CS 343H: Artificial Intelligence

Week 1a: Introduction

Good Morning Colleagues

- Welcome to a fun, but challenging course
- Goal: Learn about Artificial Intelligence
  - Increase AI literacy
  - Prepare you for topics course
  - Breadth over depth

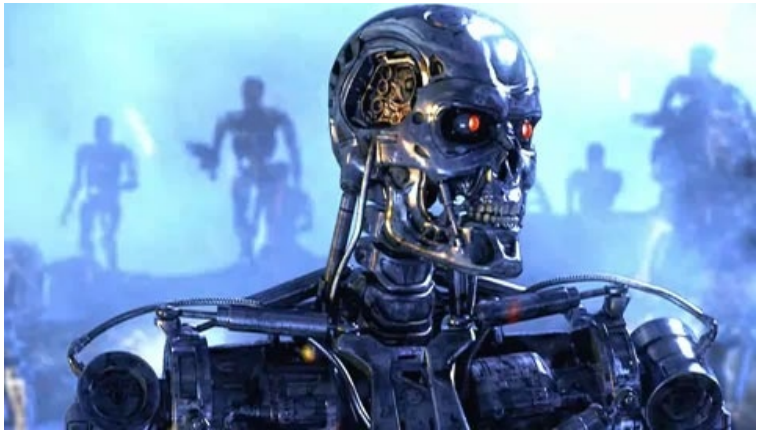
Teaching staff

- Prof. Peter Stone
- TA: Kim Houck

Today

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

Sci-Fi AI?



Slide credit: Dan Klein, UC Berkeley

Definition

- Artificial intelligence is…
  - The science of getting computers to do the things they can't do yet?
  - Finding fast algorithms for NP-hard problems?
  - Getting computers to do the things they do in the movies?
- No generally accepted definition…
- Textbook: autonomous agent

Science and engineering

- AI is one of the great intellectual adventures of the 20th and 21st centuries.
  - What is a mind?
  - How can a physical object have a mind?
    - Is a running computer (just) a physical object?
  - Can we build a mind?
  - Can trying to build one teach us what a mind is?

A (Short) History of AI

- 1940-1950: Early days
  - 1943: McCulloch & Pitts: Boolean circuit model of brain
  - 1950: Turing's “Computing Machinery and Intelligence”

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  - 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

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- 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”

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- 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?

Slide credit: Dan Klein, UC Berkeley

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What Can AI Do?

Quiz: 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 along Sixth Street?
- ✓ Buy a week's worth of groceries on the web?
- ✗ Buy a week's worth of groceries at HEB?
- ? Discover and prove a new mathematical theorem?
- ✗ Converse successfully with another person for an hour?
- ? Perform a complex surgical operation?
- ✓ Put away the dishes and fold the laundry?
- ✓ Translate spoken Chinese into spoken English in real time?
- ✗ Write an intentionally funny story?

Slide credit: Dan Klein, UC Berkeley

Unintentionally Funny Stories

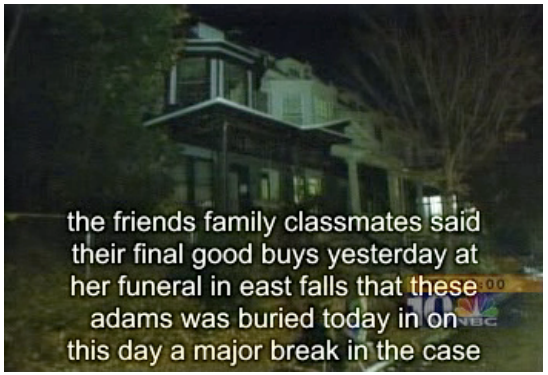
- One day Joe Bear was hungry. He asked his friend Irving Bird where some honey was. Irving told him there was a beehive in the oak tree. Joe walked to the oak tree. He ate the beehive. The End.
- Henry Squirrel was thirsty. He walked over to the river bank where his good friend Bill Bird was sitting. Henry slipped and fell in the river. Gravity drowned. The End.

[Shank, Tale-Spin System, 1984]

Slide credit: Dan Klein, UC Berkeley

Natural Language

- Speech technologies
  - Automatic speech recognition (ASR)
  - Text-to-speech synthesis (TTS)
  - Dialog systems



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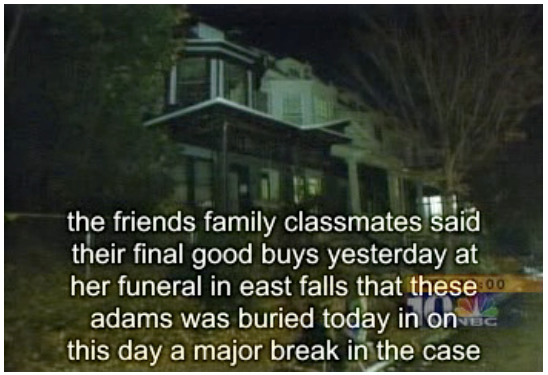
- Language processing technologies
  - Question answering



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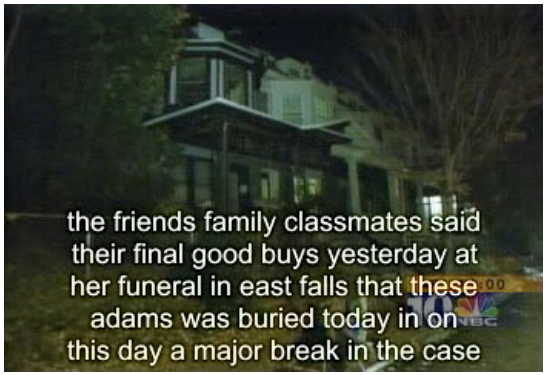

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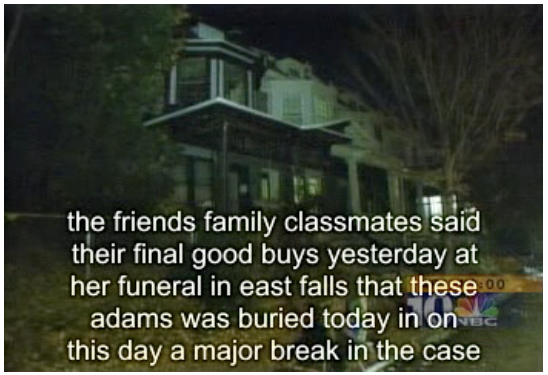

- Language processing technologies
  - Question answering
  - Machine translation

  - Information extraction
  - Text classification, spam filtering, etc…

Vision (Perception)

