Course Overview and Introduction

CE417: Introduction to Artificial Intelligence
Sharif University of Technology
Fall 2023

Soleymani

Some slides have been adopted from:
- Klein and Abdeel, CS188, UC Berkeley.
- Sandholm, 15381, CMU.

Course Info

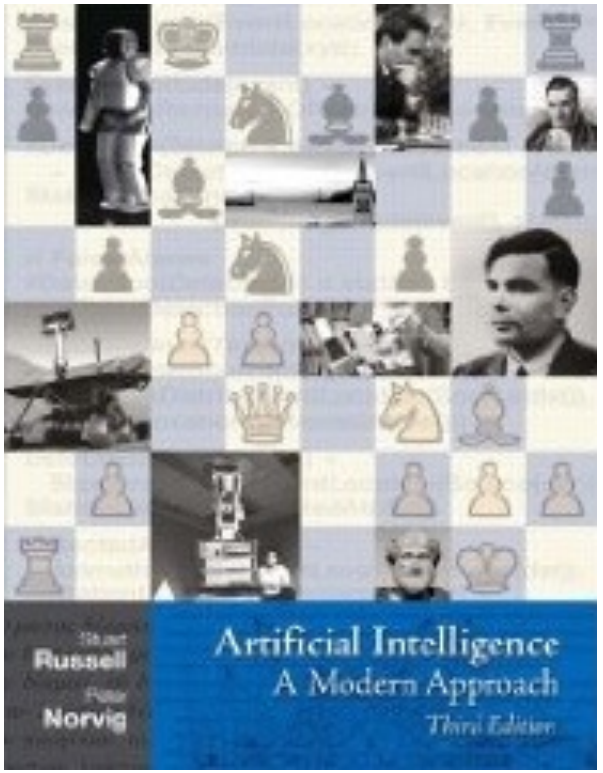
- Instructor: M. Soleymani
  - Email: soleymani@sharif.edu
- Office hours: set appointment through email.
- Head TAs: S. Vafaei Tabar & A. Mari Oriyad
- Website: https://sut-ai.github.io/
  - Slides and notes
  - Policies and rules
- Email: sharifaicentral@gmail.com
- HWs: On Quera

Text Book

Artificial Intelligence: A Modern Approach

by Stuart Russell and Peter Norvig 3rd Edition, 2009

[On a Quera Post]

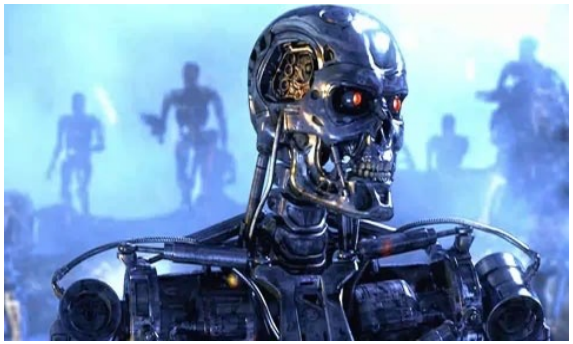


- Prerequisites:
  - Knowledge of a programming language
  - Data Structures and Algorithms
  - Probability and Statistics

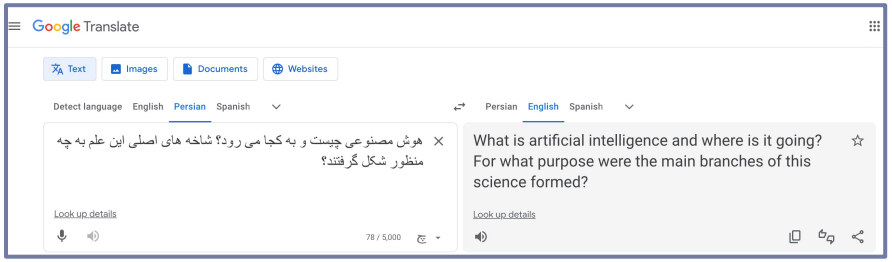
Marking

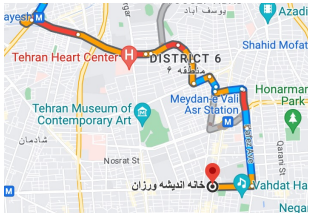
- Homeworks (written & programming): 7.5 + 0.5 points
- Mid Term 1: 3 points
- Mid Term 2: 4 points
- Final Exam: 5 points
- Presentation: 0.5 points
- Project: + 1 point

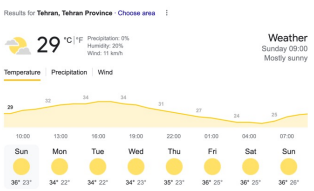
Sci-Fi AI?

