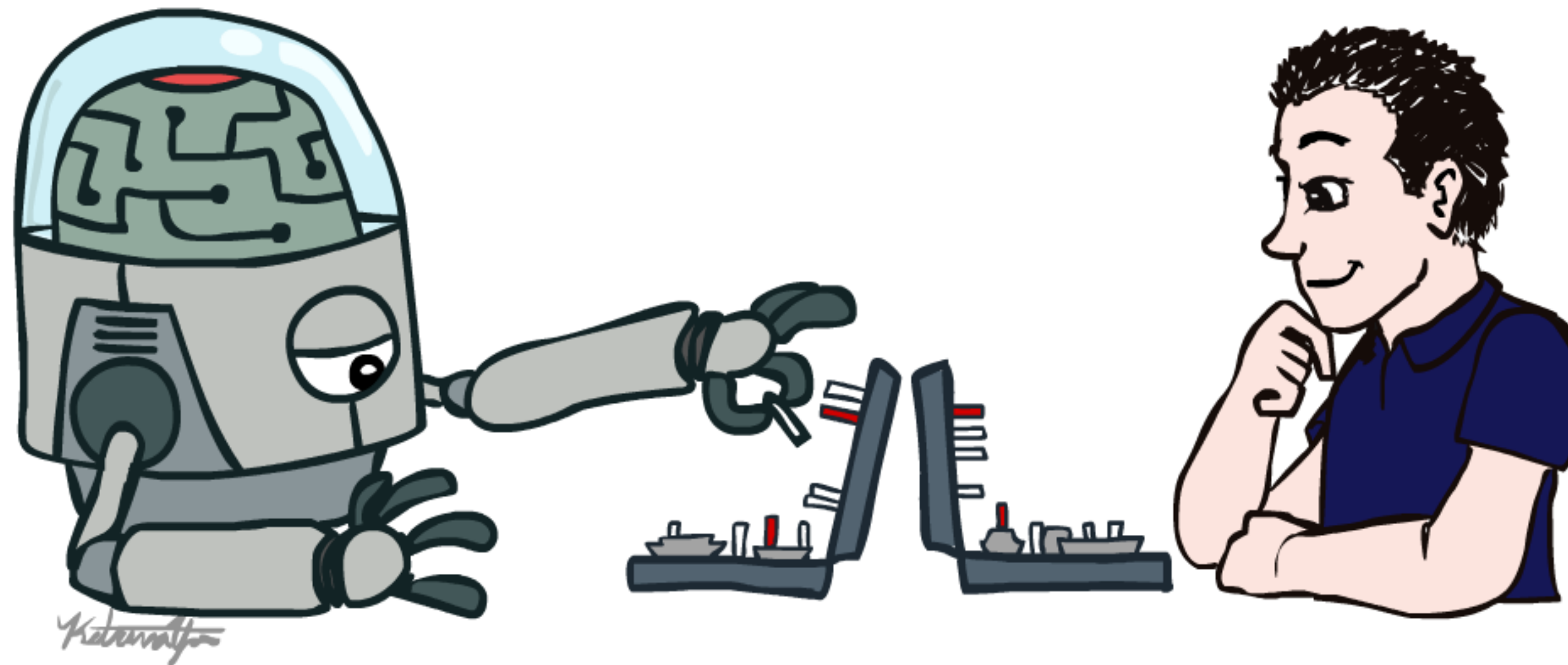# CS343: Artificial Intelligence

Introduction

Profs. Peter Stone and Yuke Zhu

The University of Texas at Austin

[Based on slides created by Dan Klein and Pieter Abbeel for CS188 Intro to AI at UC Berkeley, modified by Scott Niekum at UT Austin.

All materials available at http://ai.berkeley.edu.]

Good Morning Colleagues

- **Welcome to a fun, but challenging course**
- **Goal: Learn about Artificial Intelligence**
  - Increase AI literacy (it's not magic!)
  - Prepare you for topics courses
  - Broad coverage of topics
  - NOT a current events class

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"?