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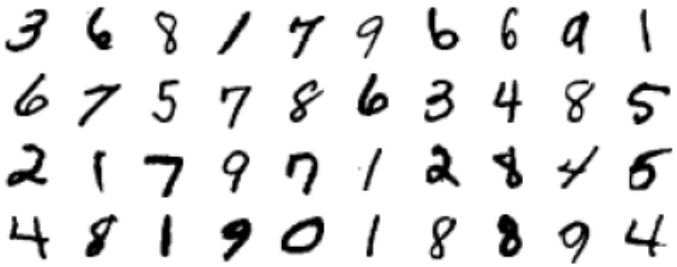
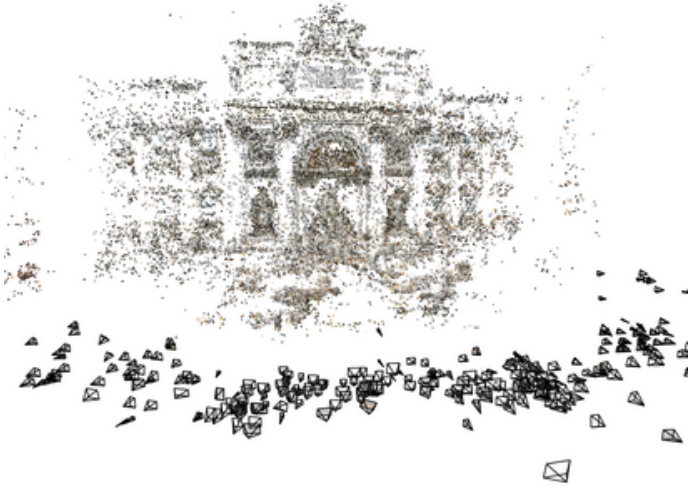