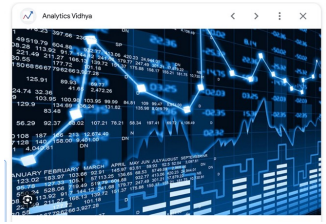


Real-world AI



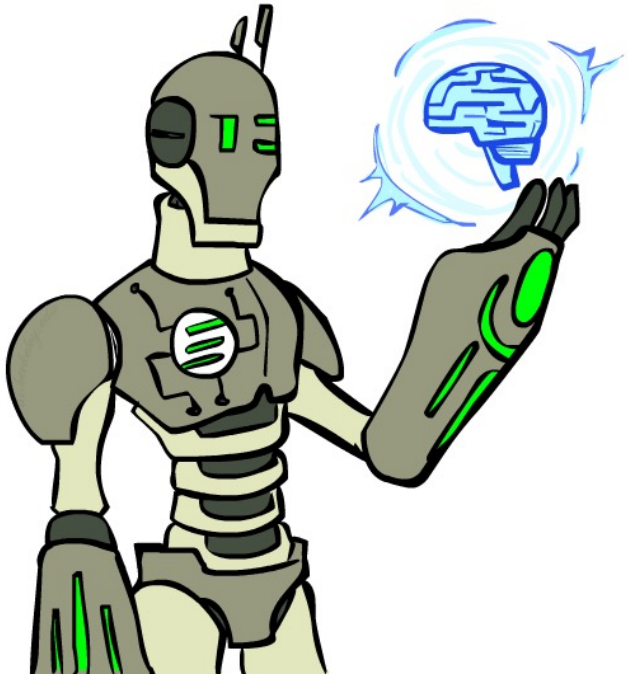






Today

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



Formal Definitions of Artificial Intelligence

	Human intelligence	Rational
Thinking	Thinking humanly	Thinking rationally
Behavior	Acting humanly	Acting rationally

What is AI?

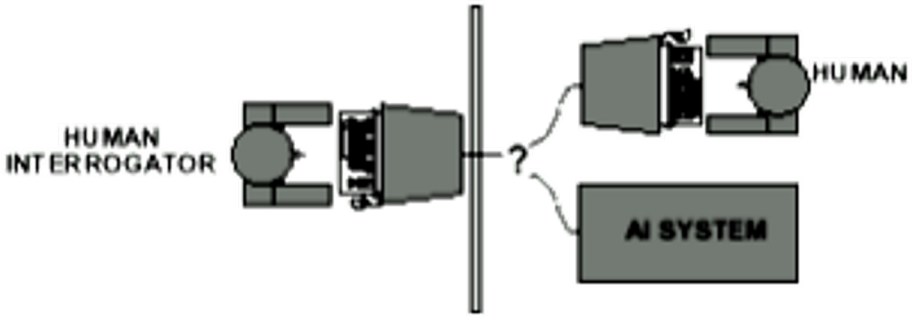
The science of making machines that:

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

Acting Humanly

- Turing Test *(Turing, 1950):* Operational test for intelligent behavior:
  - 5 minutes test, it passes by fooling the interrogator 30% of time



- Turing predicted that by 2000 a computer could pass the test.
  - He was wrong.

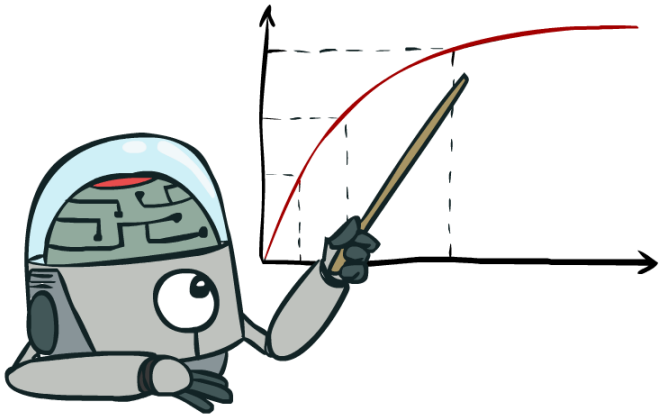
Rational Decisions

- 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**

A better title for this course would be:

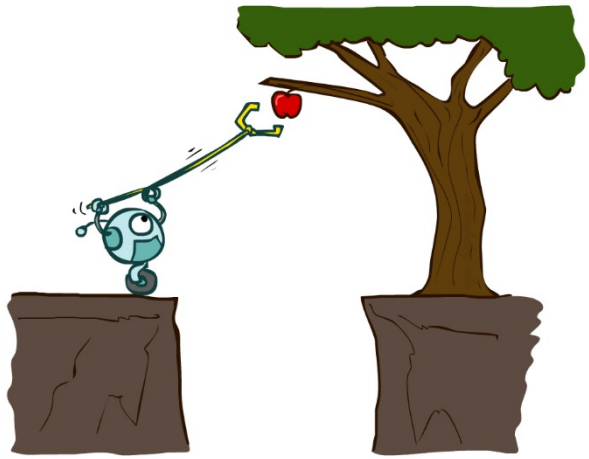
Computational Rationality

Maximize Your Expected Utility

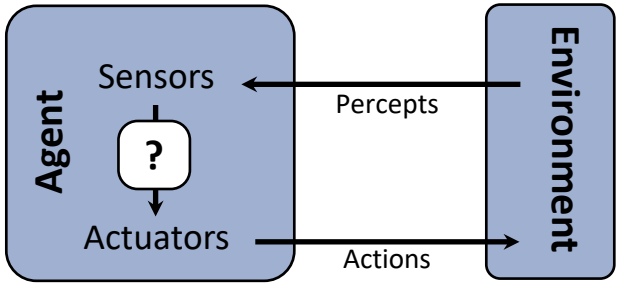


Designing Rational Agents

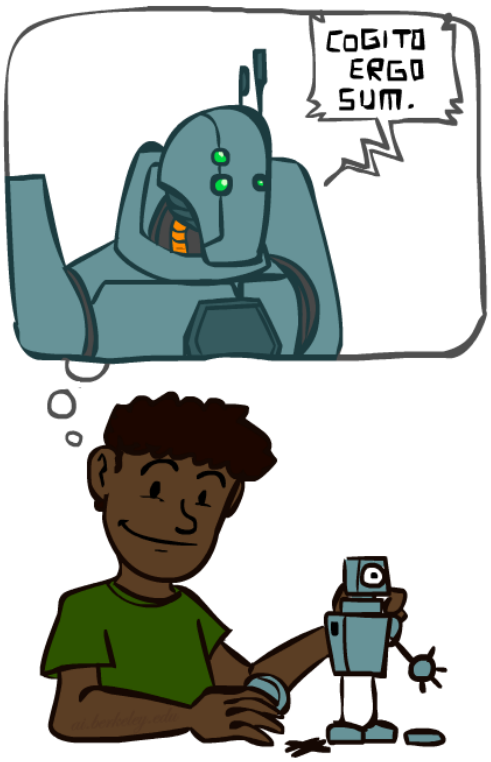
- An **agent** is an entity that *perceives* and *acts*.
- A **rational agent** selects actions that maximize its (expected) **utility**.
- Characteristics of the **percepts, environment,** and **action space** dictate techniques for selecting rational actions



- **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



A (Short) History of AI



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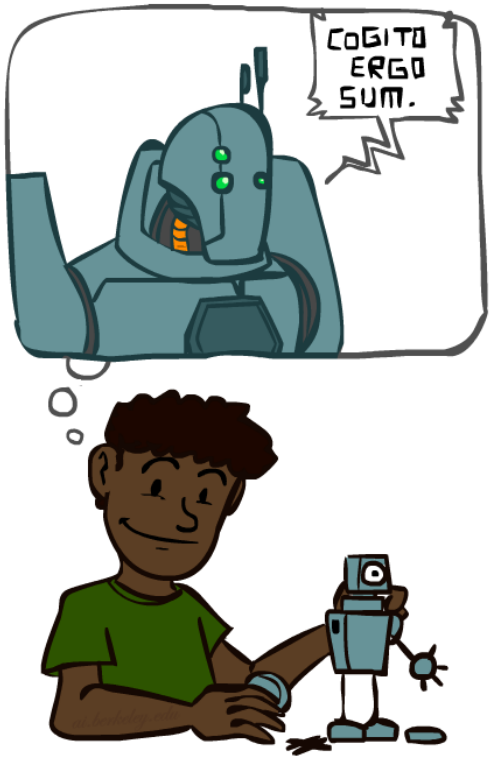
  - 1943: McCulloch & Pitts: Boolean circuit model of brain
  - 1950: Turing's “Computing Machinery and Intelligence”
- 1950—70: Excitement: Look, Ma, no hands!
  - 1950s: Early AI programs, including Samuel's checkers program, Newell & Simon's Logic Theorist, Gelernter's Geometry Engine
  - 1956: Dartmouth 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—: Scientific method (Statistical approaches)
  - Resurgence of probability, focus on uncertainty
  - General increase in technical depth
  - Agents and learning systems… “AI Spring”?
  - 1997: Deep Blue defeats Kasparov at chess
- 2000—: Where are we now?
  - Big data, big compute, neural networks
  - AI used in many industries
  - 2016: Google’s AlphaGo beats Lee Sedol at Go



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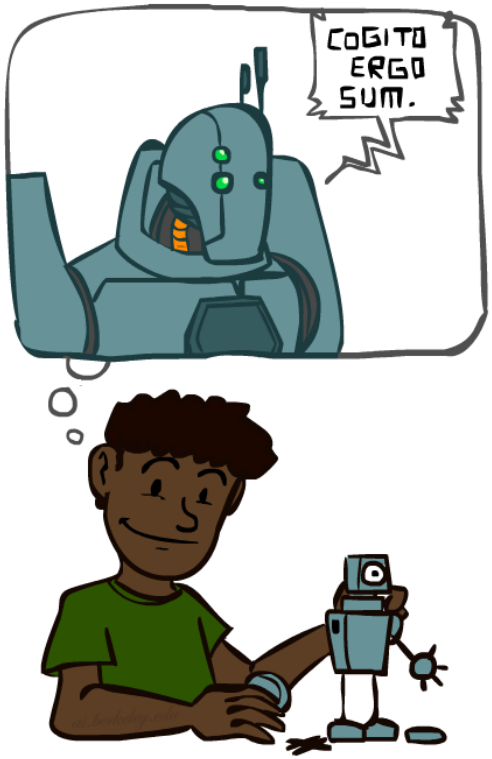

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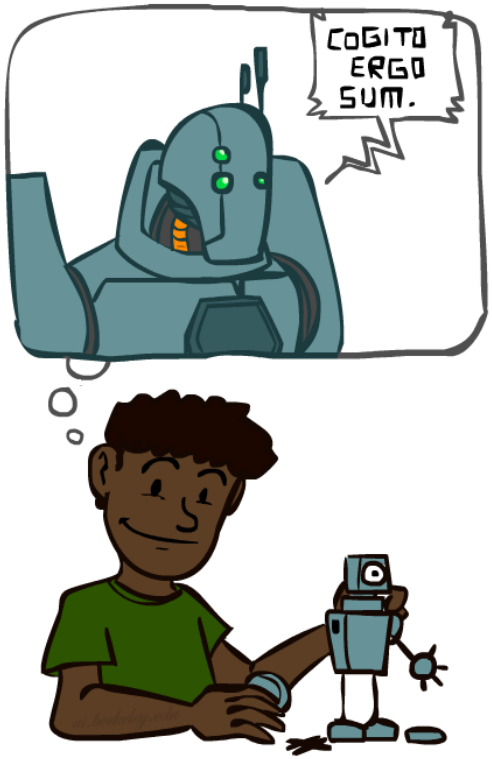

First AI Winter: Late 1970s

Many early promises of AI fall short

1969 – Minsky and Pappert's "Perceptrons" book shows that single-layer neural network cannot represent XOR function

1973 – Lighthill report effectively ends AI funding in U.K.

