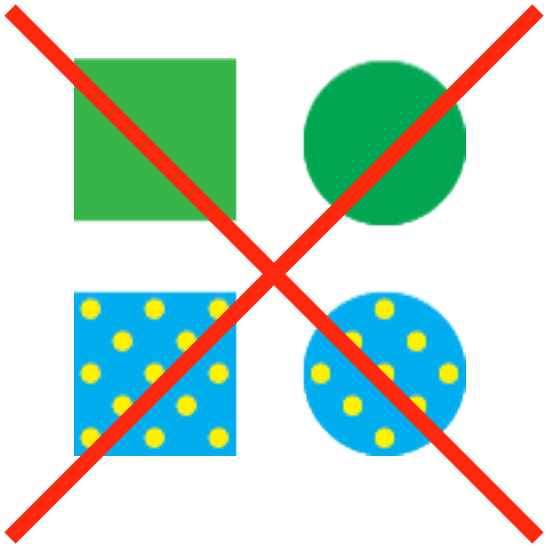
- Brittle rules break down in the real world
- Probability and uncertainty
- No “dog rule” – instead: what is the probability that the thing we’re seeing is a dog?
- Increased computational power and larger datasets



# Revival of AI

- Early neural nets theoretically less brittle than rules, but unable to learn some simple functions





# What intelligent things do people do?

Imagine cooking a meal with your roommates…

- Planning
- (Machine) Learning
- Natural Language Processing
- Motion and manipulation
- Perception
- Creativity

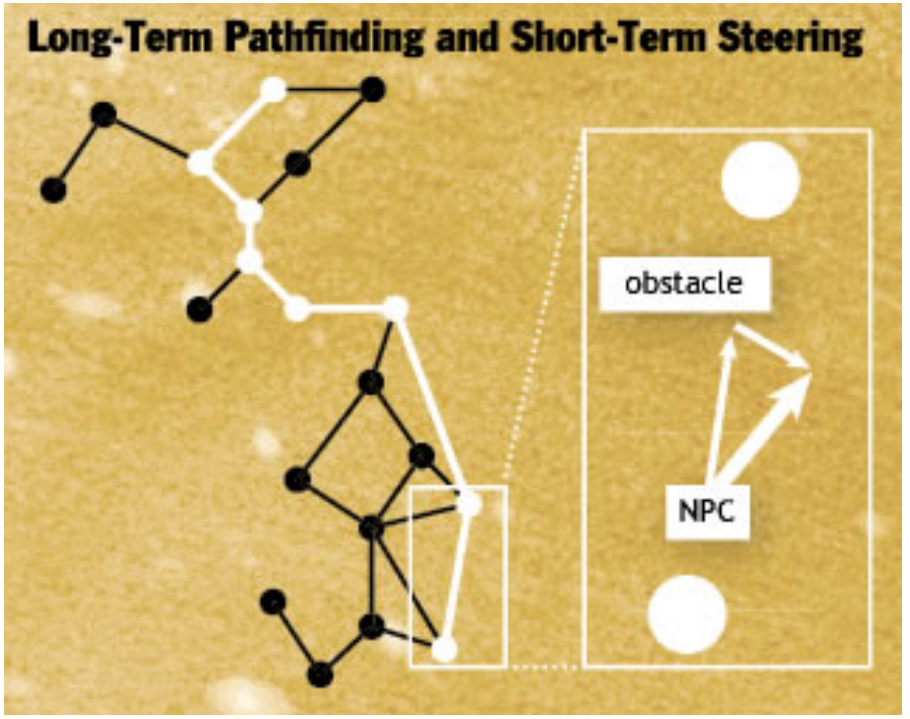
en.wikipedia.org/wiki/Artificial_intelligence

# Tour of AI Applications

- Questions to keep in mind:
  - How would you evaluate how well a machine performed on the tasks we talk about?
  - How can blending artificial and human intelligence make tasks simpler, even if the AI isn't perfect?