Reading license plates, zip codes, checks

Face detection

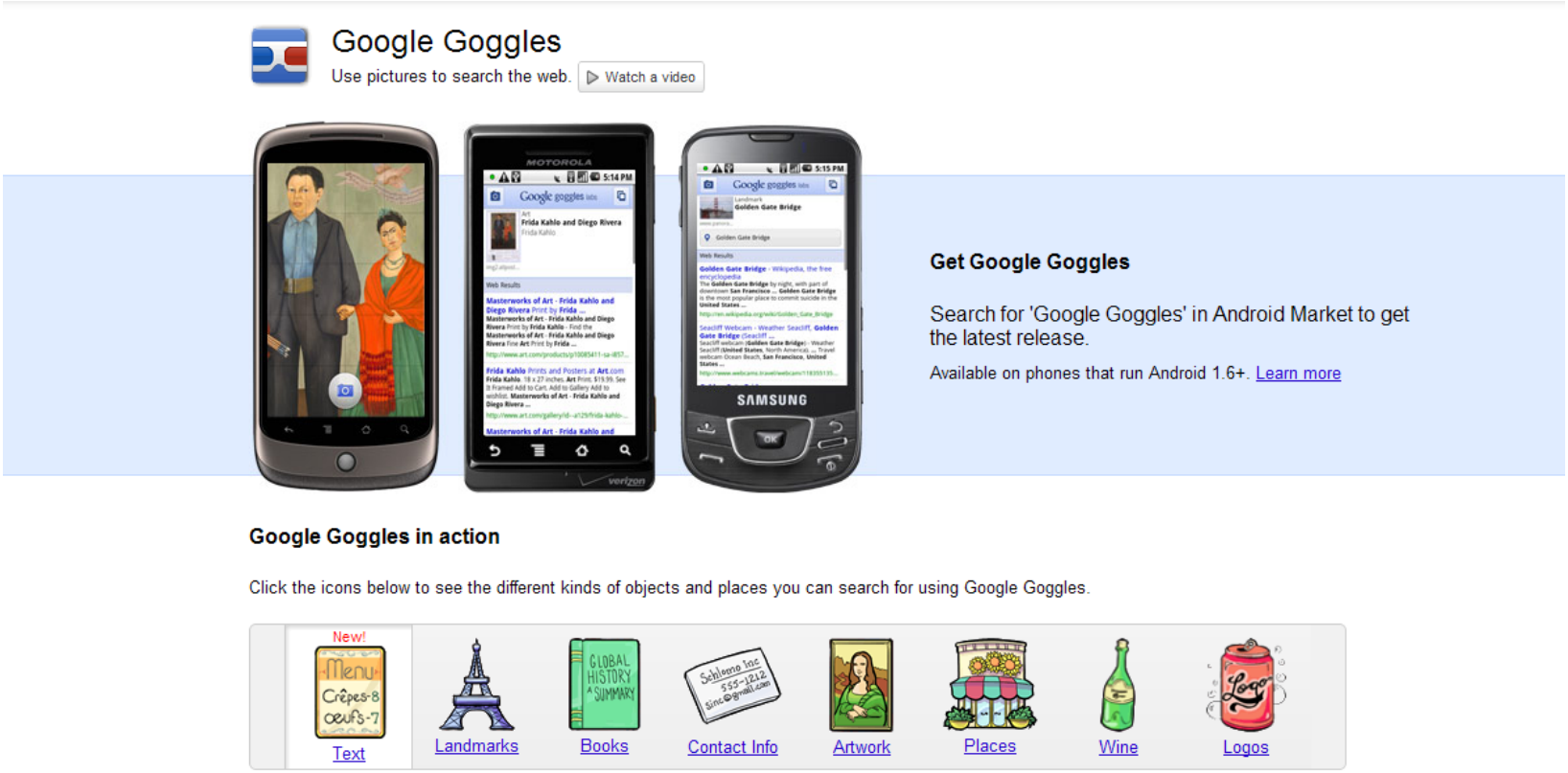


Reconstructing 3D

Instance recognition

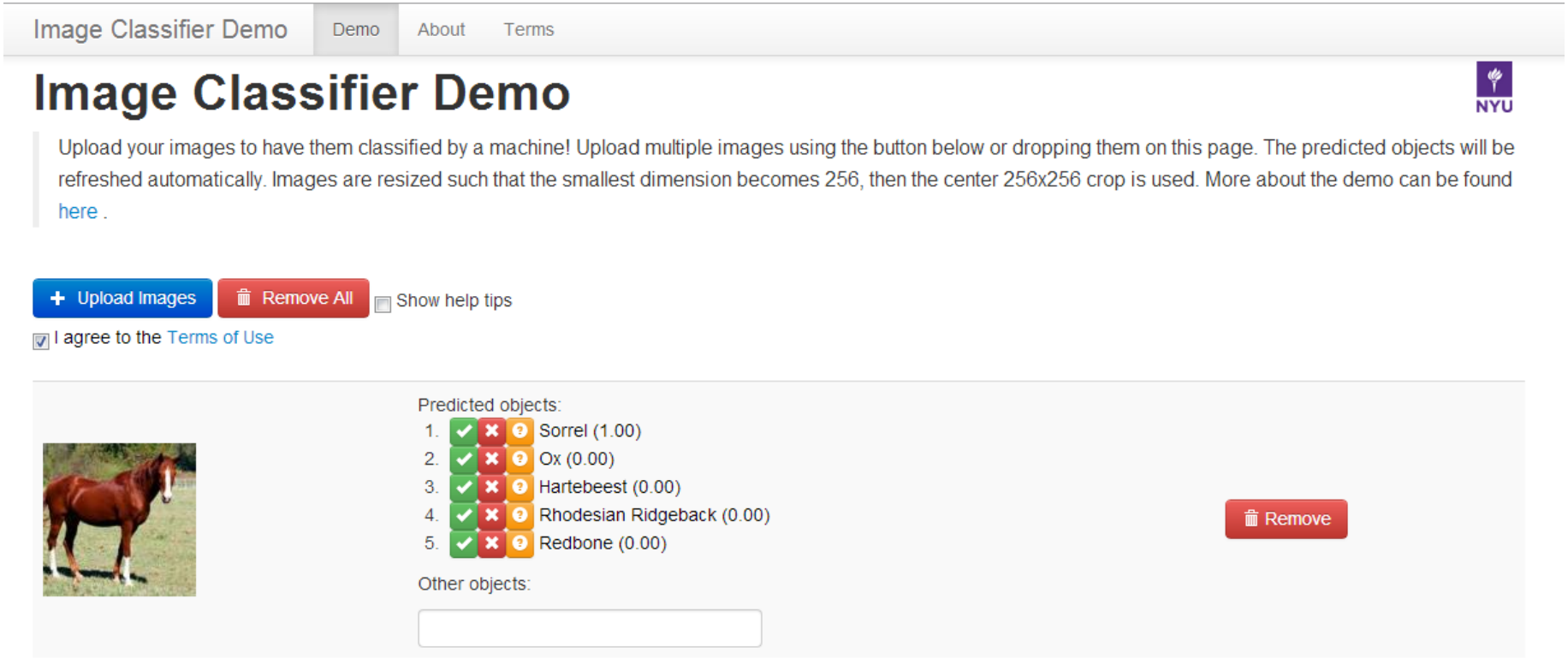
Vision (Perception)

- Instance recognition



Vision (Perception)

- Object/image categorization



Matthew Zeiler, New York University:
http://horatio.cs.nyu.edu/index.html

Vision (Perception)

Augmented reality

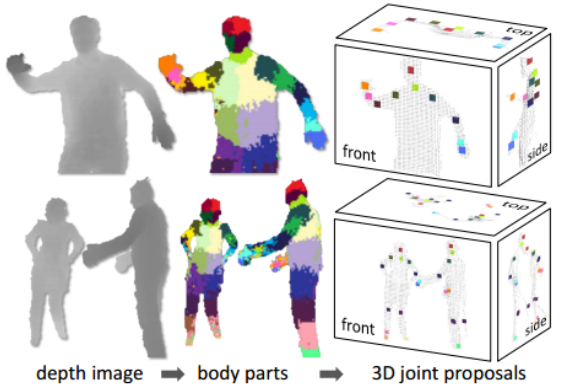
Kim et al. 2009

Unusual event detection