- ▪ **2010-: Neural networks (deep learning)**
  - ➢ Great progress in vision, NLP.. "AI Summer"?
  - ▪
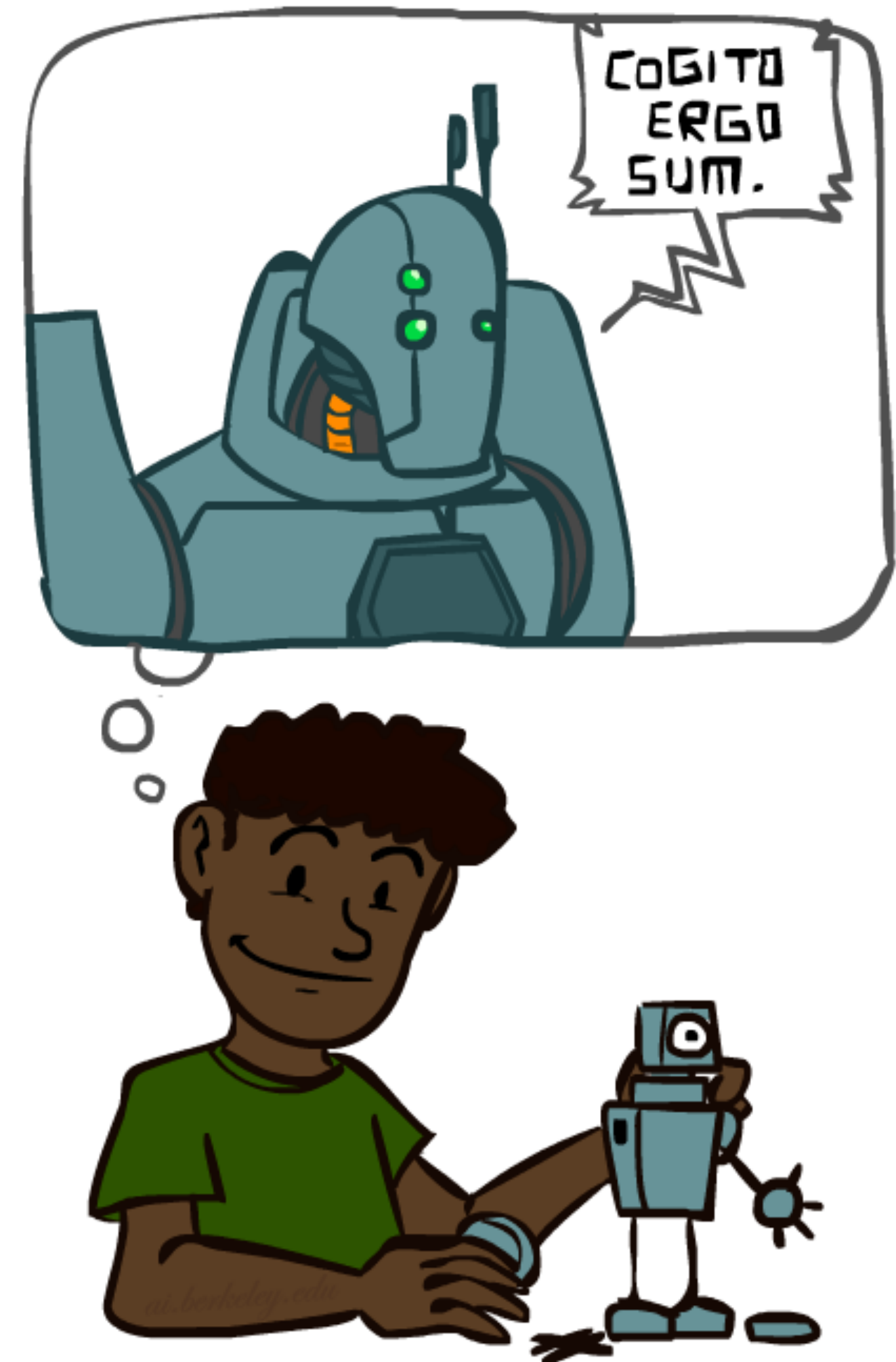
The Big Scientific Questions of our Time

- How did the **universe** originate?