1970s – DARPA cuts funding for several AI projects

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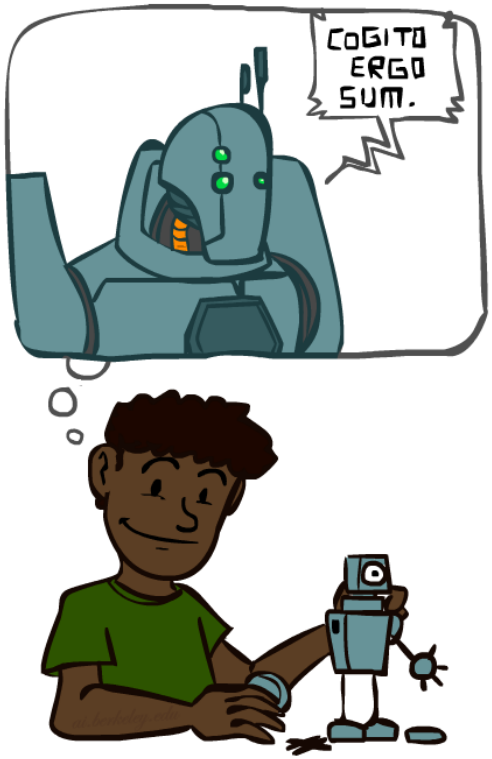

Expert Systems and Business (1970s-1980s)

Move towards encoding domain expert knowledge as logical rules

1971-74 – Feigenbaum's DENDRAL (molecular structure prediction) and MYCIN (medical diagnoses)

1981 – Japan's "fifth generation" computer project, intelligent computers running Prolog

1982 – R1, expert system for configuring computer orders, deployed at DEC

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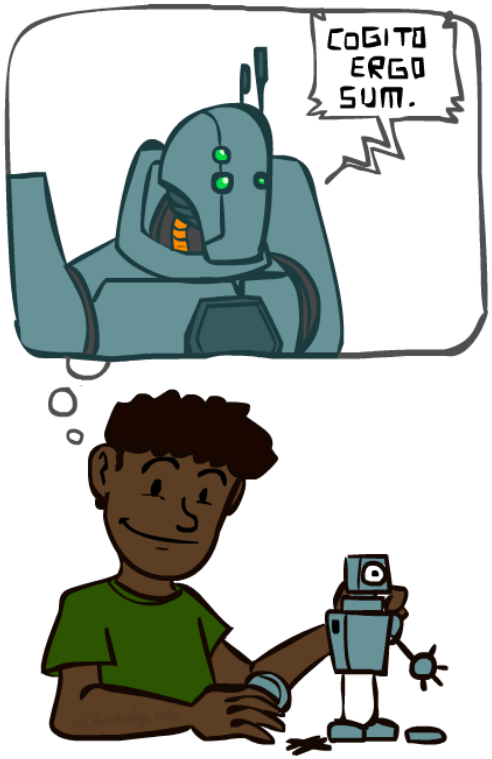

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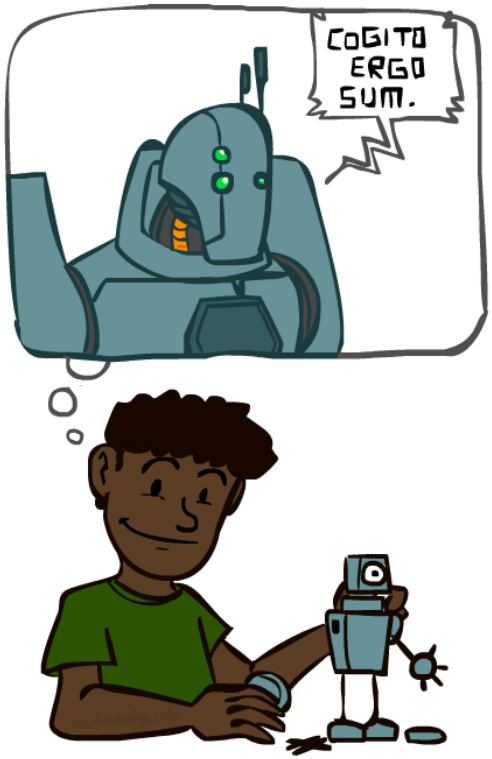


Reemergence of AI (2010s-??)

