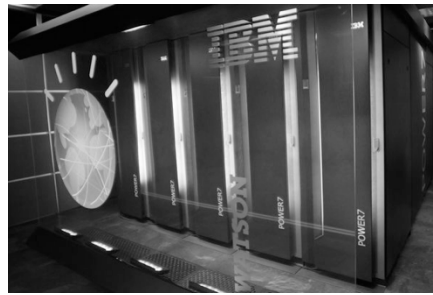


# CS10: The Beauty and Joy of Computing

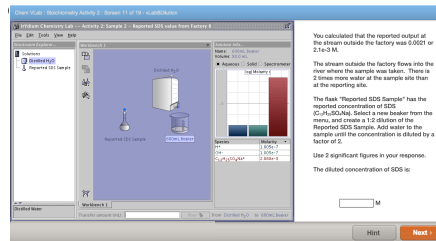
## Artificial Intelligence



Anna Rafferty  
(Slides adapted from Dan Garcia)  
18 November 2013

## 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

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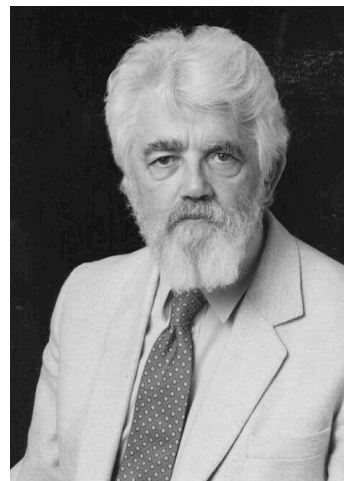
- What is AI?
- Some AI history: AI winter and the resurgence!
- Tour of areas of AI
- Philosophy: What would it mean for a program to be intelligent?



## AI Definition by John McCarthy

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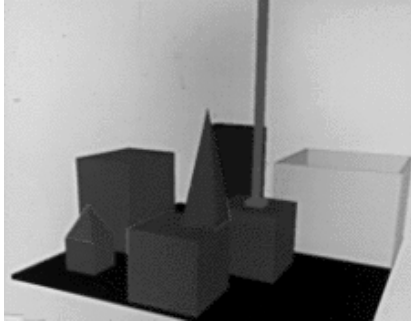
- “Getting a computer to do things which, when done by people, are said to involve intelligence”
- Finesses the idea of whether a computer has consciousness, whether they have rights, etc.



## A little history...

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- 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

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- 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](http://vision.stanford.edu/resources_links.html))

## Revival of AI: Big Ideas

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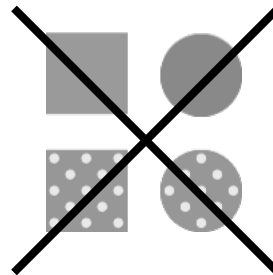
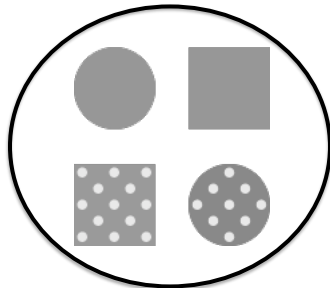
- Brittle rules break down in the real world
- Probability and uncertainty
- No “dog rule” – instead: what is the probability that the thing we’re seeing is a dog?
- Increased computational power and larger datasets



## Revival of AI

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



## What intelligent things do people do?

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Imagine cooking a meal with your roommates...

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

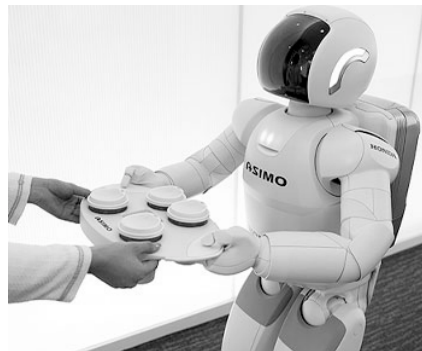


[en.wikipedia.org/wiki/Artificial\\_intelligence](https://en.wikipedia.org/wiki/Artificial_intelligence)

## Tour of AI Applications

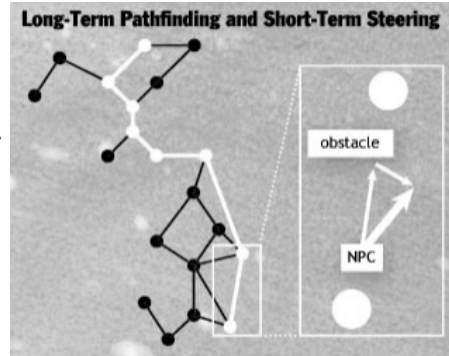
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- Questions to keep in mind:
  - How would you evaluate how well a machine performed on the tasks we talk about?
  - How can blending artificial and human intelligence make tasks simpler, even if the AI isn't perfect?



# 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](http://www.businessweek.com/innovate/content/aug2008/id20080820_123140.htm)  
[en.wikipedia.org/wiki/Dynamic\\_game\\_difficulty\\_balancing](http://en.wikipedia.org/wiki/Dynamic_game_difficulty_balancing)  
[en.wikipedia.org/wiki/Game\\_artificial\\_intelligence](http://en.wikipedia.org/wiki/Game_artificial_intelligence)  
[queue.acm.org/detail.cfm?id=971593](http://queue.acm.org/detail.cfm?id=971593)



# Clicker Question



The WORLD'S BEST AI StarCraft player is from:

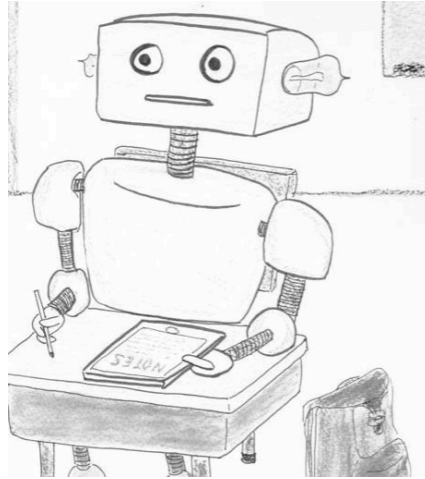


- a) Google
- b) IBM (folks who did Watson)
- c) Stanford
- d) Berkeley
- e) MIT



# Machine Learning

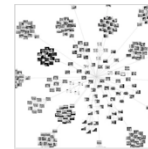
- “A program learns if, after an experience, it performs better”
- Machine learning enables a program to act without behavior being explicitly programmed.
- Need to discover the right generalizations



[en.wikipedia.org/wiki/Machine\\_learning](http://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](http://en.wikipedia.org/wiki/Machine_learning)

## Clicker question

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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

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

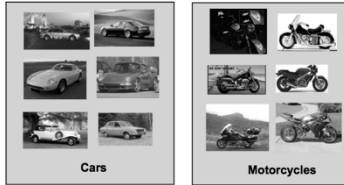




# Benefiting from Big Data



Translation



Computer vision



Recommendation

Rank	Team Name	Best Score	% Improvement	Last Submit Time
1	Bethesda Program Group	0.8758	10.05	2009-09-26 18:42:37
<b>Grand Prize: 0.8758 (10.05%)</b>				
2	Princeton	0.8762	9.80	2009-05-25 22:15:51
3	Bethesda BioClass	0.8780	9.71	2009-05-13 08:14:09
4	GrandCross Team	0.8853	9.58	2009-06-10 02:02:24
5	Case	0.8854	9.56	2009-04-22 05:57:53
6	BioClass	0.8815	9.47	2009-08-23 23:05:52
<b>Minimum: 0.8758 (10.05%)</b>				
7	Bethesda	0.8820	9.40	2009-05-24 07:16:02
8	Stanford	0.8834	9.25	2009-04-22 18:11:32
9	Case & Rutgers	0.8838	9.21	2009-06-22 05:03:30
10	MSD	0.8839	9.20	2009-09-26 13:49:54
11	Washington	0.8839	9.20	2009-05-26 07:47:34
12	Bethesda BioClass	0.8841	9.18	2009-06-02 17:58:31
13	Case	0.8842	9.17	2009-08-24 14:24:14
14	MSD	0.8842	9.17	2009-06-23 08:07:53

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

phoning



(Some images from Berkeley vision group)

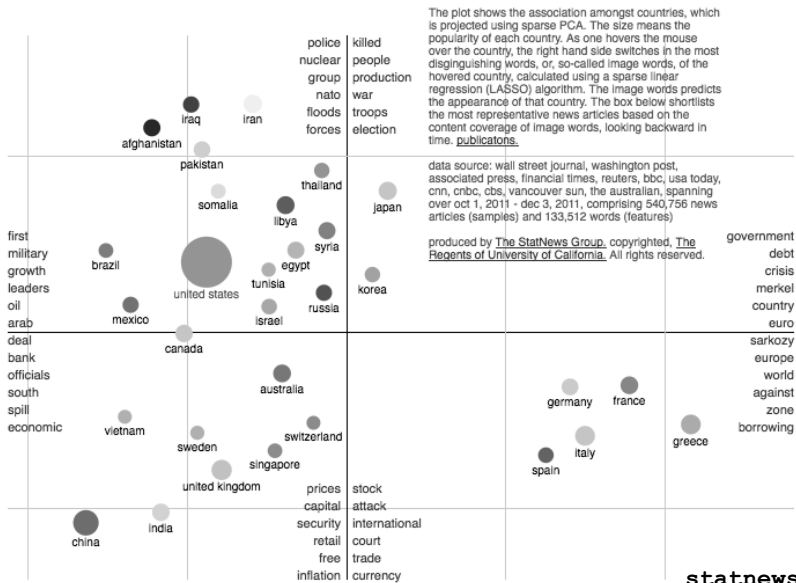
# Natural Language Processing

- 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](http://en.wikipedia.org/wiki/Natural_language_processing)

# Unsupervised Learning Example



# Robotics

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

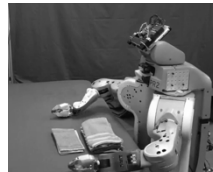


TOPIO, the ping-pong playing robot



Assistive robots

Surgical robots



UC Berkeley's towel-folder



Autonomous helicopter



[en.wikipedia.org/wiki/Robotics](http://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

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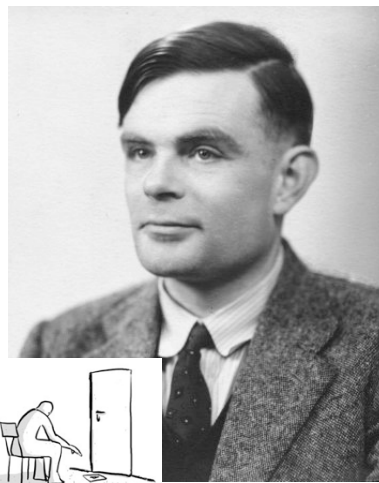
- What would a “truly intelligent” AI system look like?
  - (A) Behaves in an optimal or rational manner
  - (B) Behaves similarly to people – when it makes errors, those errors are similar to people’s errors
  - (C) Carries out the same type of processing (mental representations) people do – i.e., thinks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



## Turing Test for Intelligence

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- 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?



## Clicker Question

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- 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

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- 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](mailto:rafferty@cs.berkeley.edu)