- How did **life** on Earth originate?

- What is the nature of **intelligence**?

The Nature of Intelligence

How can we Study it?

- Study human (or animal) **behavior** – Psychology

- Study human (or animal) **brains** – Neuroscience

- **Think** about it – Philosophy

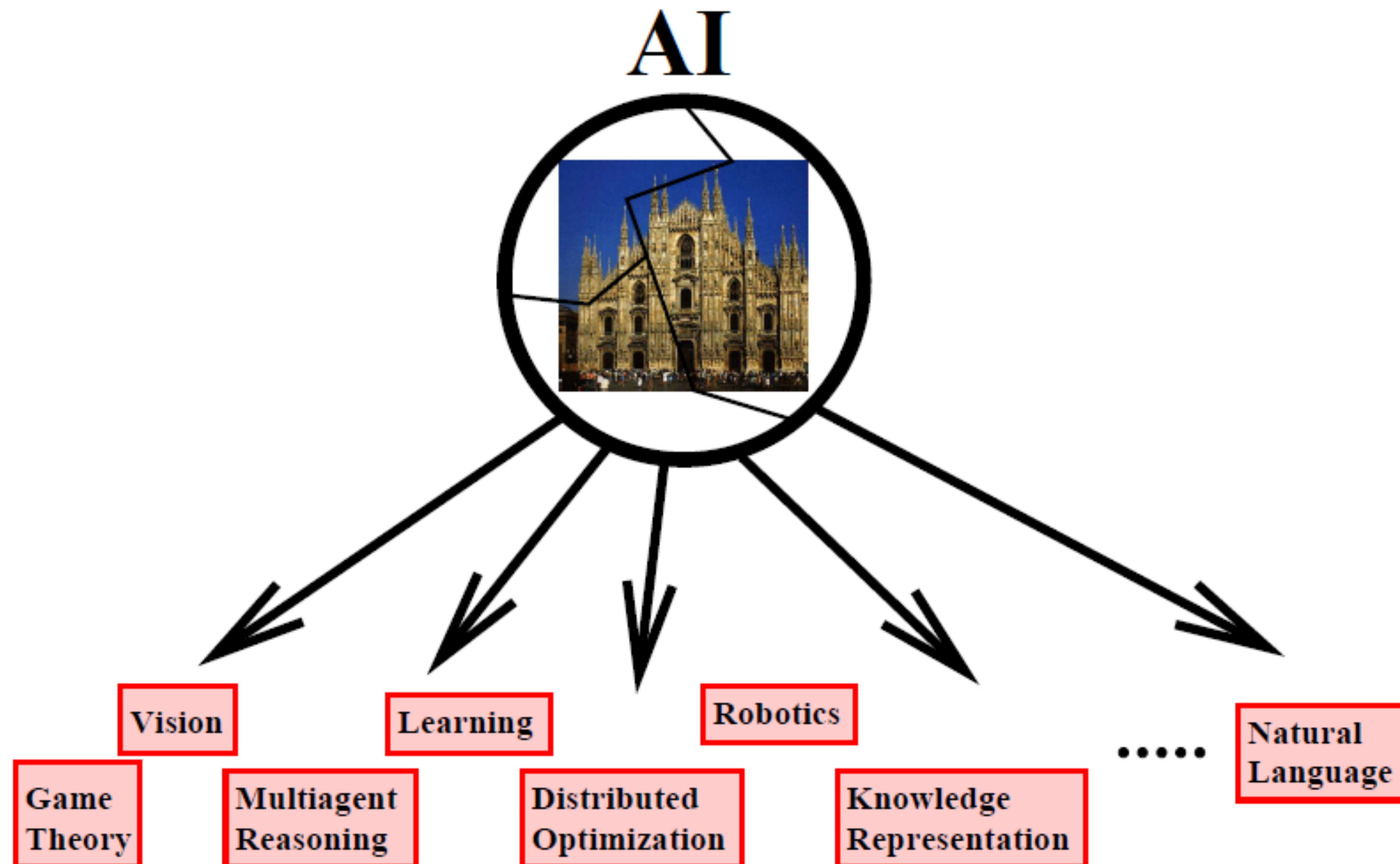- **Build and analyze** intelligent artifacts – Computer Science