"wearing red shirt"

Soft biometrics

IBM, Feris et al.



Shotton et al. 2011

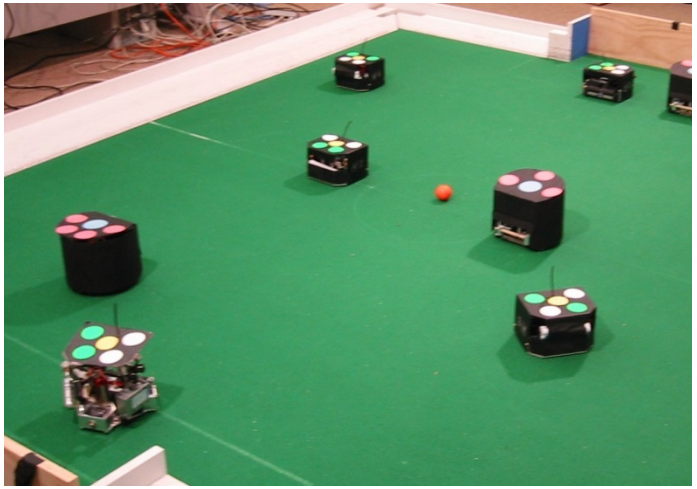
Pose & tracking

[videos: robotics]

Robotics

- 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

Images from stanfordracing.org, CMU RoboCup, Honda ASIMO sites

Logic

- Logical systems
  - Theorem provers
  - NASA fault diagnosis
  - Question answering

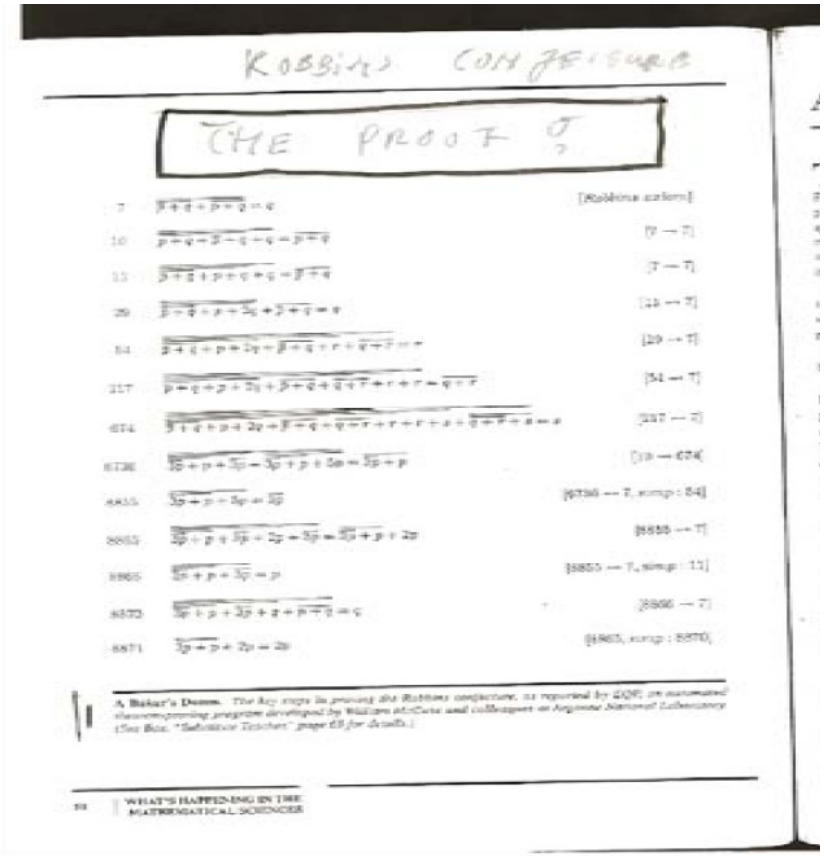
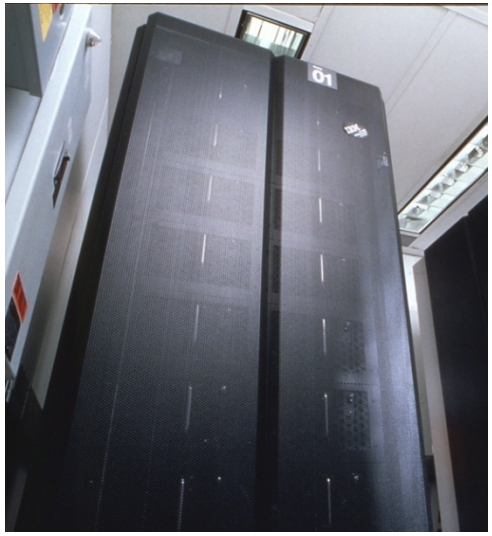


