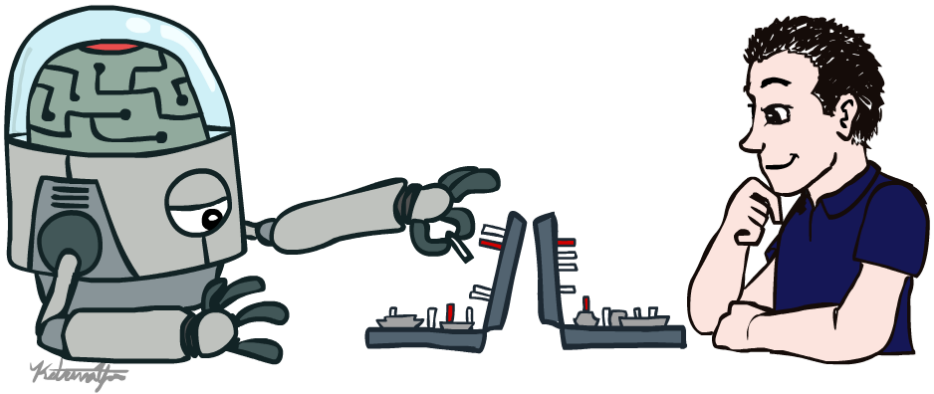
CS 5522: Artificial Intelligence II

Introduction



Instructor: Wei Xu

Ohio State University

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

Who is the instructor?

http://web.cse.ohio-state.edu/~weixu/

Wei Xu Follow @cocoweixu

[phonetic pronunciation: way shoo]

Assistant Professor
Department of Computer Science and Engineering
The Ohio State University
weixu@cse.ohio-state.edu
495 Dreese Lab (2015 Neil Ave, Columbus, OH 43210)

My research lies at the intersections of **machine learning**, **natural language processing**, and **social media**. I focus on designing algorithms for learning semantics from large data for natural language understanding, and generation in particular with stylistic variations. I recently received the NSF CRII Award, Criteo Faculty Research Award, CrowdFlower AI for Everyone Award, Best Paper Award at COLING'18, as well as research funds from DARPA. Previously, I was a postdoctoral researcher at the University of Pennsylvania. I received my PhD in Computer Science from New York University where I was a MacCracken Fellow, MS and BS from Tsinghua University.

I am an area chair for EMNLP 2018 (social media area), COLING 2018 (semantics area), EMNLP 2016 (generation area), a workshop chair for ACL 2017, and the publicity chair for NAACL 2016 and 2018. I also created the Twitter API tutorial and a new course on Social Media and Text Analytics.

Where is the instructor?

The 27th International Conference on Computational Linguistics (COLING 2018) will take place in Santa Fe, New-Mexico, USA. COLING 2018 will be held at the Santa Fe Community Convention Center from August 20th through 26th 2018.

http://coling2018.org/

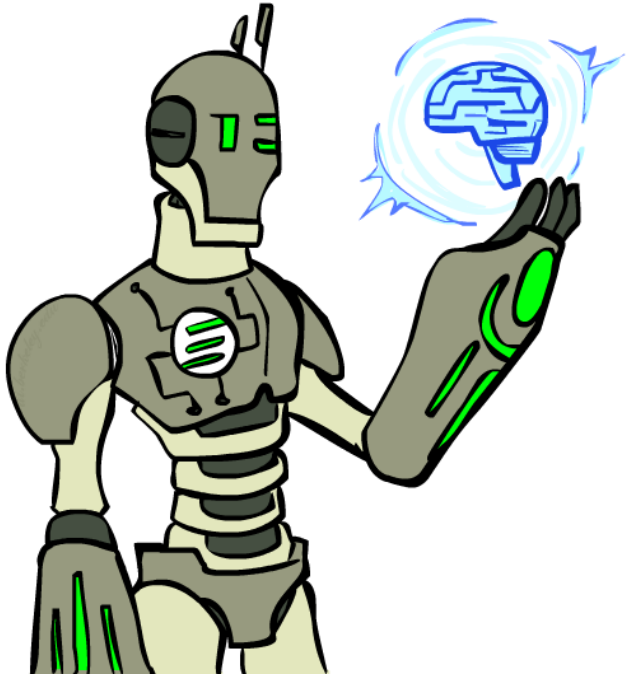
Neural Network Models for Paraphrase Identification, Semantic Textual Similarity, Natural Language Inference, and Question Answering

