# COMP 590: Artificial Intelligence

Today

- Course overview
- What is AI?
- State of the art in AI today
- Topics covered in the course

Who is this course for?

- An introductory survey of AI techniques for students who have not previously had an exposure to this subject
  - Juniors, seniors, beginning graduate students

- Prerequisites: solid programming skills, algorithms, calculus
  - Exposure to linear algebra and probability a plus

- Credit: 3 units

Basic Info

- **Instructor:** Svetlana Lazebnik (lazebnik@cs.unc.edu)
  Office hours: email me

- **Textbook:** S. Russell and P. Norvig, *Artificial Intelligence: A Modern Approach,* Prentice Hall, 2nd or 3rd ed. http://aima.cs.berkeley.edu/

- **Class webpage:**
  http://www.cs.unc.edu/~lazebnik/fall10
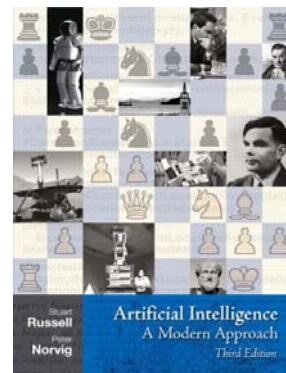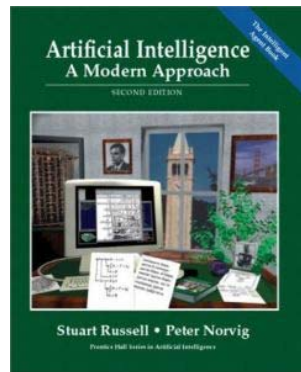
Course Requirements

- ## Participation: 20%
  - Come to class!
  - Ask questions
  - Answer questions
  - Participate in discussions

- ## Assignments: 50%
  - Written and programming
  - Programming assignments: you can use whatever language you wish. The focus is on problem solving, not specific programming skills.

- ## Midterm/final: 30%
  - No book, no notes, no calculator, no collaboration
  - Not meant to be scary
  - Mainly straightforward questions testing comprehension

Academic integrity policy

- Feel free to discuss assignments with each other, but coding must be done individually

- Feel free to incorporate code or tips you find on the Web, provided this doesn't make the assignment trivial and you explicitly acknowledge your sources

- Remember: I can Google as well as you can

What is AI?

Some possible definitions from the textbook:

- Thinking humanly
- Acting humanly
- Thinking rationally
- Acting rationally

Thinking humanly

- Cognitive science: the brain as an information processing machine
  - Requires scientific theories of how the brain works
- How to understand cognition as a computational process?
  - Introspection: try to think about how we think
  - Predict and test behavior of human subjects
  - Image the brain, examine neurological data
- The latter two methodologies are the domains of cognitive science and cognitive neuroscience

Acting humanly

- Turing (1950) "Computing machinery and intelligence"
- The Turing Test
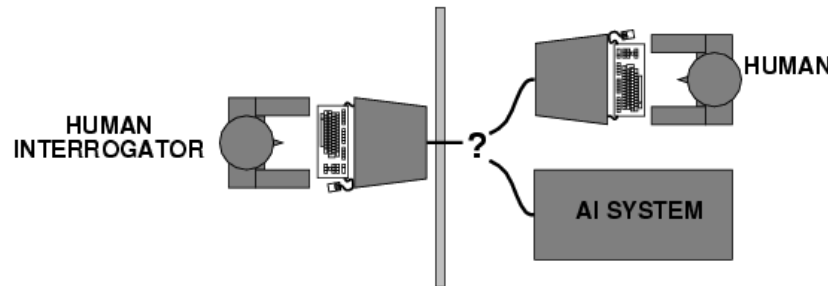
- What capabilities would a computer need to have to pass the Turing Test?
  - Natural language processing
  - Knowledge representation
  - Automated reasoning
  - Machine learning
- Turing predicted that by the year 2000, machines would be able to fool 30% of human judges for five minutes

Turing Test: Criticism

- What are some potential problems with the Turing Test?
  - Some human behavior is not intelligent
  - Some intelligent behavior may not be human
  - Human observers may be easy to fool
    - A lot depends on expectations
    - *Anthropomorphic fallacy*
    - Chatbots, e.g., ELIZA
  - Chinese room argument: one may simulate intelligence without having true intelligence (more of a philosophical objection)
- Is passing the Turing test a good scientific goal?
  - Not a good way to solve practical problems
  - Can create intelligent agents without trying to imitate humans

Thinking rationally

- Idealized or "right" way of thinking
- **Logic:** patterns of argument that always yield correct conclusions when supplied with correct premises
  - "Socrates is a man; all men are mortal; therefore Socrates is mortal."
- Beginning with Aristotle, philosophers and mathematicians have attempted to formalize the rules of logical thought
- ***Logicist* approach to AI:** describe problem in formal logical notation and apply general deduction procedures to solve it
- Problems with the logicist approach
  - Computational complexity of finding the solution
  - Describing real-world problems and knowledge in logical notation
  - A lot of intelligent or "rational" behavior has nothing to do with logic