Image from Bart Selman

Game Playing

- 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 big 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.”

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. mapquest
- Medical diagnosis
- Web search engines
- Spam classifiers
- Automated help desks
- Fraud detection
- Product recommendations
- … Lots more!

Strategy in AI

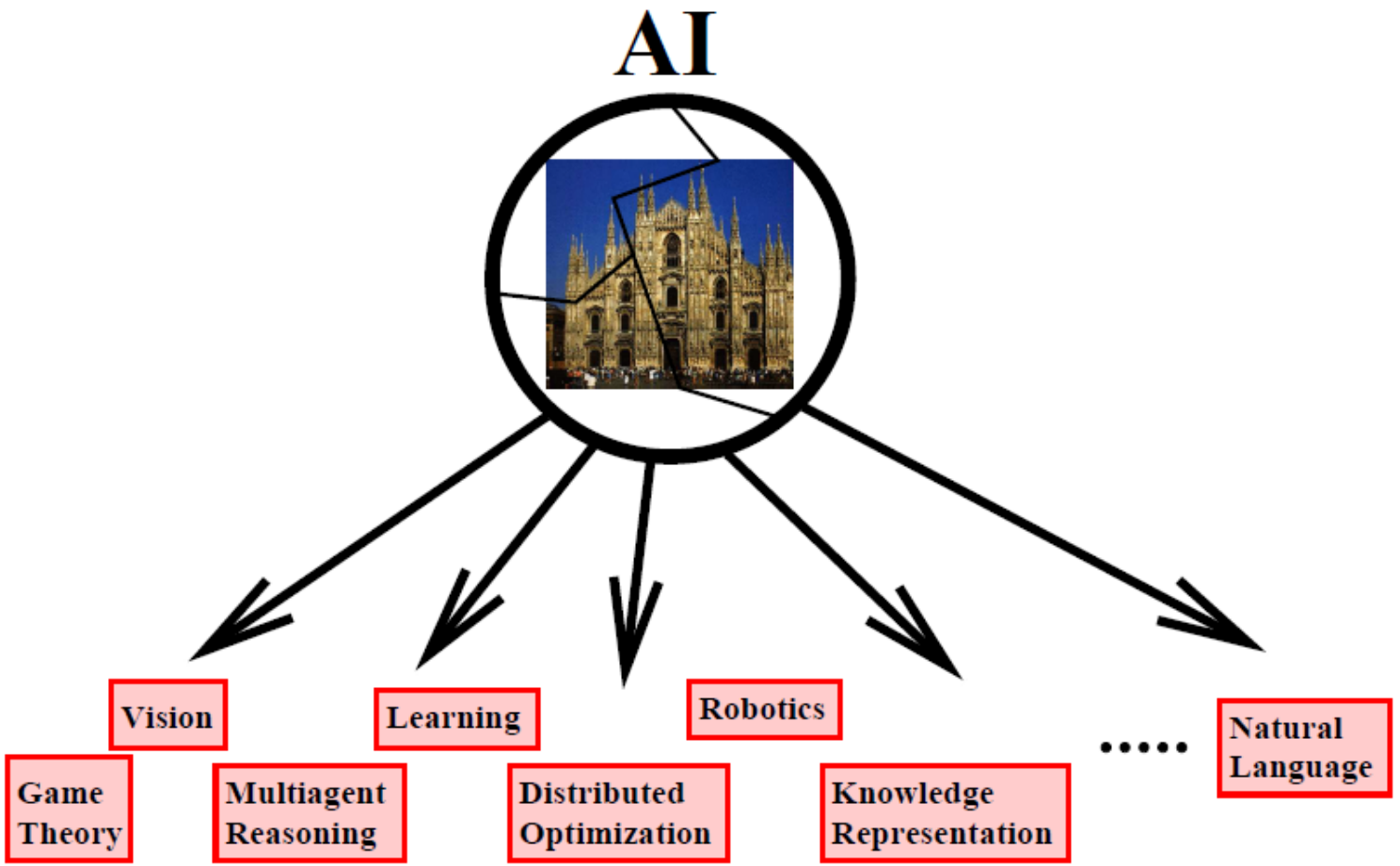
- A goal of AI: Robust, fully autonomous agents in the real world

- Bottom-up metaphor:

  Russell, '95: *"Theoreticians can produce the AI equivalent of bricks, beams, and mortar with which AI architects can build the equivalent of cathedrals."*