Wuwei Lan and Wei Xu
Department of Computer Science and Engineering
Ohio State University
{lan.105, xu.1265}@osu.edu

Best Paper Award

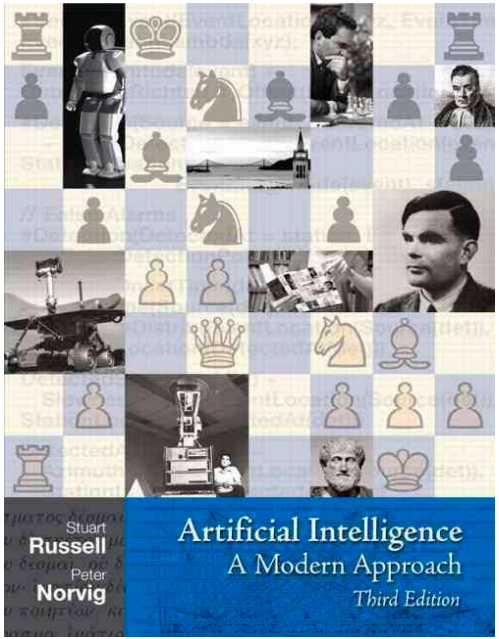
Today

- What is artificial intelligence?
- What can AI do?
- What is this course?
- Review Some Search Algorithms



Textbook

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



- Expectation is that you do read the textbook.

Prerequisites

- CSE 3521 or CSE 5521 or CSE 630 or grad standing
- Probability
- Calculus
- Linear Algebra
- Python

- Lots of Math and Programming in Python!

Example Slides in Class

- Reinforcement Learning

  - Evaluation: For fixed current policy π, find values with policy evaluation:
    - Iterate until values converge:

$$V_{k+1}^{\pi_i}(s) \leftarrow \sum_{s'} T(s, \pi_i(s), s') \left[R(s, \pi_i(s), s') + \gamma V_k^{\pi_i}(s') \right]$$

  - Improvement: For fixed values, get a better policy using policy extraction
    - One-step look-ahead:

$$\pi_{i+1}(s) = \arg\max_a \sum_{s'} T(s, a, s') \left[R(s, a, s') + \gamma V^{\pi_i}(s') \right]$$

Example Slides in Class

Bayes Net

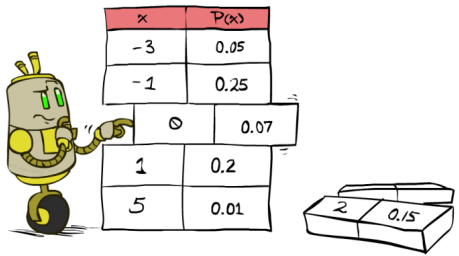
- General case:
  - Evidence variables: $E_1 \dots E_k = e_1 \dots e_k$
  - Query* variable: Q
  - Hidden variables: $H_1 \dots H_r$

  $X_1, X_2, \dots X_n$ *All variables*

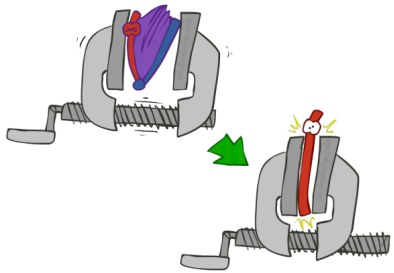
- We want: $P(Q|e_1 \dots e_k)$

** Works fine with multiple query variables, too*

- Step 1: Select the entries consistent with the evidence



- Step 2: Sum out H to get joint of Query and evidence



$$P(Q, e_1 \dots e_k) = \sum_{h_1 \dots h_r} \underbrace{P(Q, h_1 \dots h_r, e_1 \dots e_k)}_{X_1, X_2, \dots X_n}$$