# Planning

- Range of intelligence
  - Low: simple heuristics
  - Medium: pathfinding
  - High: Learns from player
- Dynamic difficulty - adjust to player's skill
- Allocation of resources
  - E.g., choose what land resources to give to which conservation projects




www.businessweek.com/innovate/content/aug2008/id20080820_123140.htm
en.wikipedia.org/wiki/Dynamic_game_difficulty_balancing
en.wikipedia.org/wiki/Game_artificial_intelligence
queue.acm.org/detail.cfm?id=971593

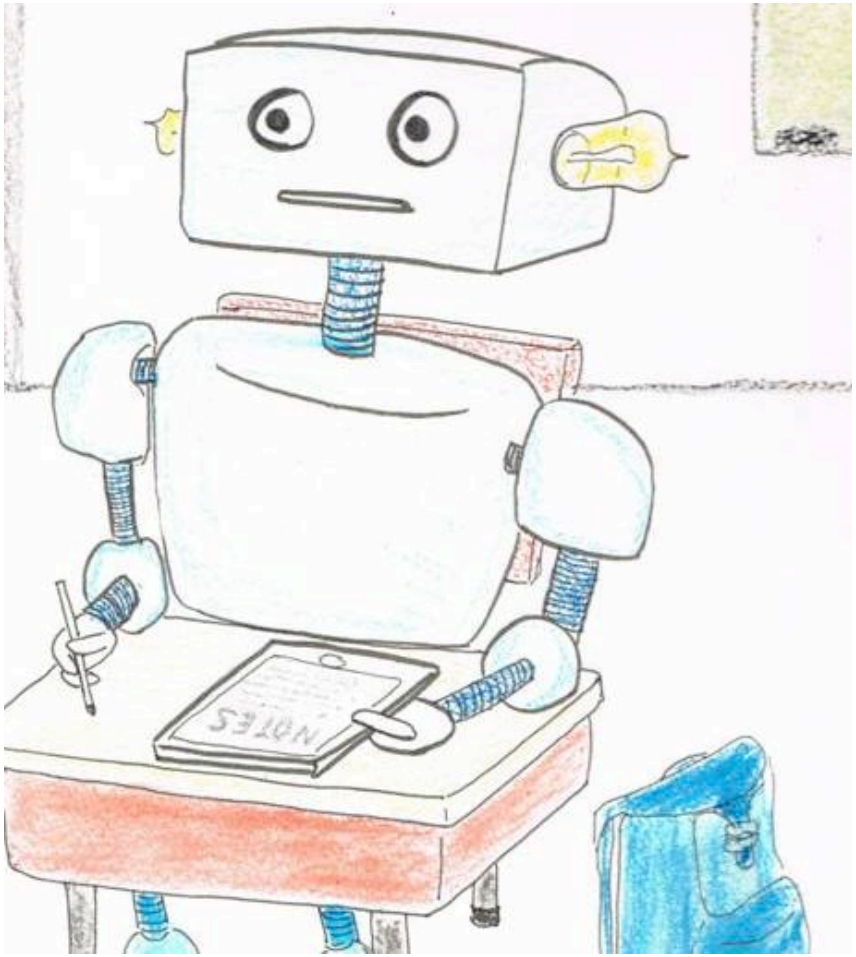
# Clicker Question

The WORLD'S BEST AI StarCraft player is from:

a) Google
b) IBM (folks who did Watson)
c) Stanford
d) Berkeley
e) MIT

# Machine Learning

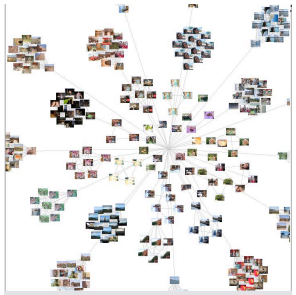
- "A program learns if, after an experience, it performs better"
- Machine learning enables a program to act without behavior being explicitly programmed.
- Need to discover the right generalizations




en.wikipedia.org/wiki/Machine_learning

# Machine Learning

- Algorithm Types
  - Supervised learning
    - Give a system input & output training data, and it produces a classifier
  - Unsupervised learning
    - Determine how data is organized or clustered
  - Reinforcement learning
    - No training data, real-time corrections adjust behavior

en.wikipedia.org/wiki/Machine_learning

# Clicker question

You want to make a spam filter that can tell you if an email is spam or not. What might be some good features for your algorithm?