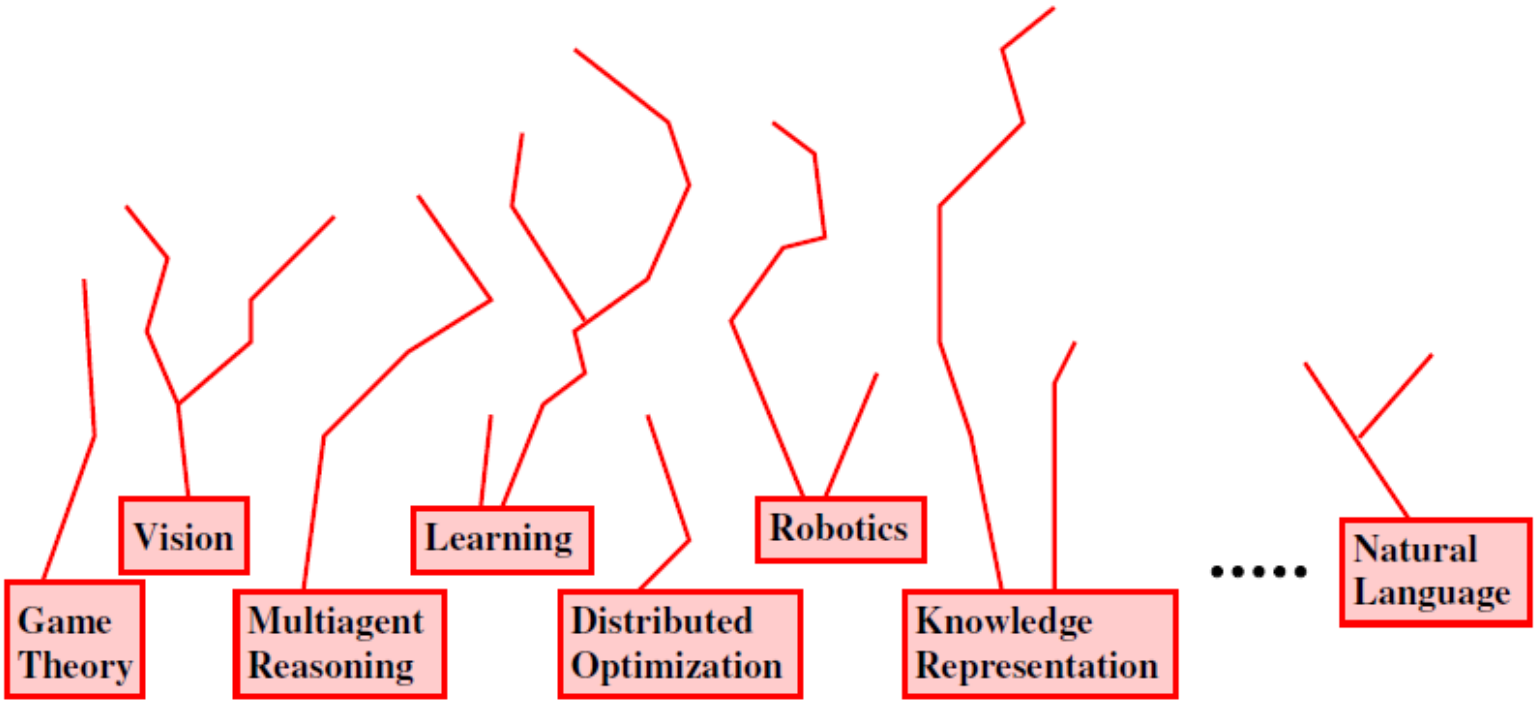
Slide credit: Peter Stone

Bottom-up approach

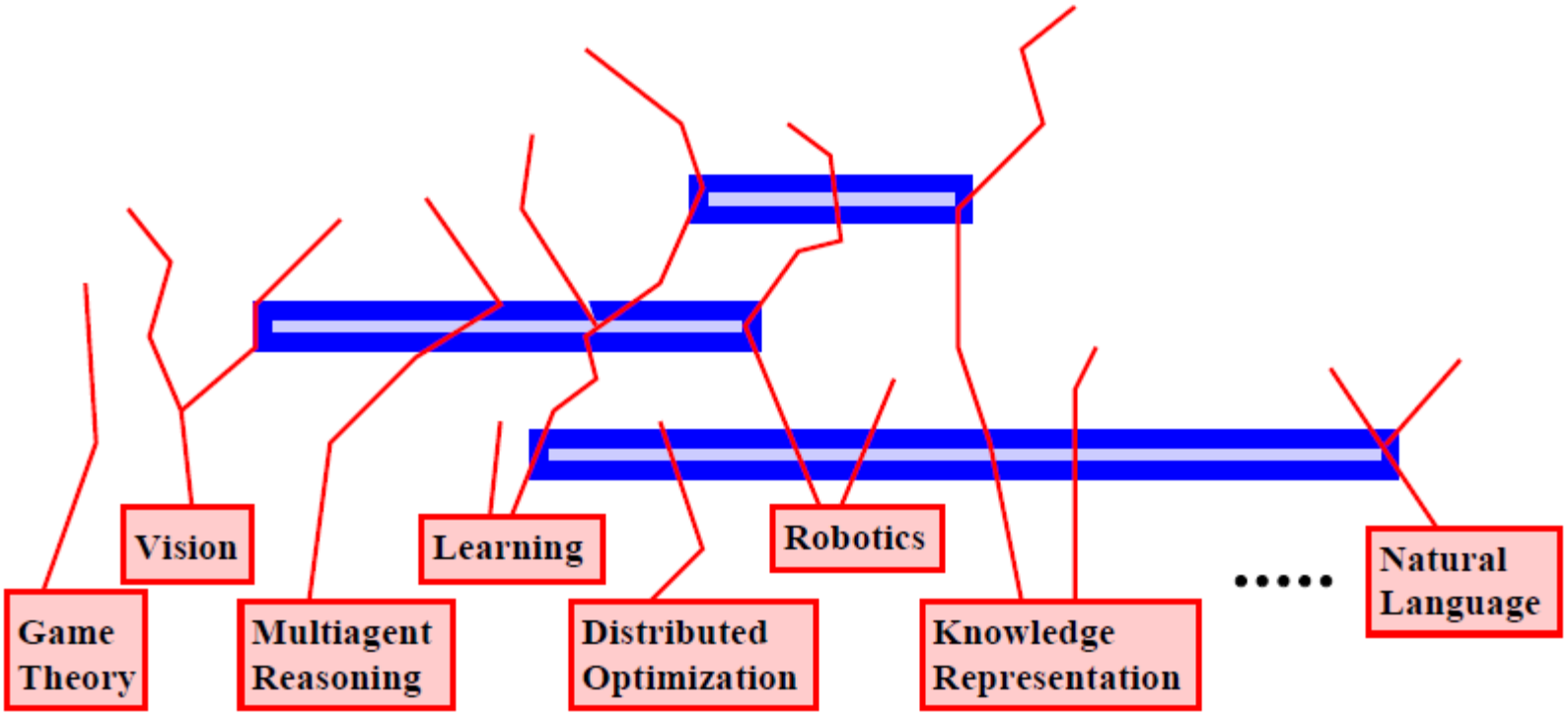


Slide credit: Peter Stone

The bricks

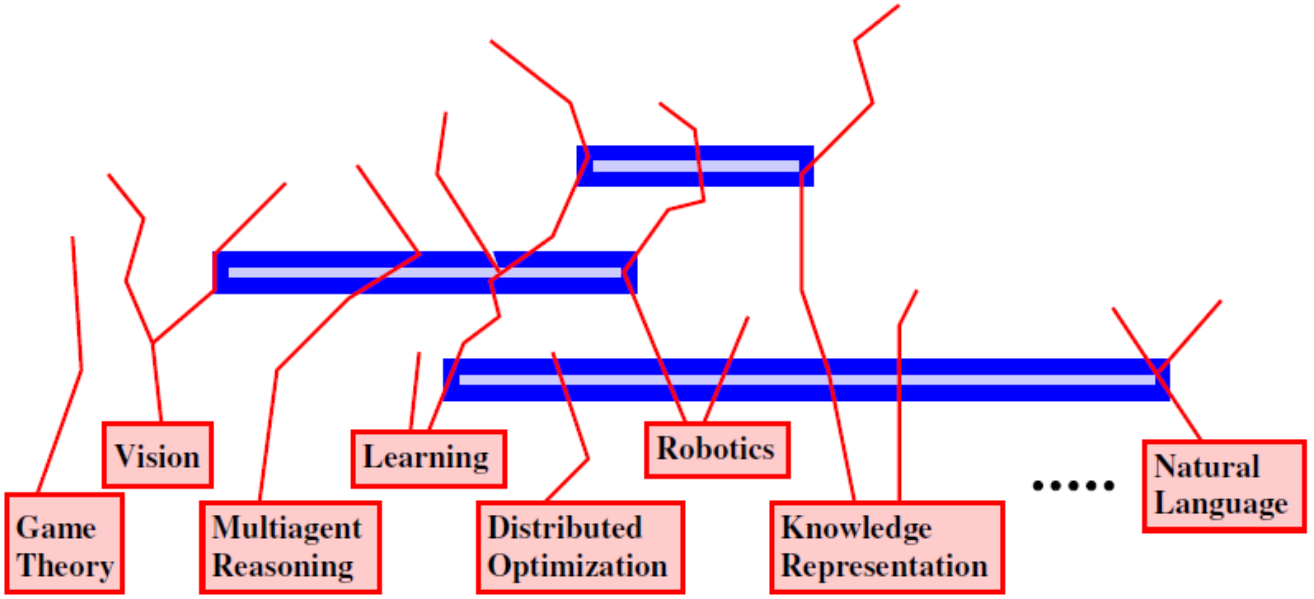

Game Theory
Vision
Multiagent Reasoning
Learning
Distributed Optimization
Robotics
Knowledge Representation
.....
Natural Language

The beams and mortar



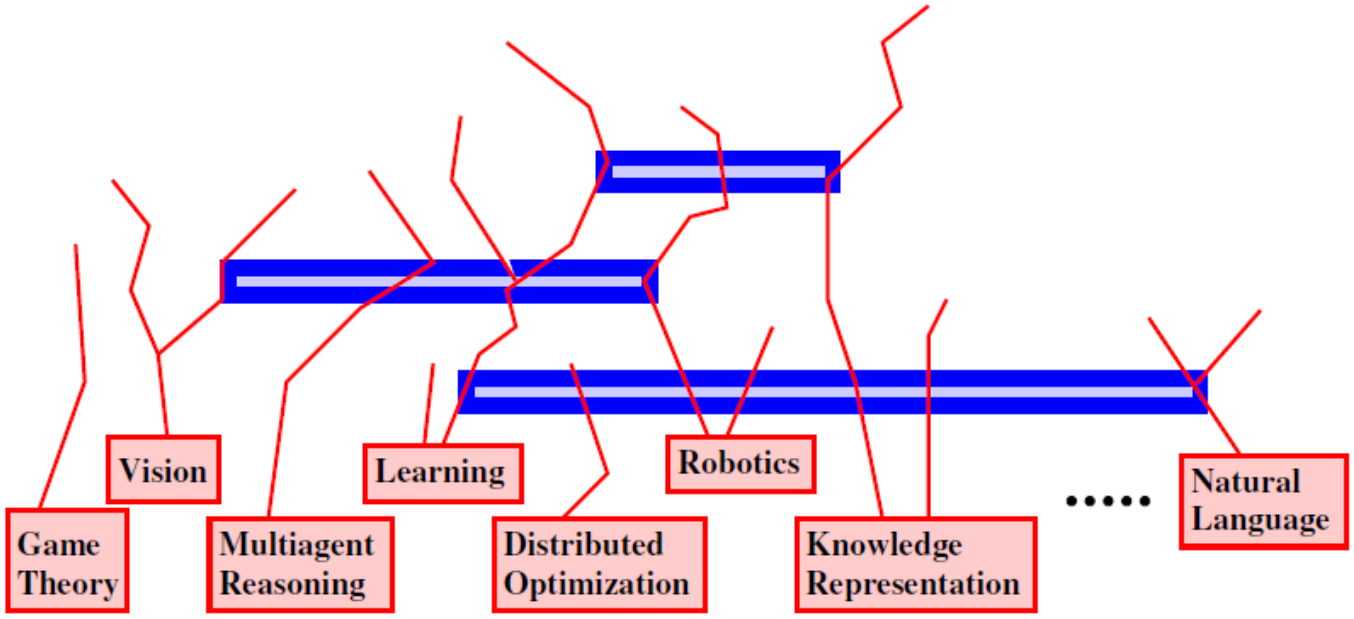
Towards and cathedral?

?