- Step 3: Normalize

$$\times \frac{1}{Z}$$

$$Z = \sum_q P(Q, e_1 \cdots e_k)$$

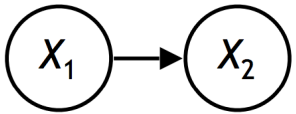
$$P(Q|e_1 \cdots e_k) = \frac{1}{Z} P(Q, e_1 \cdots e_k)$$

Example Slides in Class

- Hidden Markov Model

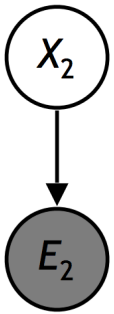
  - Every time step, we start with current P(X | evidence)
  - We update for time:

$$P(x_t|e_{1:t-1}) = \sum_{x_{t-1}} P(x_{t-1}|e_{1:t-1}) \cdot P(x_t|x_{t-1})$$



  - We update for evidence:

$$P(x_t|e_{1:t}) \propto_X P(x_t|e_{1:t-1}) \cdot P(e_t|x_t)$$



  - The forward algorithm does both at once (and doesn't normalize)

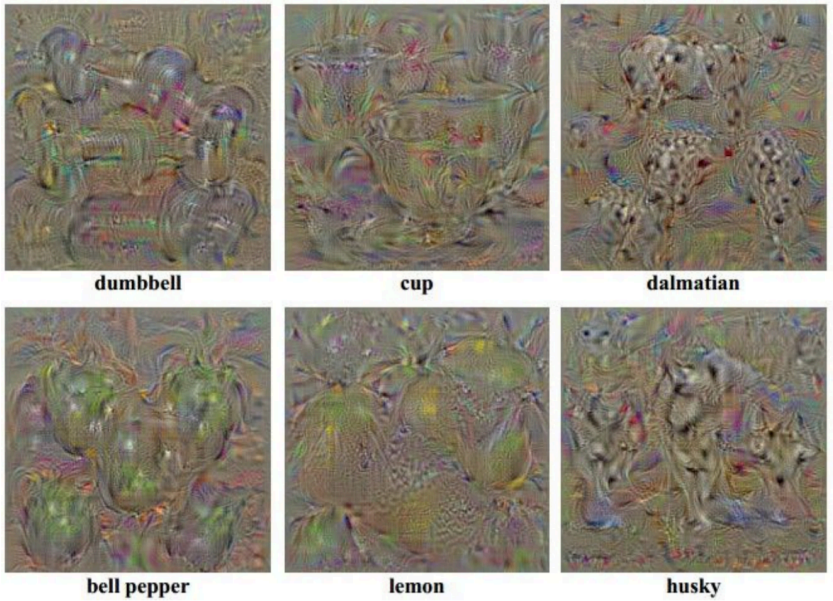
Example Slides in Class

- Computer Vision

Visualizing CNN features: Gradient Ascent

$$\arg\max_I S_c(I) - \lambda \|I\|_2^2$$

Simple regularizer: Penalize L2 norm of generated image



Course Website

https://cocoxu.github.io/courses/5522_autum18.html

CSE 5522 Artificial Intelligence II: Advanced Techniques

Advanced concepts, techniques, and applications of artificial intelligence, including knowledge representation, learning, natural language understanding, and vision.

Details
Wednesday & Friday, 2:20 - 3:40pm
Place: Caldwell 120
Instructor: Wei Xu (Office Hours: Wednesday 4:00-5:00pm, Dreese 495)
TA: TBA

- Example homework, projects, exams, lecture slides are provided;
- subject to change as the autumn 2018 term progresses.

Grading

Grading

Participation (5%)

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

Homeworks (12%)

Written homeworks will be very short (one or two exam-style questions) and will be graded in a good/mediocre/incomplete basis. You should be prepared to do regular work each week to keep up with the material and the assignments. Homeworks due before class on day X will include topics we will discuss in class on day X. We will talk about solution in class if people have questions. Homework assignments may **NOT** be turned in late. Homeworks are **NOT** accepted by email. There will be 1 grace homework grade per semester, that is, each student receiving full credit for the lowest or a missing homework grade.