"AI" seems to be a buzzword again

Google, Facebook, Twitter, etc, all have large AI labs, labeled as such

2012 – Deep neural network wins image classification contest

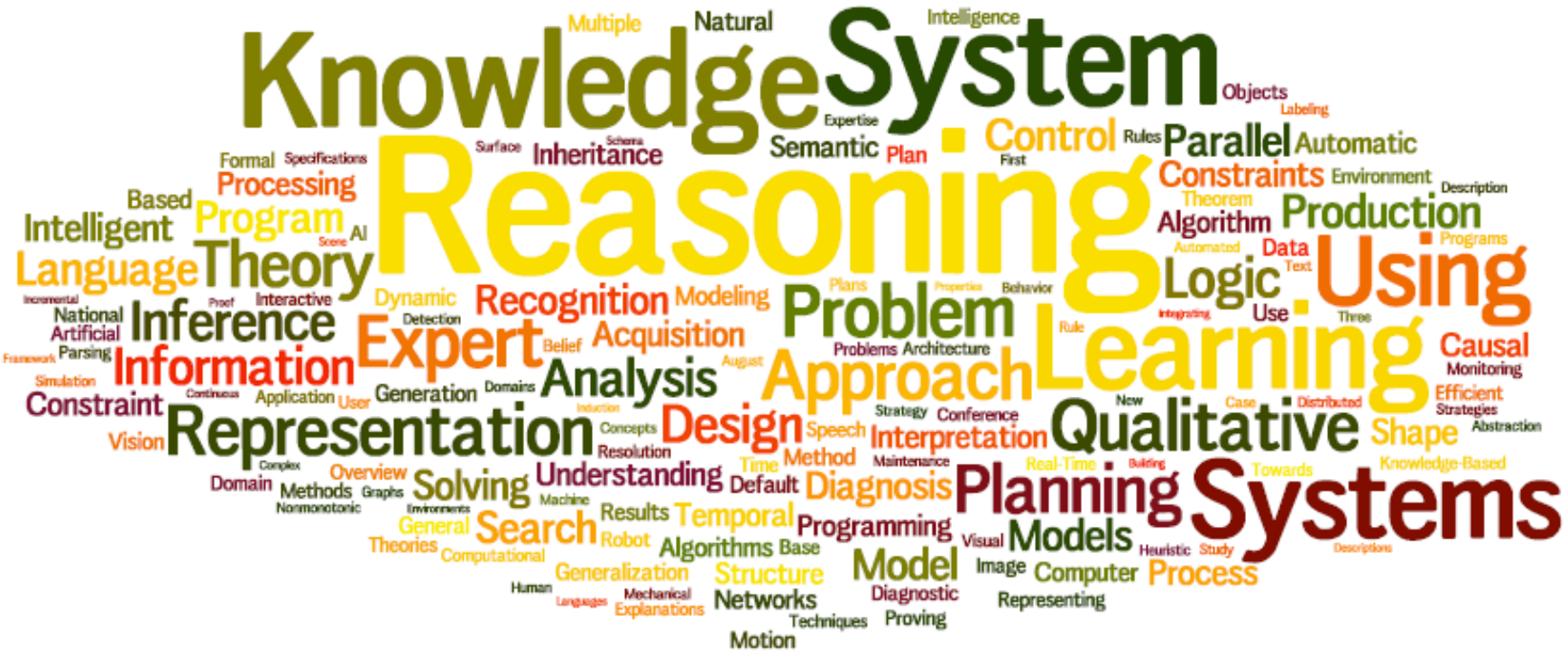
2013 – DeepMind shows computer learning to play Atari games

Many successful stories in the last decade

- Computer vision
  - Image classification, object detection, segmentation
- Speech recognition
- NLP
  - Machine translation, question answering, ….

- In the last few years, foundation models have played an importatnt role in many tasks

AI is that which appears in academic conferences of AI.



1980s

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1990s

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2000s

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2010s

Symbolic vs. Connectionist

Symbolic

knowledge and its use in reasoning and learning (with only modest input data)

Connectionist

learning associations from data as the basis of intelligence (with little or no prior knowledge)

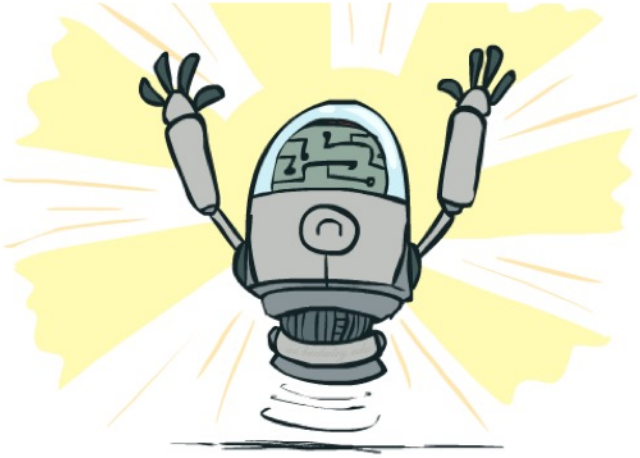
AI

- We won't worry too much about definition of AI, but the following will suffice:
  - AI is the development and study of computing systems that address a problem typically associated with some form of intelligence
- AI is a fast-moving exciting area
- We can directly make the world a better place using AI

What Can AI Do Now?

Quiz: Which of the following can be done at present?