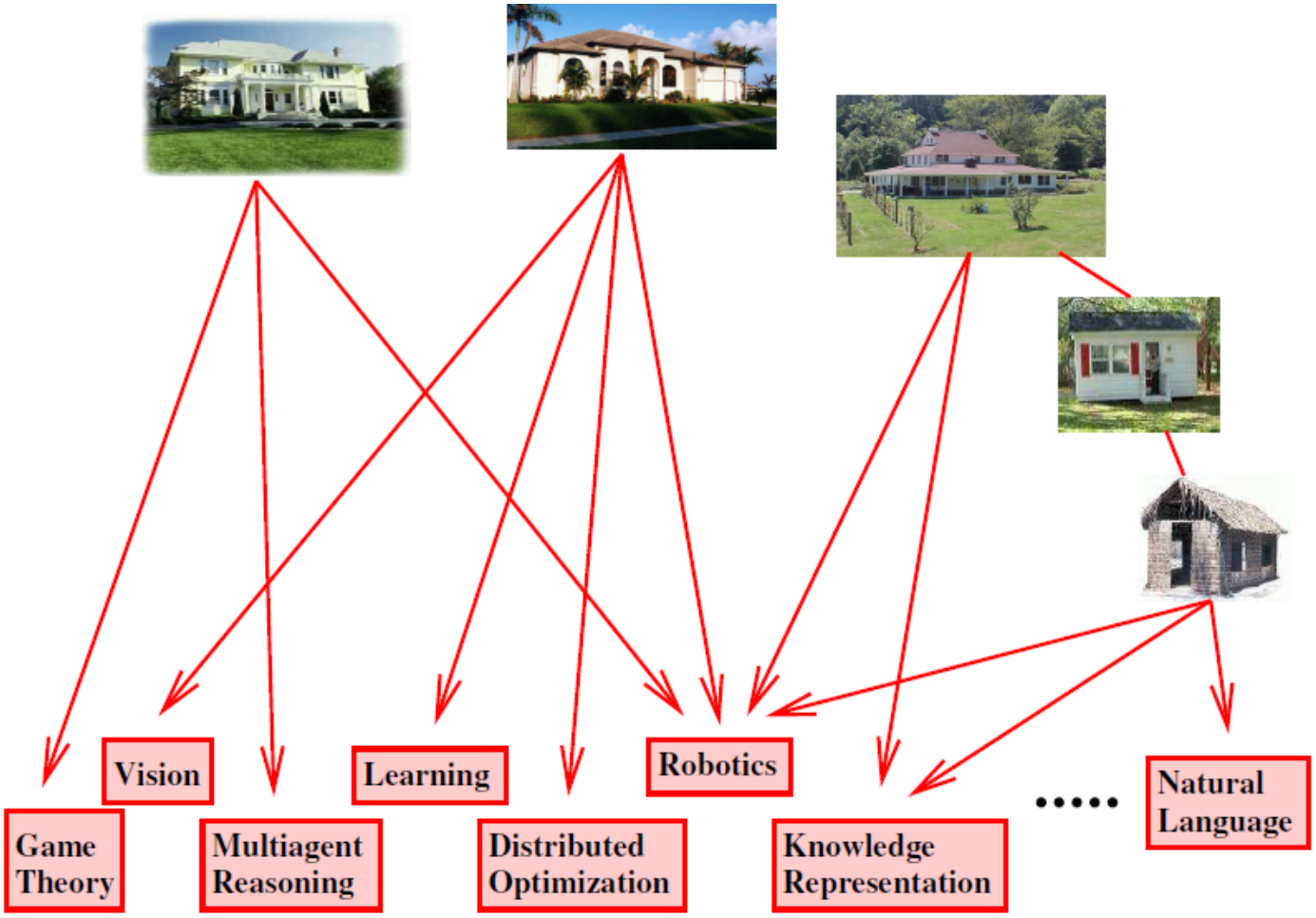


Or something else?

?

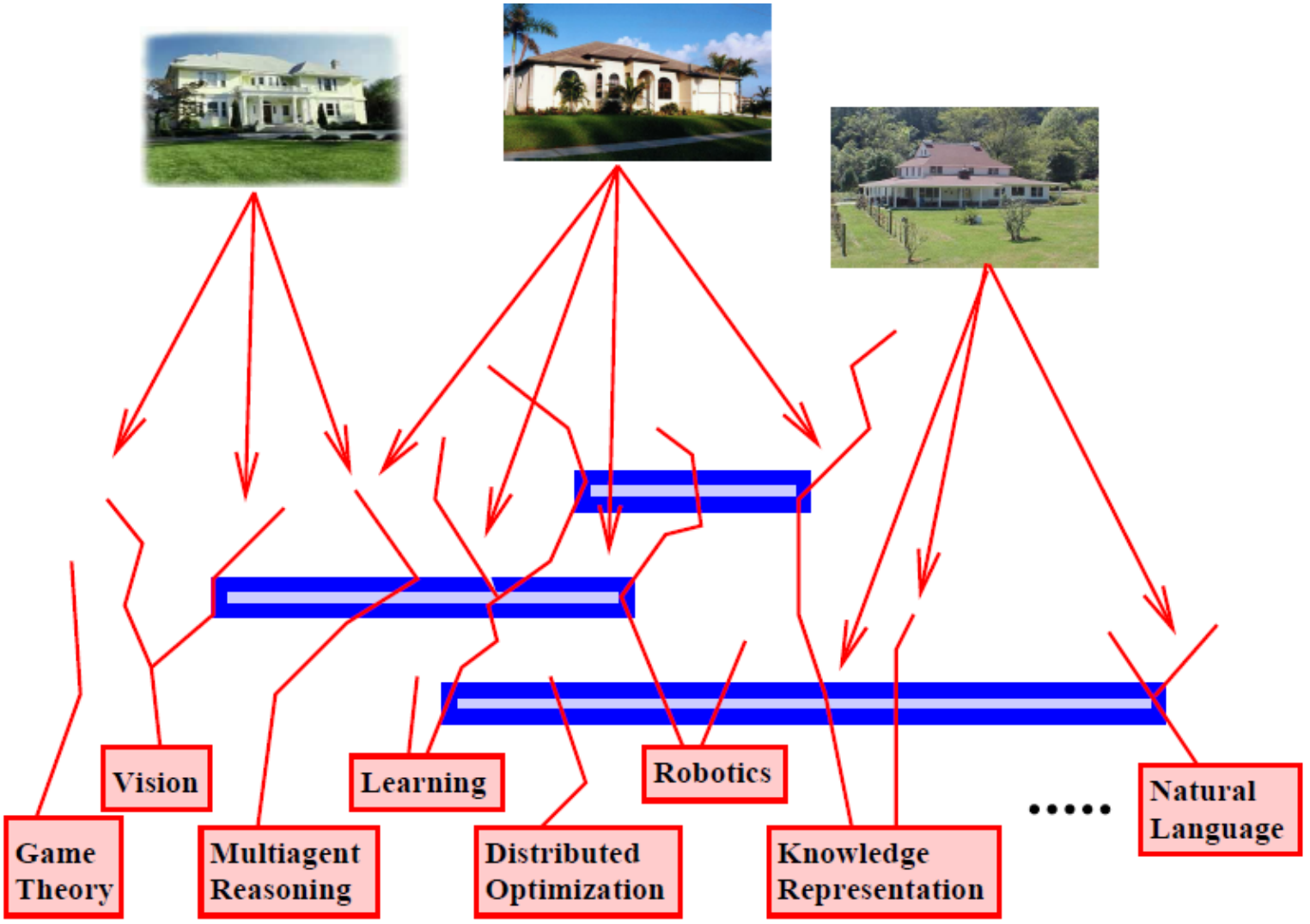


Top-down approach



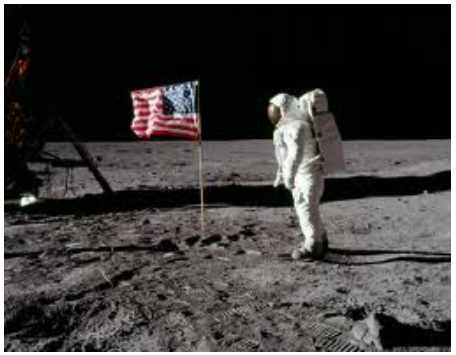
"Good problems . . . produce good science" [Cohen, '04]