(a) The full text of each email you've marked as spam

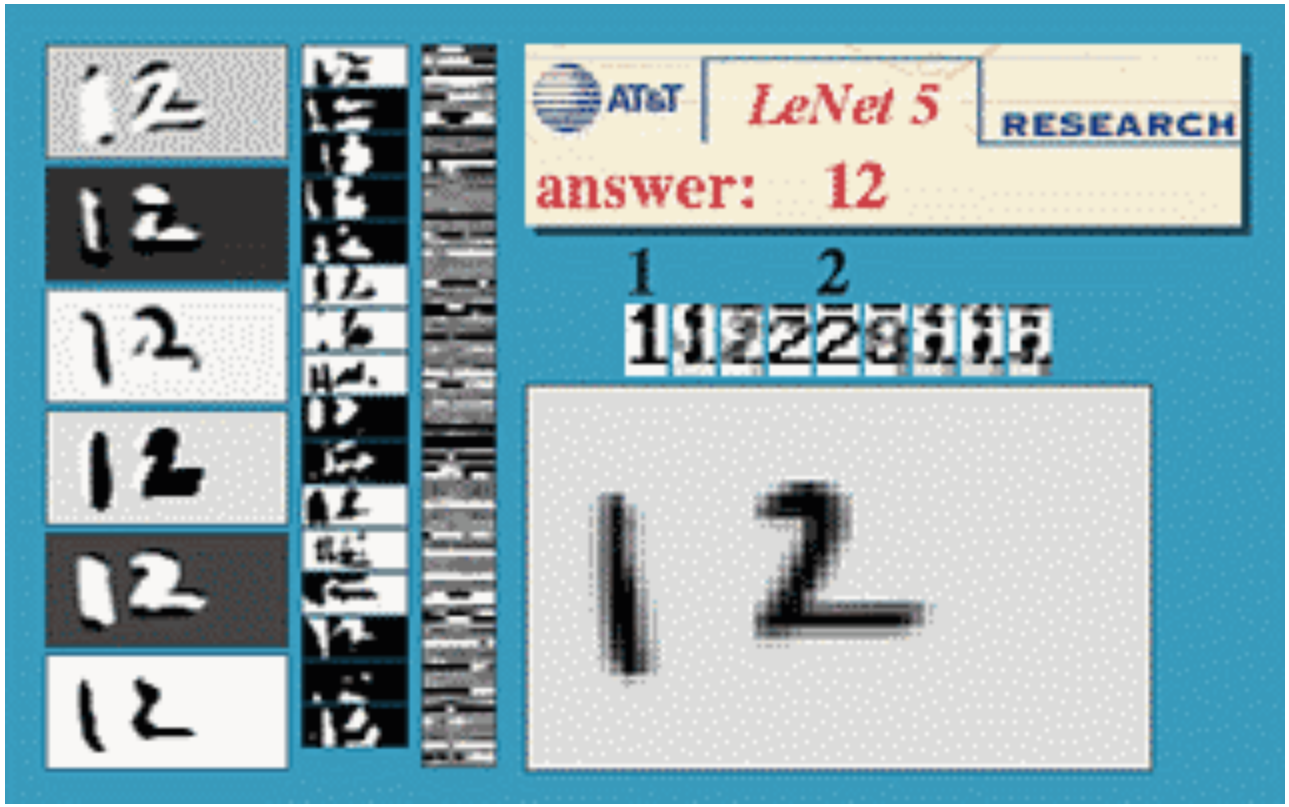
(b) Individual sentences from emails marked as spam or not spam

(c) Character counts (e.g., $ seen 54 times in spam emails, A seen 85 times in spam email)