Building Intelligent Artifacts

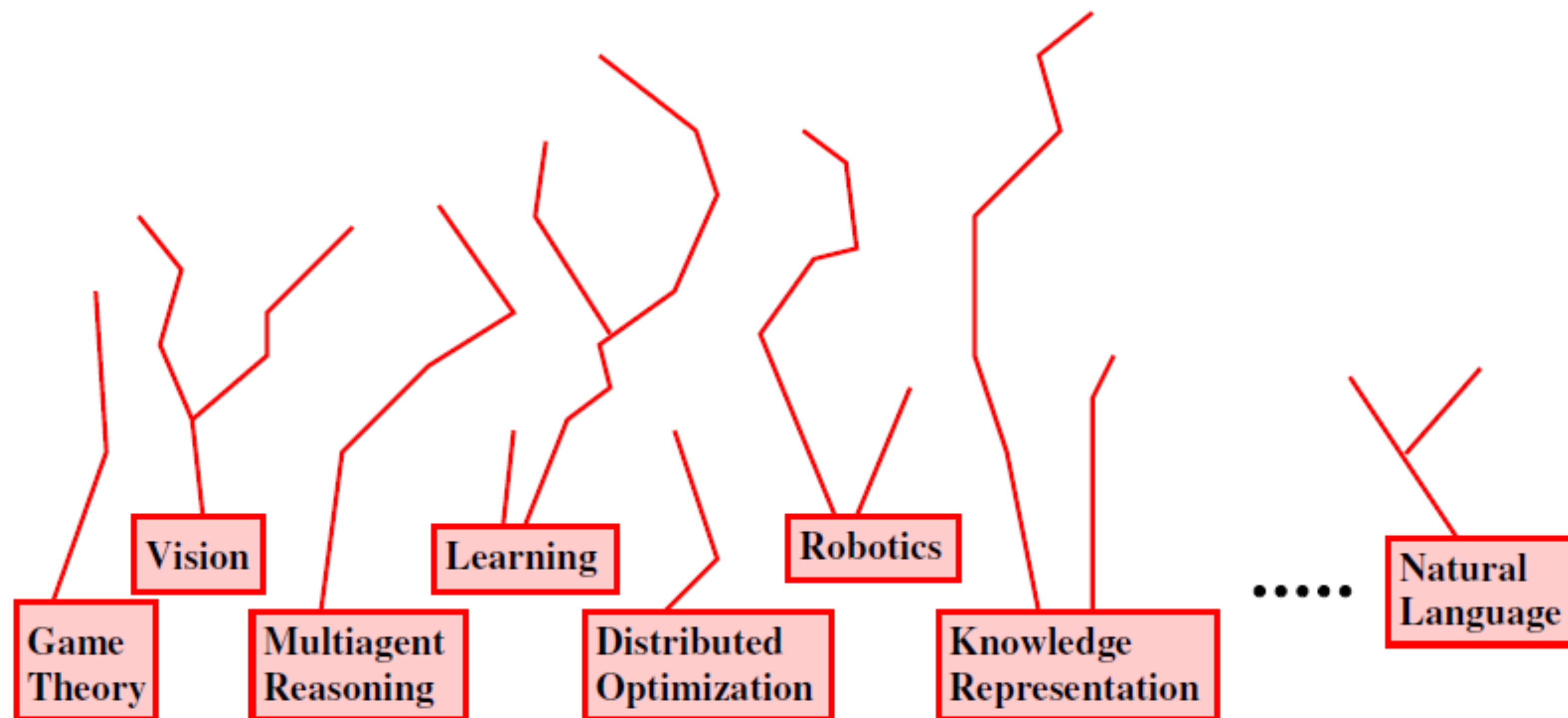▪ **A goal of AI:** Robust, fully autonomous agents in the real world