Projects (40%)

Programming projects will be in Python, and should be submitted to 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 loose 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 (18%)

Midterm exam will be close book and notes.

Final Exam (25%)

Final exam will be close book and notes.

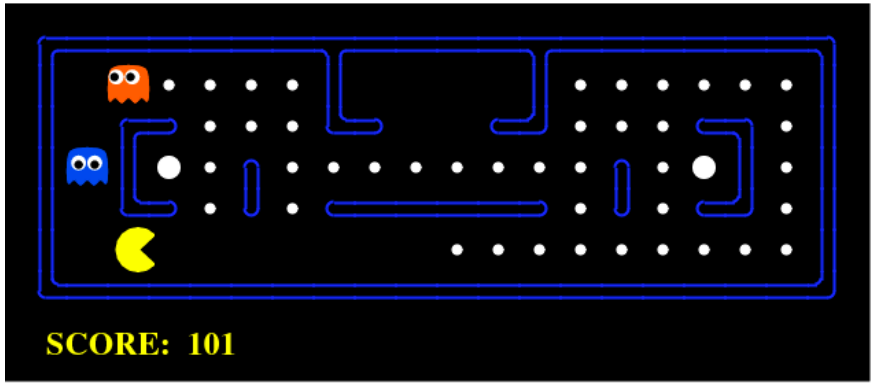
Written Homeworks

Homework Assignments (subject to change as the autumn 2018 term progresses.)

- Homework 0 - Math and Python Review (due 8/24)
- Homework 1 - Search Review (due TBA)
- Homework 2 - Markov Decision Processes (due TBA)
- Homework 3 - Reinforcement Learning: Q-learning (due TBA)
- Homework 4 - Reinforcement Learning: Feature-based Representations (due TBA)
- Homework 5 - Probability Review (due TBA)
- Homework 6 - Hidden Markov Models (due TBA)
- Homework 7 - Bayes Nets (due TBA)
- Homework 8 - Naive Bayes (due TBA)

- Interactive Practice - Alpha-Beta Pruning
- Example Exam - MDPs, Reinforcement Learning, Markov Model, HMM, Bayes Nets

Programming Projects: Berkeley Pac-Man



Programming Projects

- Project 0 - Unix/Python/Autograder Tutorial (optional)
- Project 1 - Search (optional)
- Project 2 - Multi-Agent Search (optional)
- Project 3 - Reinforcement Learning (due TBA)
- Project 4 - Ghostbusters (due TBA)
- Project 5 - Classification (due TBA)

Course Topics (part 1)

Schedule (subject to change as the autumn 2018 term progresses.)

Date	Topic	Required Reading	Suggested Reading
TBD	Course Overview	Russel & Norvig Chapter 1,2	Microsoft Ms. PacMan
TBD	Search Review	3.1-3.6	Pancake Sorting
TBD	Game Playing 1 - Minimax	5.1, 5.2, 5.3, 5.4	Machine Translation class and book
TBD	Game Playing 2 - Expectimax and Utilities	5.5, 13.1, 13.2, 16.1, 16.2, 16.3	Rosen's note on Alpha Beta Pruning
	Reinforcement Learning		
TBD	Reinforcement Learning 1 - Markov Decision Processes	17.1, 17.2	
TBD	Reinforcement Learning 2 - Value Iteration and Policy Iteration	17.3	Real-life examples of Markov Decision Processes
TBD	Reinforcement Learning 3 - Temporal Difference Learning	21.1, 21.2, 21.3	Google AlphaGo
TBD	Reinforcement Learning 4 - Q-Learning	21.1, 21.2, 21.3	
TBD	Reinforcement Learning 5 - Function Approximation	21.4	Sutten & Barto's new reinforcement learning book (Ch. 5, 6, 13)
TBD	Reinforcement Learning 6 - Policy Gradient Methods	21.5, 21.6	Deep Q-Learning

Course Topics (part 2)