(d) Words from emails marked as spam or not spam

# Example: Deep Learning

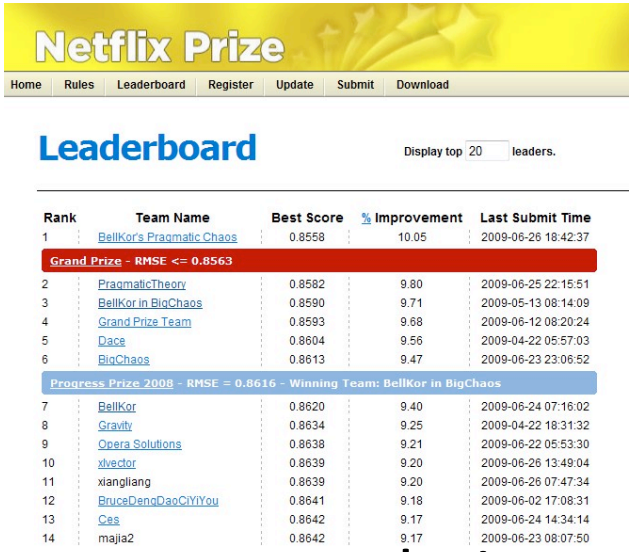
- Combines supervised and unsupervised learning: Learn the right *representations* for input -> output




# Benefiting from Big Data


Translation


Computer vision

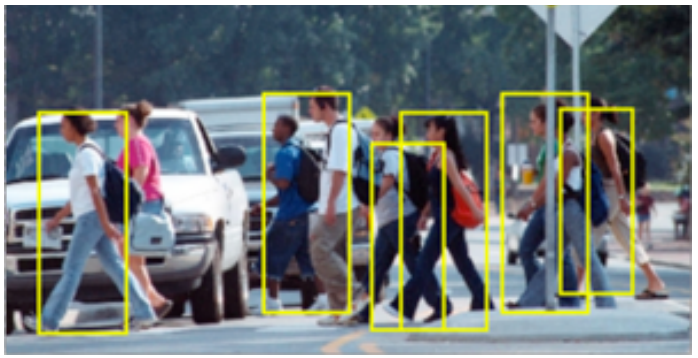



Recommendation

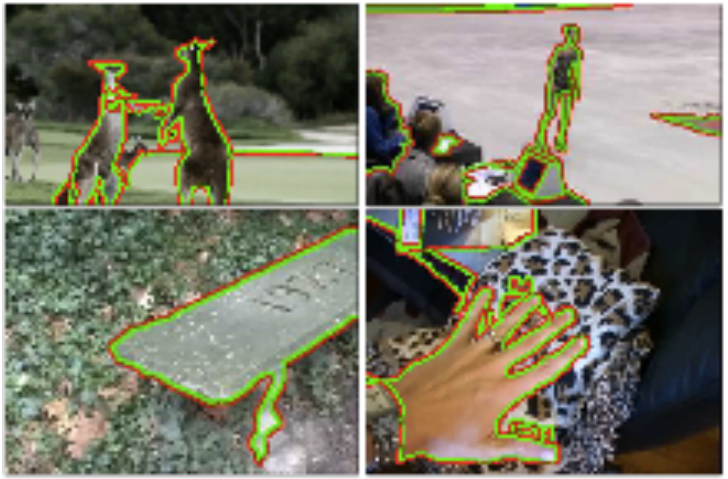
More examples help algorithms recognize trends and similarities across instances.