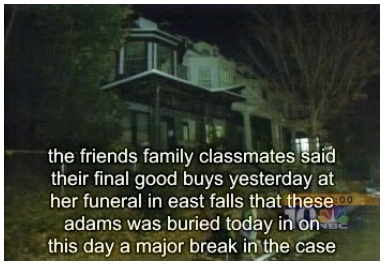
- ✓ Win against any human at chess
- ✓ Win against the best humans at Go
- ✓ Play a decent game of tennis
- ✗ Unload any dishwasher in any home
- ✓ Drive safely along the highway
- ? Drive safely along streets of San Francisco
- ✓ Buy a week's worth of groceries on the web
- ✗ Buy a week's worth of groceries at Berkeley Bowl
- ? Discover and prove a new mathematical theorem
- ✗ Perform a surgical operation
- ✓ Translate spoken Chinese into spoken English in real time
- ✓ Win an art competition
- ✓ Write an intentionally funny story
- ✗ Construct a building



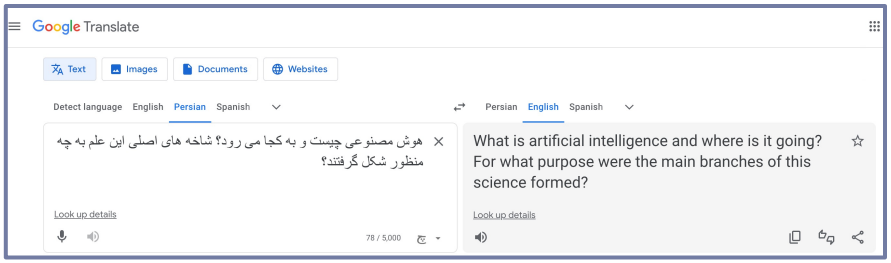
Applications

Natural Language

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

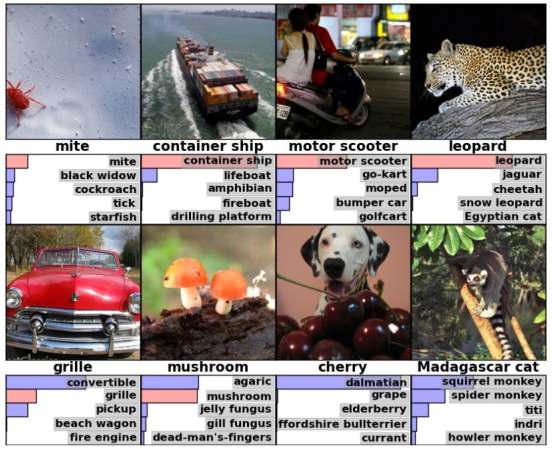


- Language processing technologies
  - Text classification, spam filtering, etc…
  - Web search
  - Machine translation
  - Question answering
  - Chatbots



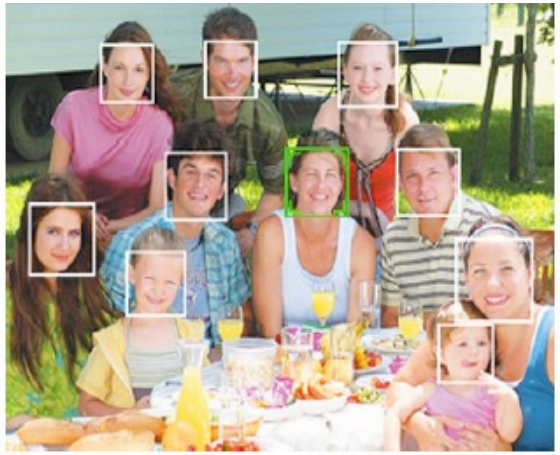
Computer Vision

- Object and face recognition
- Scene segmentation
- Image classification



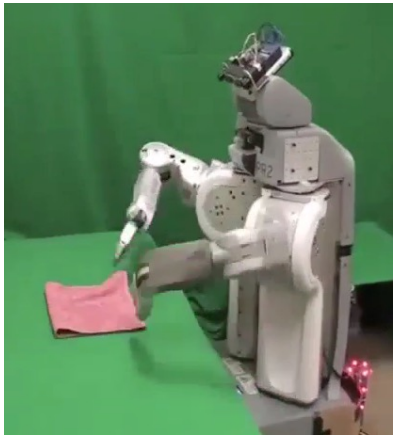
ImageNet Classification with Deep Convolutional Neural Networks

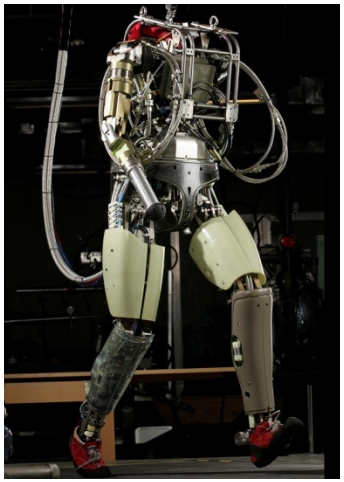
Segment Anything, Meta AI



Robotics

- Robotics
  - Mech. eng. & 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

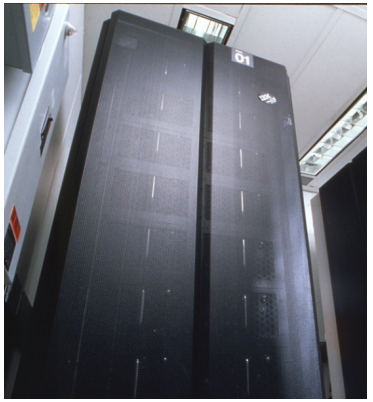




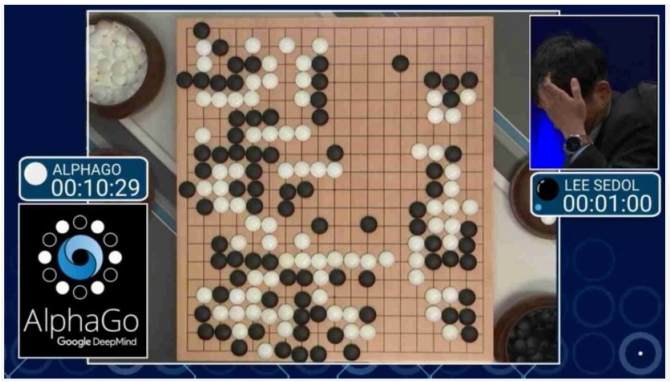
Images from UC Berkeley, Boston Dynamics, RoboCup, Google

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



- Deep Mind’s alphaGo defeats former world champion in 2016.