	Reasoning Under Uncertainty		
TBD	Probability Review	13.3, 13.4, 13.5, 13.6	Andrew Moore's tutorial and Jean Walrand's note on Probability
TBD	Markov Models	15.1, 15.2	
TBD	Midterm Review		
TBD	Midterm (In class - close book and notes)		
TBD	Hidden Markov Models 1 - Monitoring and robot localization	15.1, 15.2	
TBD	Hidden Markov Models 2 - Particle filtering and resampling	15.3, 15.5	
TBD	Bayes Nets 1 - Probabilistic Representations	14.1, 14.2	
TBD	Bayes Nets 2 - D-Seperation	14.1, 14.2	Olivier Chapelle's talk on Bayesian Network Click Model for Web Search
TBD	Bayes Nets 3 - Inference	14.4	David Blei's talk on Topic Models and User Behavior
TBD	Bayes Nets 4 - Sampling	14.5	

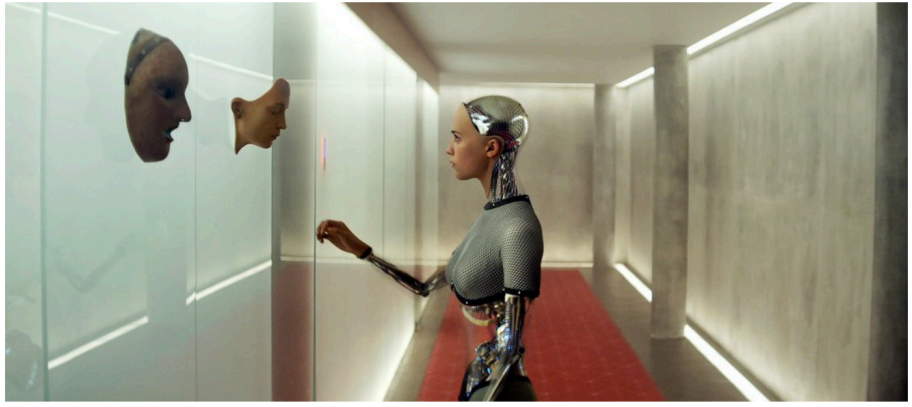
Course Topics (part 3)

	Machine Learning and Special Topics		
TBD	Perceptron and Naive Bayes	18.6	
TBD	Computer Vision 1 - Applications and CNNs		Facebook Accessibility
TBD	Computer Vision 2 - Visualization	20.1, 20.2.1, 20.2.2	Google DeepDream
TBD	Robotics Research		
TBD	Guest Lecture (Natural Language Processing Research)		
TBD	Final Review		
TBD	Final Exam (close book and notes)		