# Vision

- Tasks related to understanding images/camera input



Pedestrian detection



Figure/ground segmentation


Action recognition

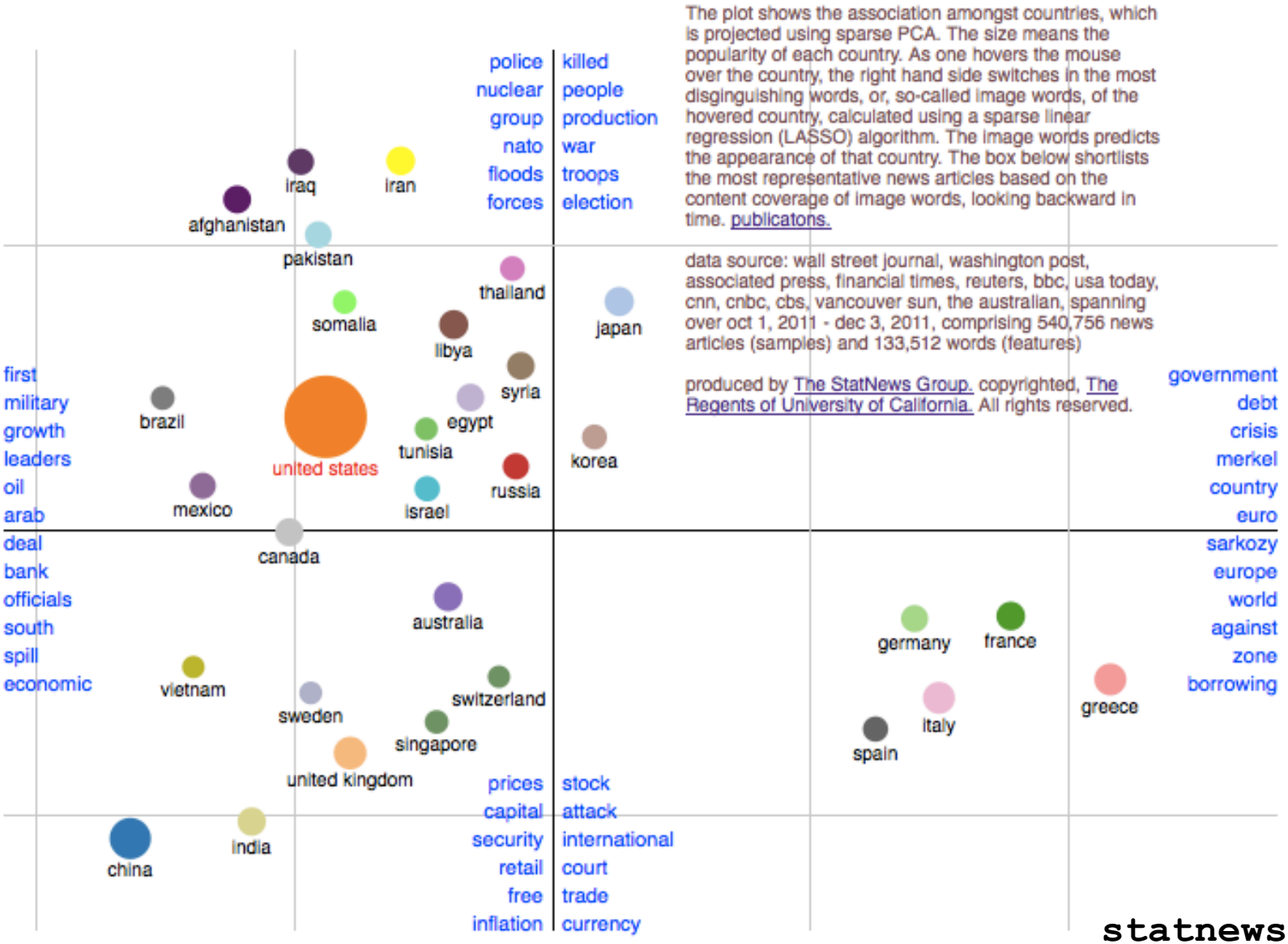
(Some images from Berkeley vision group)

# Natural Language Processing

- Known as "AI-complete" problem
  - (Often) requires extensive knowledge of world
- Statistical NLP
  - Correcting/guessing text
  - Suggesting news stories
  - Finding articles that are similar to one another
  - Translate or paraphrase texts