▪ 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.*
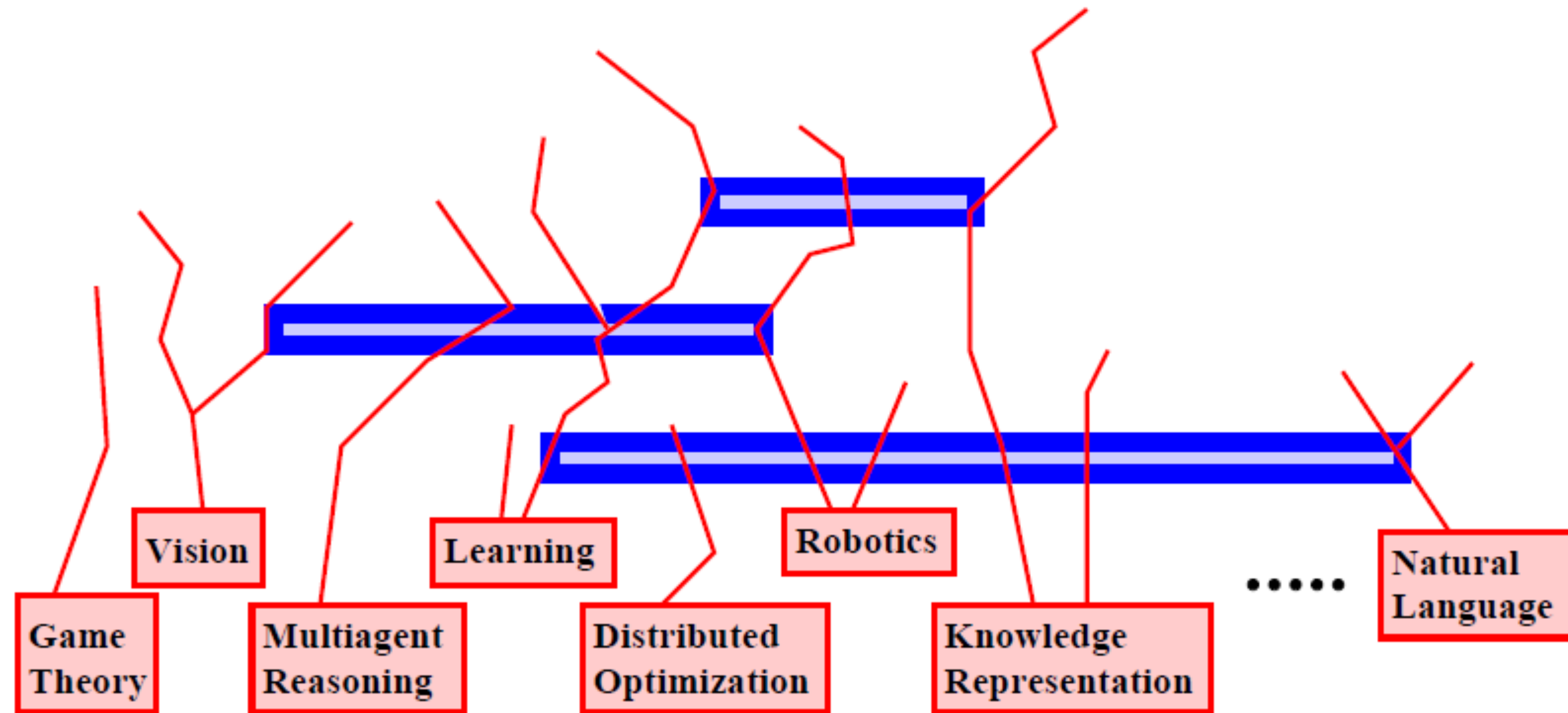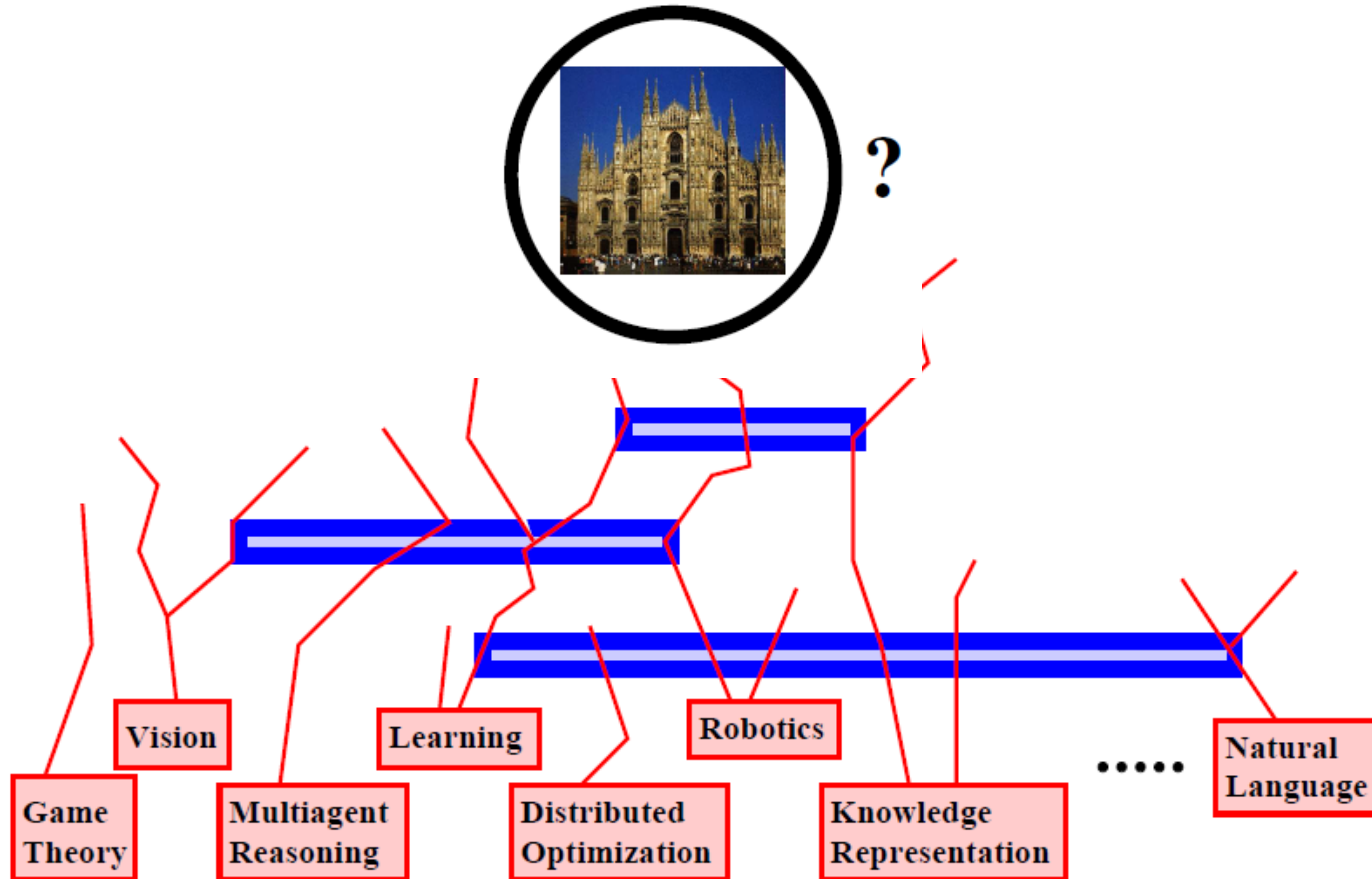