Meeting in the middle

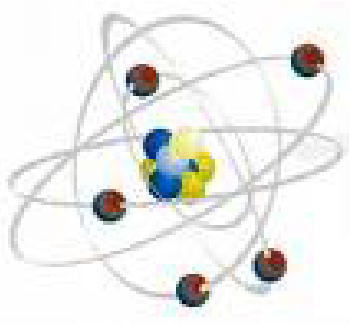


Good problems produce good science

Manned flight



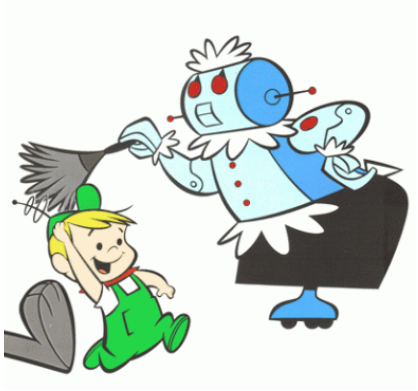
Apollo mission



Manhattan project

Autonomous vehicles

RoboCup soccer

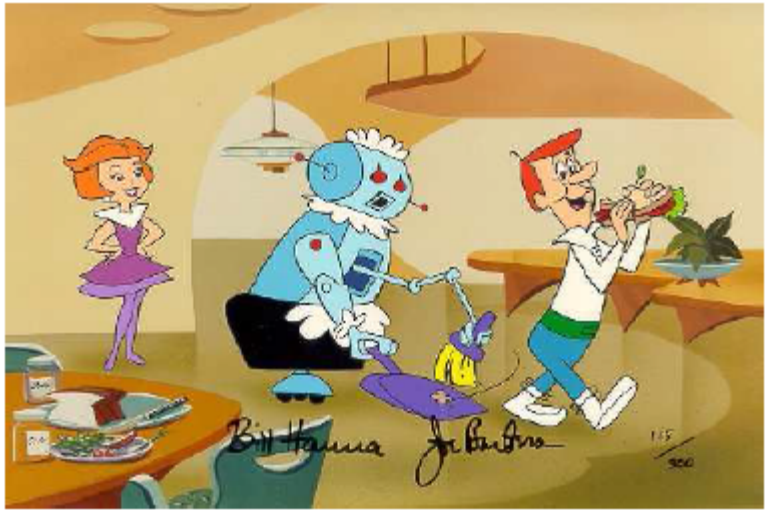


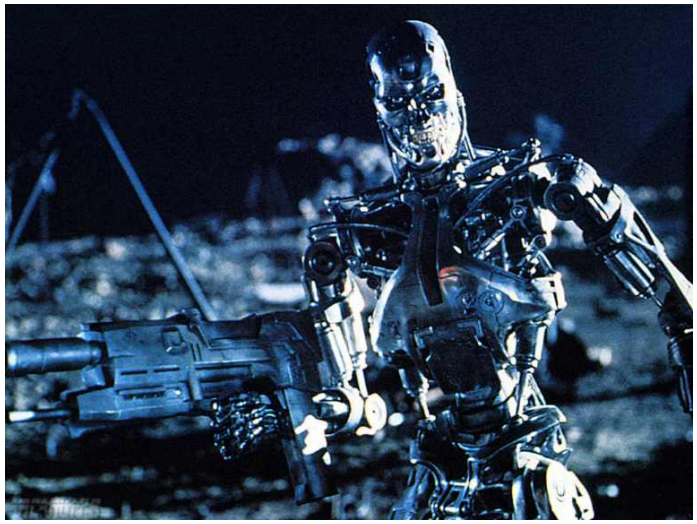
Assistive robots

Ethics, implications

- Robust, fully autonomous agents in the real world

- What happens when we achieve this goal?





Some Hard Questions…

- Who is liable if a robot driver has an accident?
- Will machines surpass human intelligence?
- What will we do with superintelligent machines?
- Would such machines have conscious existence? Rights?
- Can human minds exist indefinitely within machines (in principle)?

Slide credit: Dan Klein

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Goal of this course

- Learn about Artificial Intelligence
  - Increase your AI literacy
  - Prepare you for topic courses and/or research

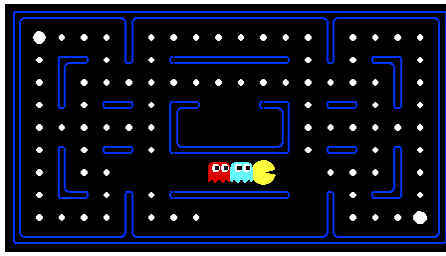
Course Topics

- Part I: Making Decisions
  - Fast search / planning
  - Adversarial and uncertain search
- Part II: Reasoning under Uncertainty
  - Bayes' nets
  - Decision theory
  - Machine learning
- Throughout: Applications
  - Natural language, vision, robotics, games, …

Overview of syllabus

- Official syllabus is online

Workload summary



- Readings due at least once per week
- Brief written responses for every reading (15%)

  sent to professor and TA
- Class attendance and participation (10%)
- Assignments (mostly programming) (35%)

  using Piazza for discussion/questions
- Midterm (15%)
- Final (25%)

Questions?

Course enrollment

- Course is for honors CS students
- If you want to enroll but are not registered, please inquire with the CS undergraduate office (first floor of GDC).

Assignments

- Read the syllabus
- Enroll on Piazza
- Post something on Piazza
- Reading assignment & email by Wed 8 pm
- Start first programming assignment – python tutorial (PS0), due 1/29
  - Complete it independently; no pairs.

Some AI successes

- Deep Blue beats Kasparov
- Sojourner, Spirit, and Opportunity explore Mars
- iRobot Roomba automated vacuum cleaner
- Automated speech/language systems for airline travel
- Spam filters using machine learning
- Usable machine translation through Google
- Watson wins at Jeopardy