en.wikipedia.org/wiki/Natural_language_processing

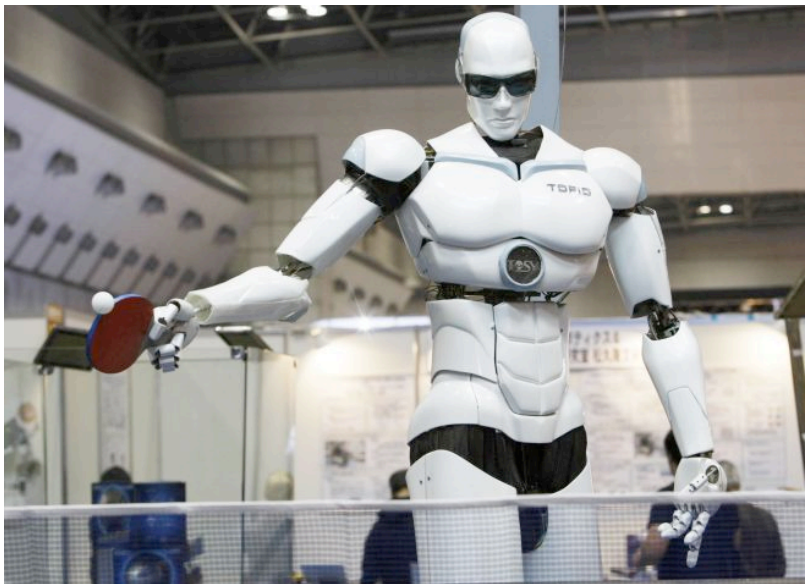
# Unsupervised Learning Example




statnews.org

# Robotics

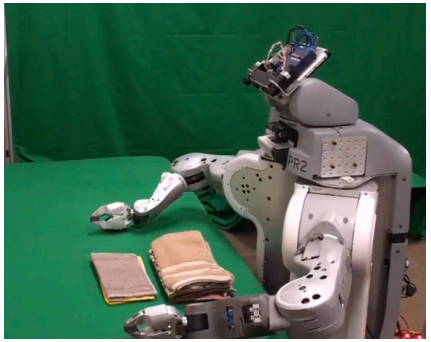
- For many, the coolest and scariest part of AI
- Combines fields of AI/CS
  - Speech recognition
  - Synthetic voice
  - Machine vision
  - Planning
  - HCI



TOPIO, the ping-pong playing robot

Assistive robots

Surgical robots



UC Berkeley's towel-folder

Autonomous helicopter

**en.wikipedia.org/wiki/Robotics**

# Recap

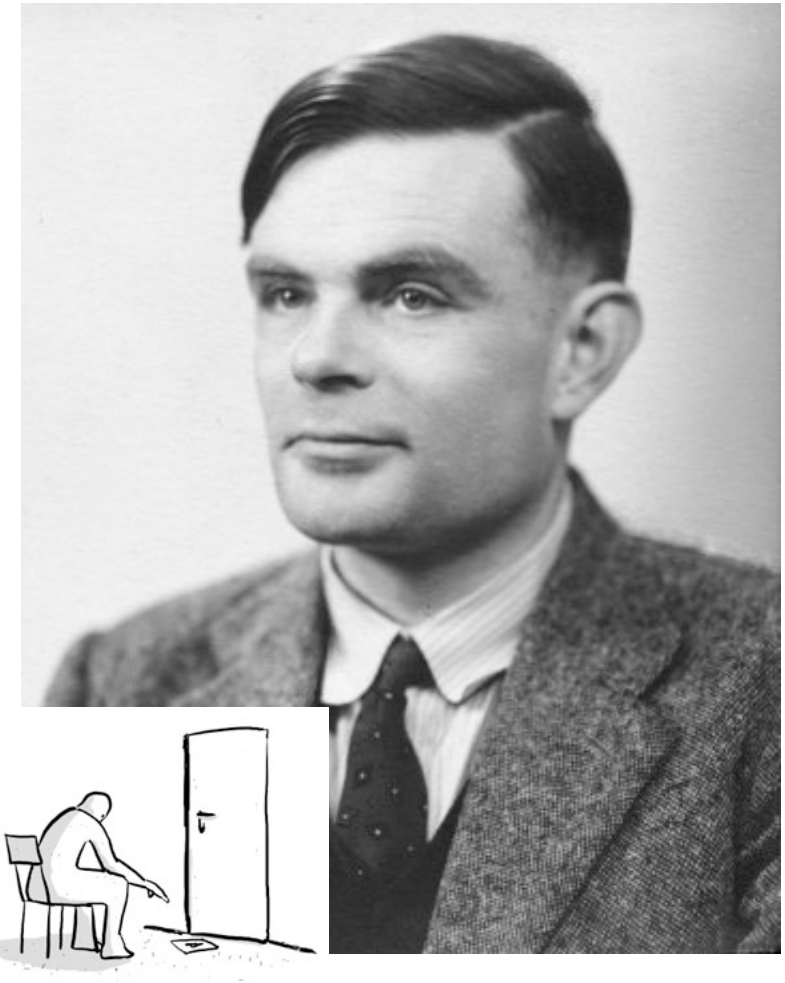
- All of these applications are tough because they require:
  - Knowing about context
  - Uncertainty about input
  - Intensive computations
- But AI has been relatively successful at making progress (and in some cases, better than people!)