Acting rationally: Rational agent

- A rational agent is one that acts to achieve the best expected outcome
  - Goals are application-dependent and are expressed in terms of the **utility of outcomes**
  - Being rational means **maximizing your expected utility**
  - In practice, utility optimization is subject to the agent's computational constraints (*bounded rationality* or *bounded optimality*)
- This definition of rationality only concerns the decisions/actions that are made, not the cognitive process behind them

Acting rationally: Rational agent

- Advantages of the "utility maximization" formulation
  - Generality: goes beyond explicit reasoning, and even human cognition altogether
  - Practicality: can be adapted to many real-world problems
  - Amenable to good scientific and engineering methodology
  - Avoids philosophy and psychology

- Any disadvantages?

AI Connections

Philosophy   logic, methods of reasoning, mind vs. matter, foundations of learning and knowledge

Mathematics   logic, probability, optimization

Economics   utility, decision theory

Neuroscience   biological basis of intelligence

Cognitive science   computational models of human intelligence

Linguistics   rules of language, language acquisition

Machine learning   design of systems that use experience to improve performance

Control theory   design of dynamical systems that use a controller to achieve desired behavior

Computer engineering, mechanical engineering, robotics, …

Where is AI today?

Logistics, scheduling, planning

- During the 1991 Gulf War, US forces deployed an AI logistics planning and scheduling program that involved up to 50,000 vehicles, cargo, and people

- NASA's Remote Agent software operated the Deep Space 1 spacecraft during two experiments in May 1999

- In 2004, NASA introduced the MAPGEN system to plan the daily operations for the Mars Exploration Rovers
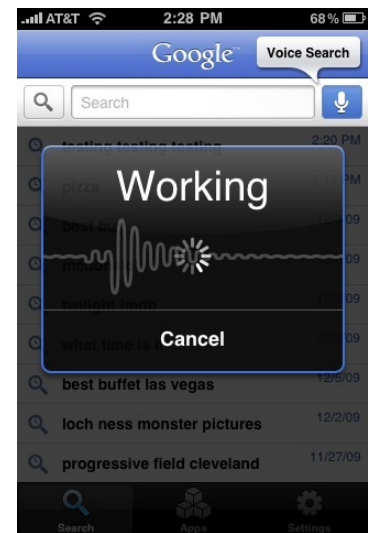
Math, games, puzzles

- In 1996, a computer program written by researchers at Argonne National Laboratory proved a mathematical conjecture (Robbins conjecture) unsolved for decades
  - [NY Times story](): "[The proof] would have been called creative if a human had thought of it"
- IBM's Deep Blue defeated the reigning world chess champion Garry Kasparov in 1997

  - **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."
- In 2007, checkers was "solved" --- a computer system that never loses was developed
  - [Science article]()

Natural Language

- ## Speech technologies
  - ### Automatic speech recognition
    - #### [Google voice search](#)
  - ### Text-to-speech synthesis
  - ### Dialog systems

- ## Machine translation
  - ### translate.google.com
  - ### [Comparison of several translation systems](#)

Source	The Original Text	Human Translation	Google Translate
French "Le Petit Prince" ("The Little Prince") By Antoine de Saint-Exupéry	Le premier soir je me suis donc endormi sur le sable à mille milles de toute terre habitée. J'étais bien plus isolé qu'un naufragé sur un radeau au milieu de l'océan. Alors vous imaginez ma surprise, au lever du jour, quand une drôle de petite voix m'a réveillé. Elle disait: -S'il vous plaît... dessine-moi un mouton!	On the first night, I fell asleep on the sand, a thousand miles from any human habitation. I was far more isolated than a shipwrecked sailor on a raft in the middle of the ocean. So you can imagine my surprise at sunrise when an odd little voice woke me up. It said: "Please ... draw me a sheep." - Wordsworth Children's Classics, 1995	The first night I went to sleep on the sand a thousand miles from any human habitation. I was more isolated than a shipwrecked sailor on a raft in the middle of the ocean. So imagine my surprise at daybreak, when a funny little voice woke me. She said: "If it pleases you ... draw me a sheep!"