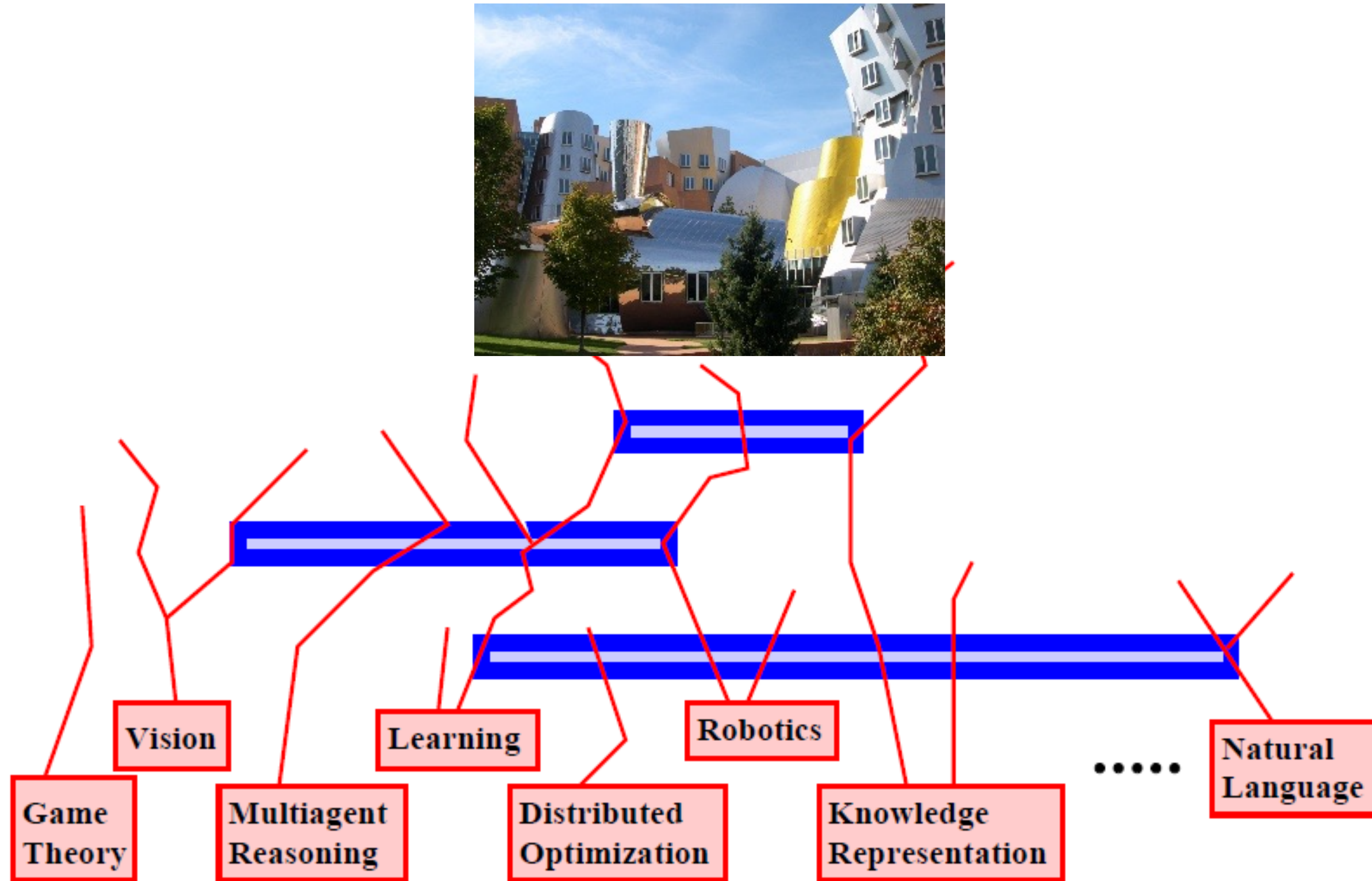
Bottom-up approach