# Clicker Question

- What would a "truly intelligent" AI system look like?
  - (A) Behaves in an optimal or rational manner
  - (B) Behaves similarly to people – when it makes errors, those errors are similar to people's errors
  - (C) Carries out the same type of processing (mental representations) people do – i.e., thinks like people

# Turing Test for Intelligence

- In 1950, Turing defined a test of whether a machine could "think"
- "A human judge engages in a natural language conversation with one human and one machine, each of which tries to appear human. If judge can't tell, machine passes the Turing test"
- John Searle argued against the test via the Chinese room experiment, in which someone carries on a conversation by looking up phrases in a book. Does that person understand Chinese?





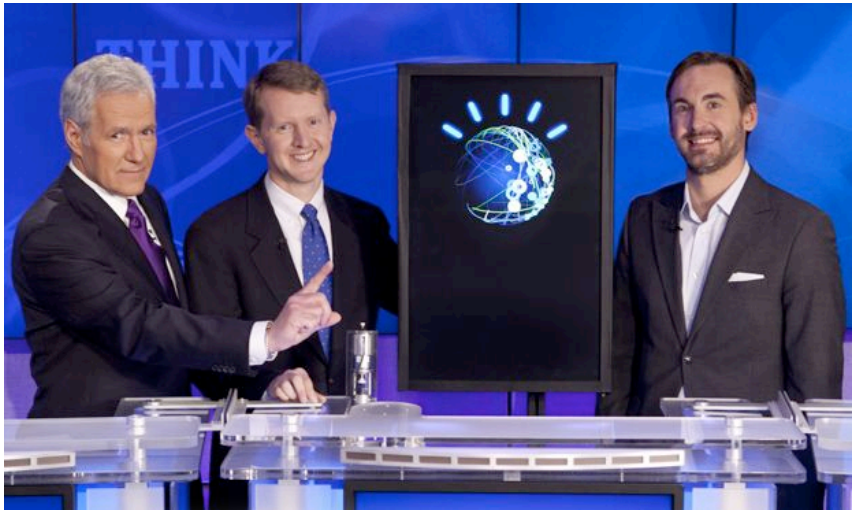
**en.wikipedia.org/wiki/Turing_test**

# Clicker Question

- How would you respond to Searle's Chinese room experiment?
  - (A) The system as a whole understands Chinese
  - (B) The man doesn't understand Chinese, but if he had a way to connect with the outside world (rather than just receiving strings of symbols), he could understand Chinese
  - (C) We must be missing something about "understanding" since the argument implies that brains, which are collections of neurons, cannot understand

# Summary

- AI systems excel in things computers are good at
  - Big data (using web to parse language)
  - Constrained worlds (chess, math)
- It's getting better at…
  - Language understanding
  - Real-time robotics
- Lots more applications that I didn't have time to talk about!
- CS188: Artificial Intelligence
  - One of the most popular courses on campus!
- CogSci131: Computational Models of Cognition




**Thanks! Feel free to email me with questions at rafferty@cs.berkeley.edu**