Question answering: IBM Watson

- http://www.research.ibm.com/deepqa/
- [NY Times article](#)
- [Trivia demo](#)
- [YouTube video](#)

Information agents

- Search engines
- Recommendation systems
- Spam filtering
- Automated helpdesks
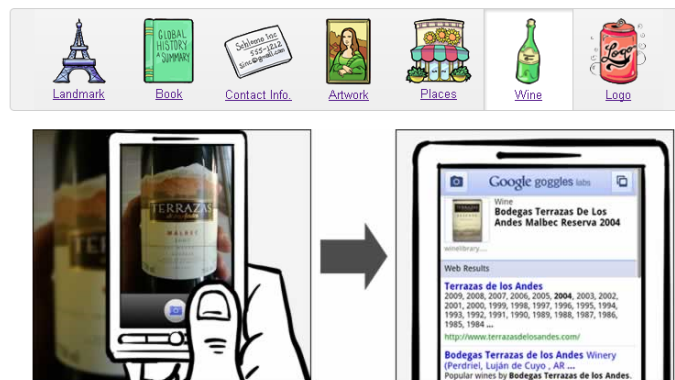- Medical diagnosis systems
- Fraud detection
- Automated trading

Vision

- OCR, handwriting recognition
- Face detection/recognition: many consumer cameras, Apple iPhoto
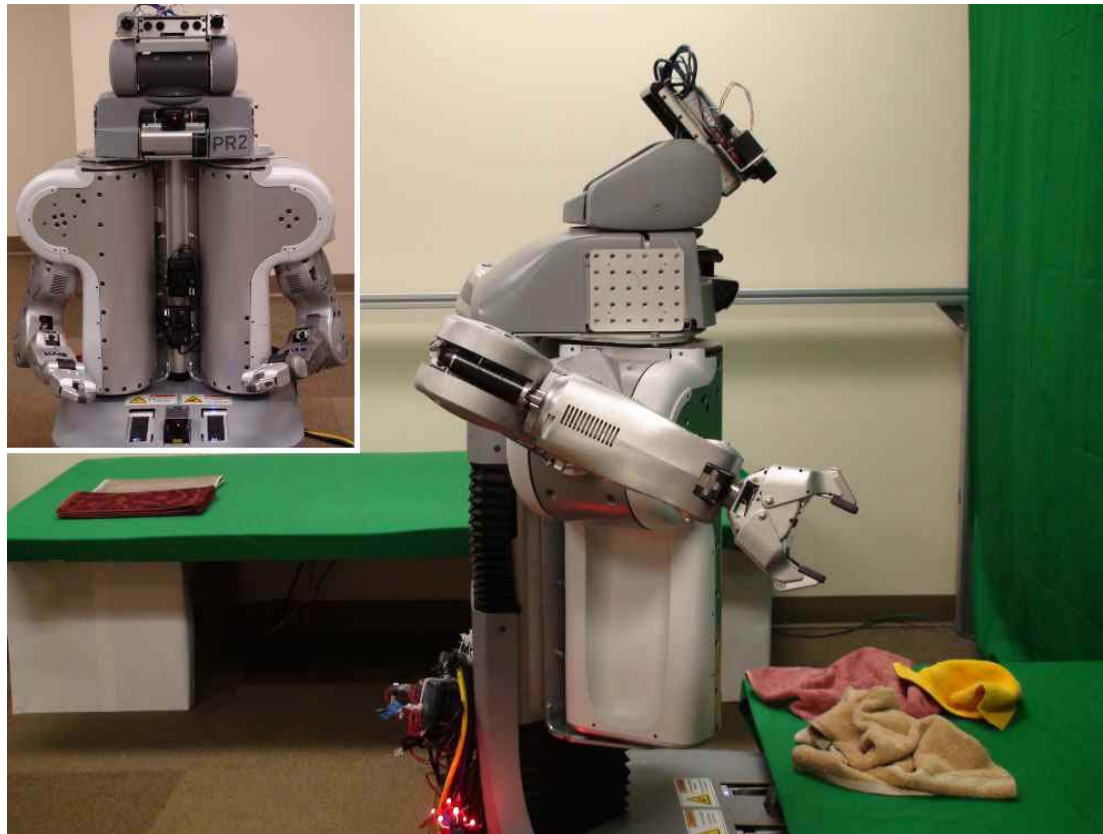- Visual search: Google Goggles
- Vehicle safety systems: Mobileye

Robotics

- Mars rovers
- Autonomous vehicles
  - DARPA Grand Challenge
- Autonomous helicopters
- Robot soccer
  - RoboCup
- Personal robotics
  - Humanoid robots
  - Robotic pets
  - Personal assistants?

Towel-folding robot

YouTube Video

J. Maitin-Shepard, M. Cusumano-Towner, J. Lei and P. Abbeel, "Cloth Grasp Point Detection based on Multiple-View Geometric Cues with Application to Robotic Towel Folding," ICRA 2010

Course Topics

- ## Search
  - Uninformed search, informed search
  - Adversarial search: minimax
  - Constraint satisfaction problems
  - Planning

- ## Logic

- ## Probability
  - Basic laws of probability
  - Bayes networks
  - Hidden Markov Models

- ## Learning
  - Decision trees
  - Linear classifiers: neural nets, support vector machines
  - Reinforcement learning

Course Topics (cont.)

- Applications (depending on time and interest)
  - Natural language
  - Speech
  - Vision
  - Robotics