Sci-Fi AI

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

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

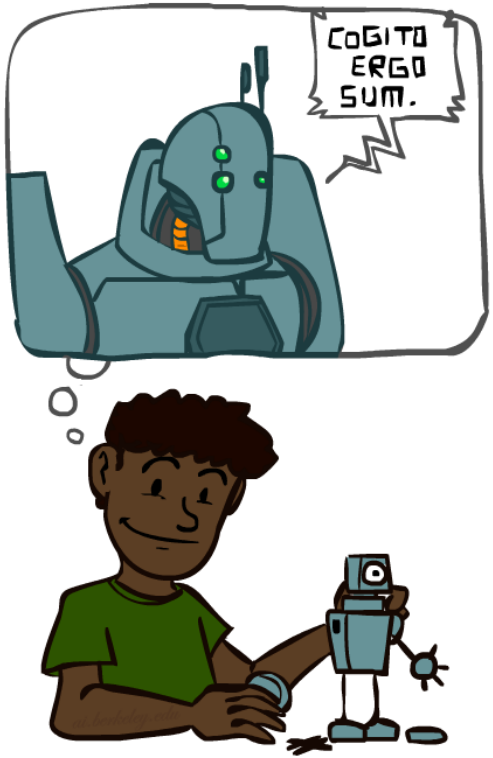
RELATED COVERAGE

'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

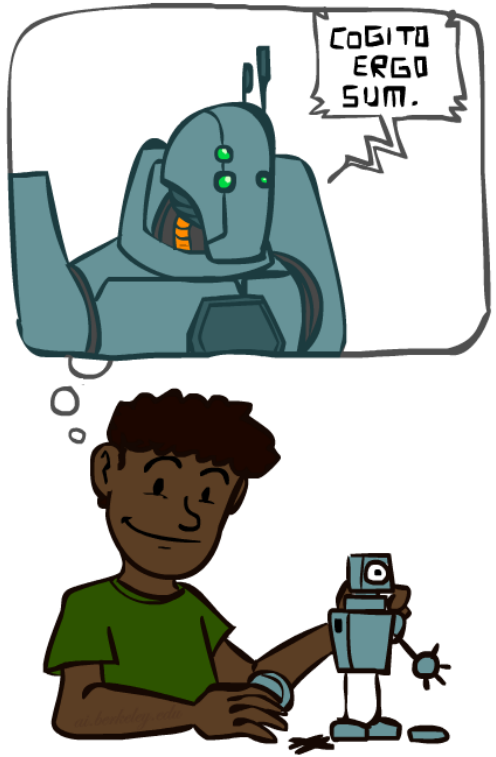
A (Short) History of AI



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

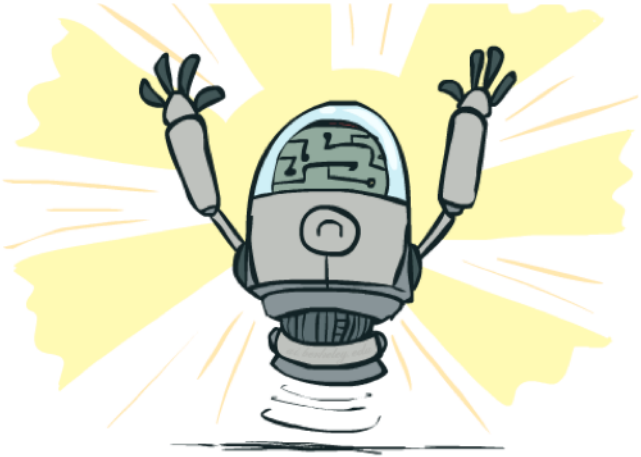
A (Short) History of AI

- 1940-1950: Early days
  - 1943: McCulloch & Pitts: Boolean circuit model of brain
  - 1950: Turing's “Computing Machinery and Intelligence”
- 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
- 1970—90: Knowledge-based approaches
  - 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”?
- 2000—: Where are we now?



Which of the following can be done at present?

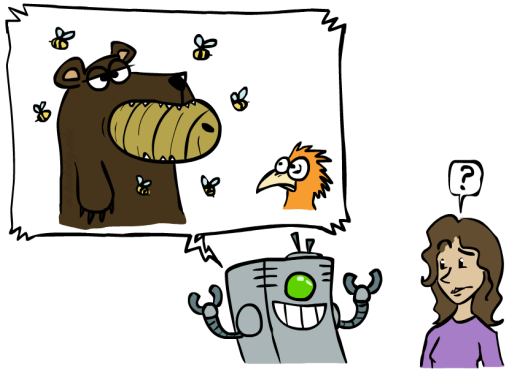
- ✓ Play a decent game of table tennis?
- ✓ Play a decent game of Jeopardy?
- ✓ Drive safely along a curving mountain road?
- ? Drive safely across campus during the Michigan Game?
- ✓ Buy a week's worth of groceries on the web?
- ✗ Buy a week's worth of groceries at North Market?
- ? Discover and prove 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?



https://www.youtube.com/watch?v=ive4sKkpCqs

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.

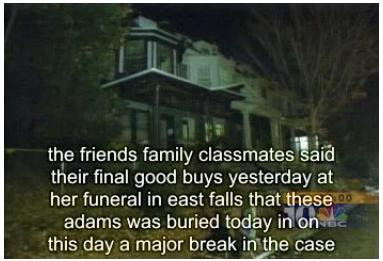


- Henry Squirrel was thirsty. He walked over to the river bank where his good friend Bill Bird was sitting. Henry slipped and fell in the river. Gravity drowned. The End.
- Once upon a time there was a dishonest fox and a vain crow. One day the crow was sitting in his tree, holding a piece of cheese 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.