Source: https://gogameguru.com/alphago-shows-true-strength-3rd-victory-lee-sedol/

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

Logic

- Logical systems
  - Theorem provers
  - NASA fault diagnosis
  - Question answering
- Methods:
  - Deduction systems
  - Constraint satisfaction
  - Satisfiability solvers (huge advances!)

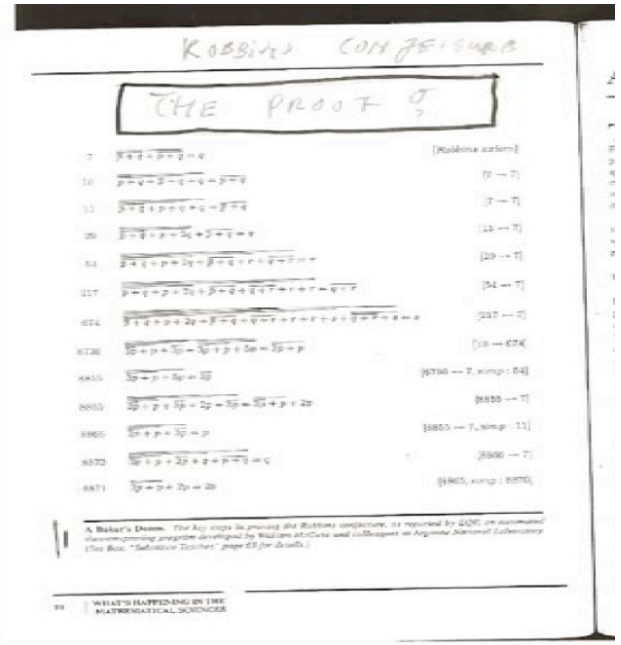
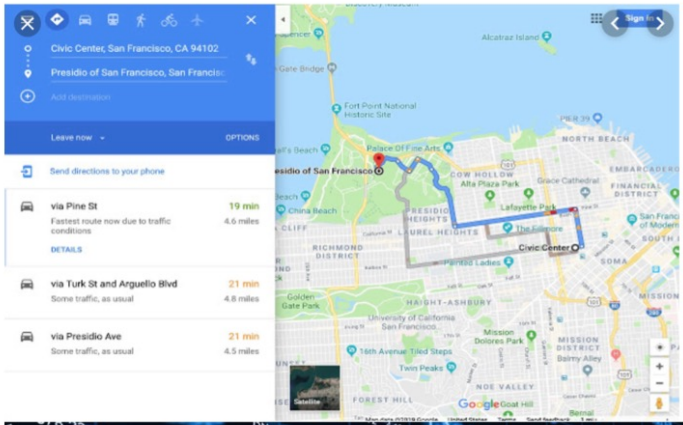
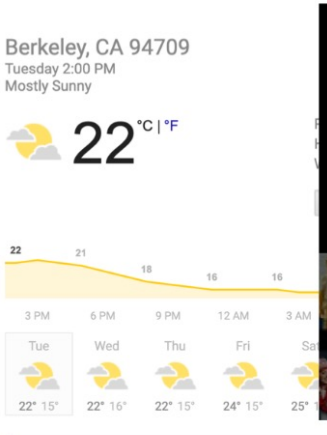
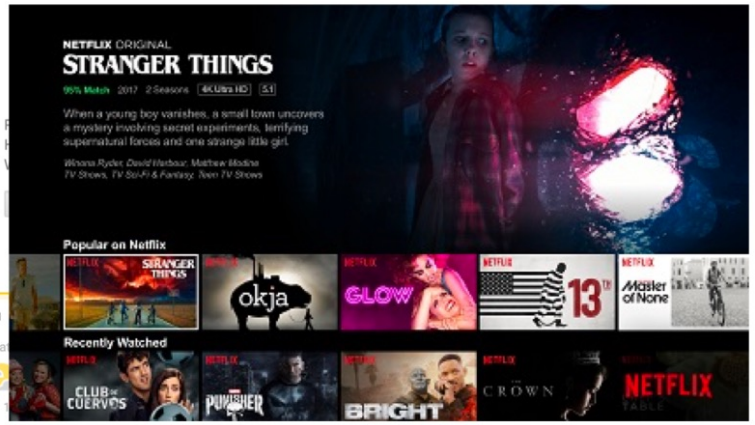


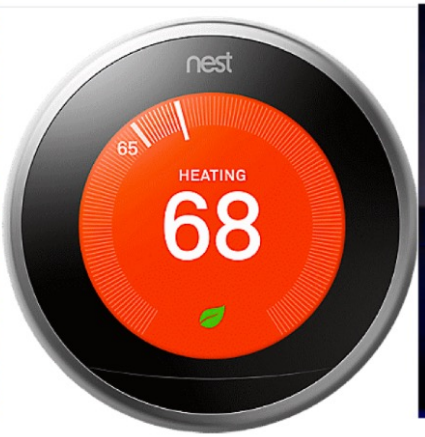
Image from Bart Selman

Tools for Predictions and Decisions



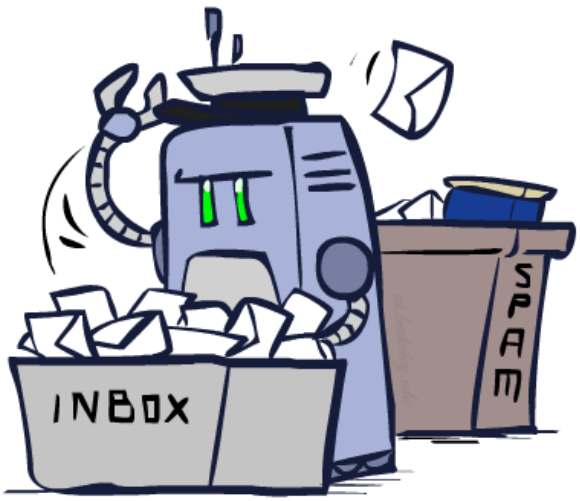




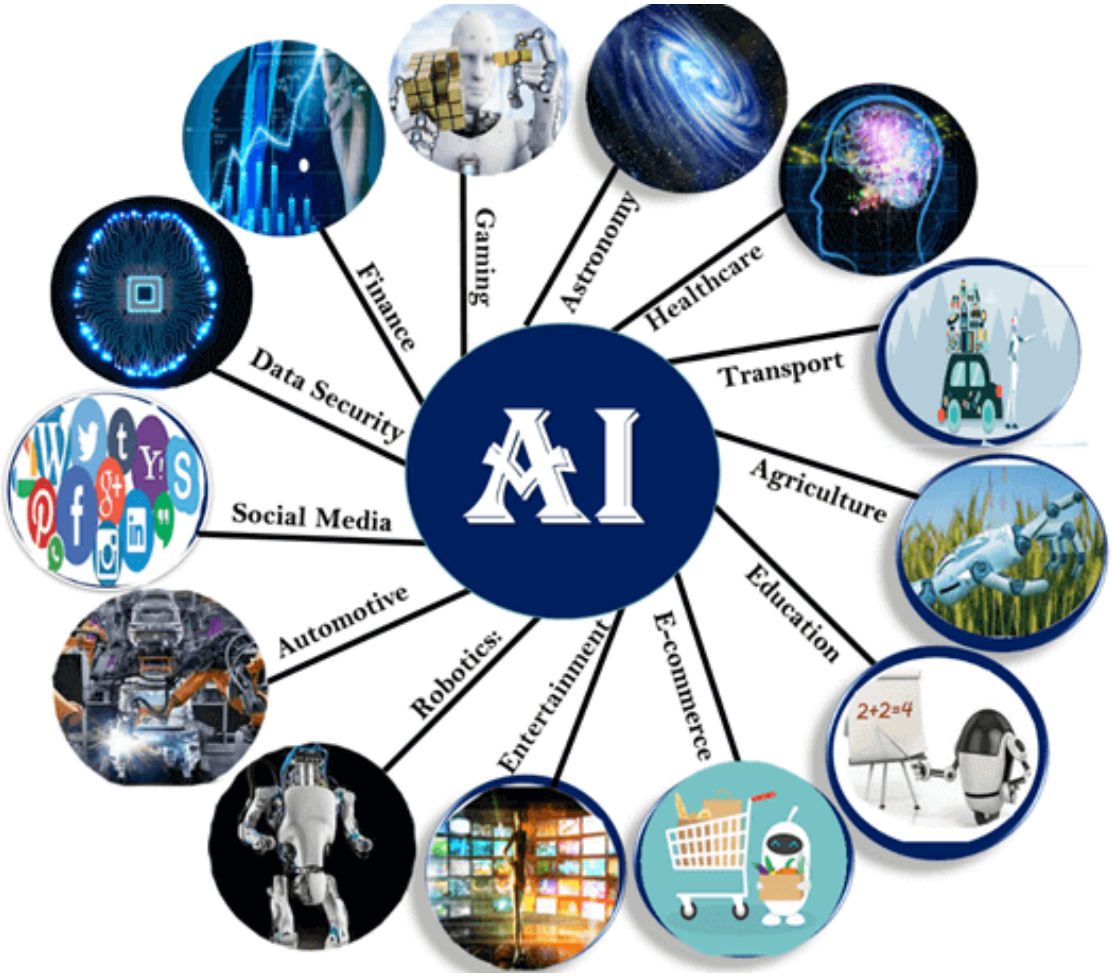


Decision Making

- 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!



Some Application Areas of AI



Source: javatpoint.com

Class Target

- Getting a feeling of Artificial Intelligence (AI)
  - 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

Course Outline

- Search
- Reasoning and knowledge Representation
- Learning

Course Outline

- Search
  - Intelligent agents (chapters 2)
  - Uninformed and informed search (Chapter 3,4)
    - Search spaces & heuristic guidance
  - Constraint Satisfaction Problems
  - Adversarial search (Chapter 5)
    - Working against an opponent

- Reasoning (and knowledge representation) under Uncertainty (Chapter 13-15)
  - Bayesian networks, probabilistic reasoning, and reasoning over time

- Learning (Chapter 16,18, 20, 21)