[Shank, Tale-Spin System, 1984]

Speech and Natural Language Processing

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

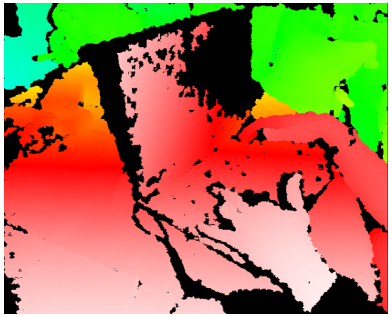


- Language processing technologies
  - Question answering
  - Machine translation

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

Computer Vision

- Object and face recognition
- Scene segmentation
- Image classification



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

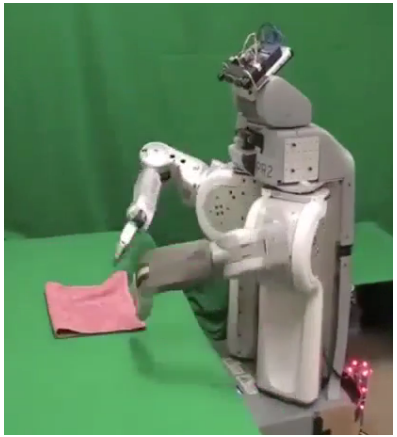
Demo1: VISION – lec_1_t2_video.flv

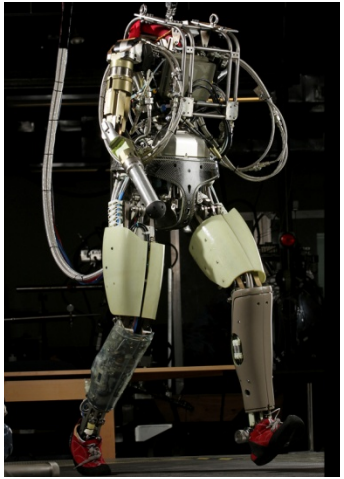
Demo2: VISION – lec_1_obj_rec_0.mpg

Robotics

Images from UC Berkeley, Boston Dynamics, RoboCup, Google

- 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

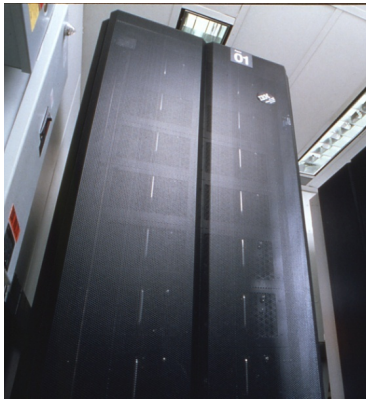




https://www.youtube.com/watch?v=XuPmqeXVKRI

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



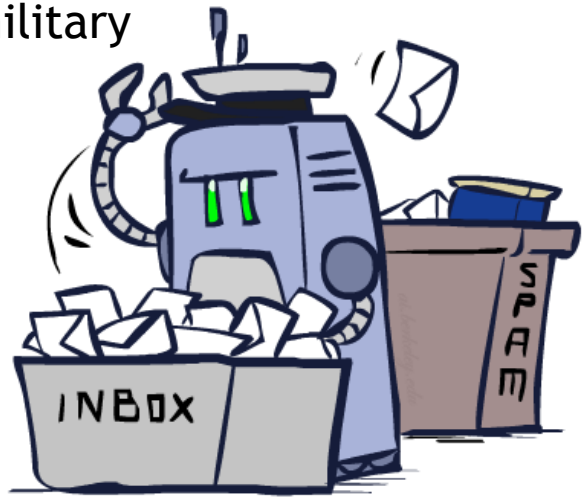
- Open question:
  - How does human cognition deal with the search space explosion of chess?
  - Or: how can humans compete with computers at all??

- 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!

Text from Bart Selman, image from IBM’s Deep Blue pages

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!



To Do

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

- On the Waiting List:
  - Fill up OSU's Course Enrollment Permission Form
  - Leave the form at the instructor's office (slip under the door of DL 495)
  - As space open up, some students will receive an email from the instructor, then pick up the signed form (pinned on the wall outside DL 495)
  - Take the signed form to college office