AI

Vision

Learning

Robotics

Natural Language

Game Theory

Multiagent Reasoning

Distributed Optimization

Knowledge Representation

The bricks

The beams and mortar

Towards a cathedral?

Vision

Learning

Robotics

Game Theory

Multiagent Reasoning

Distributed Optimization

Knowledge Representation

Natural Language

Or something else?

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

Top-down approach

Vision

Learning

Robotics

Natural Language

Game Theory

Multiagent Reasoning

Distributed Optimization

Knowledge Representation

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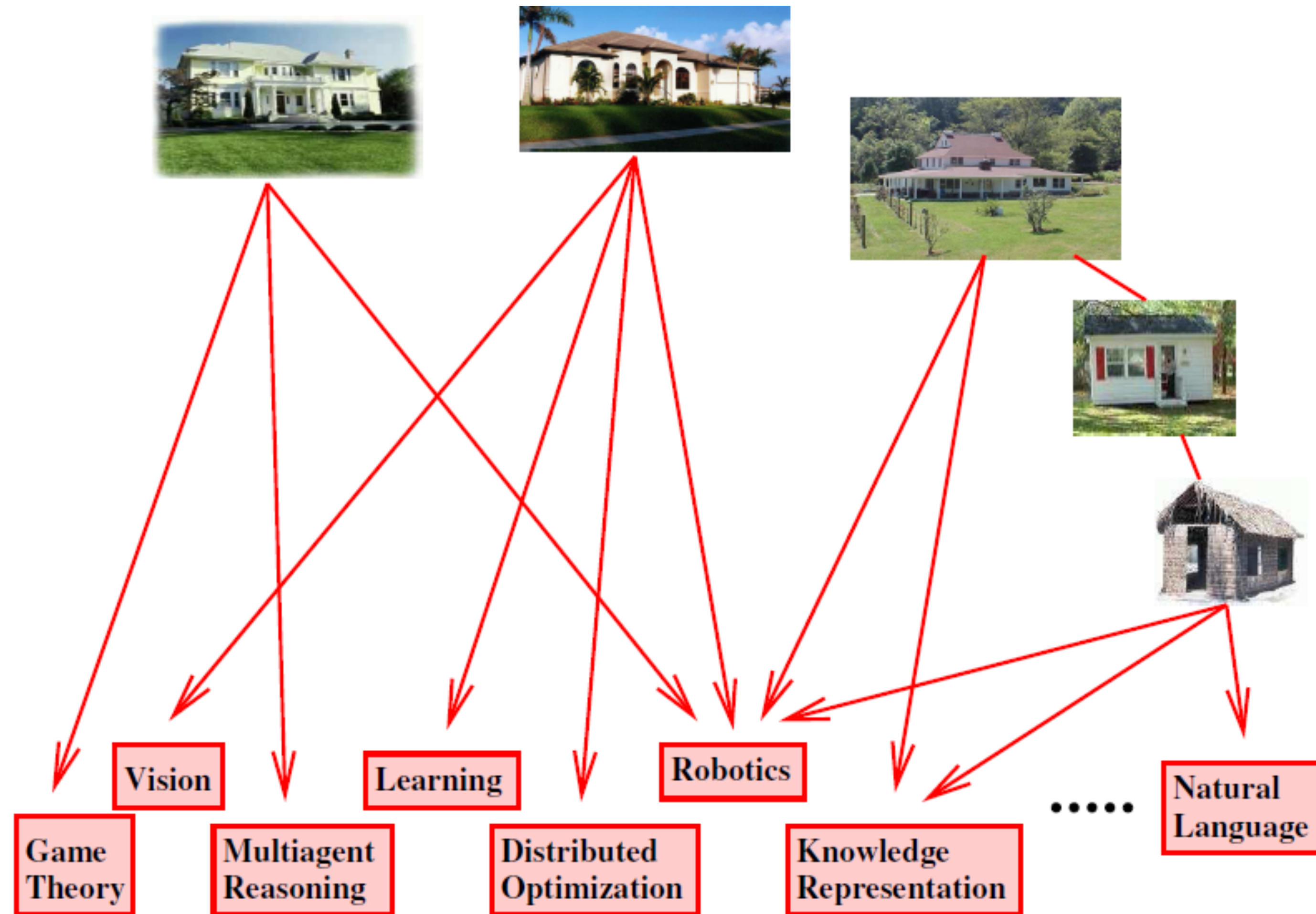
"Good problems . . . produce good science" [Cohen, '04]

Good problems produce good science

Manned flight
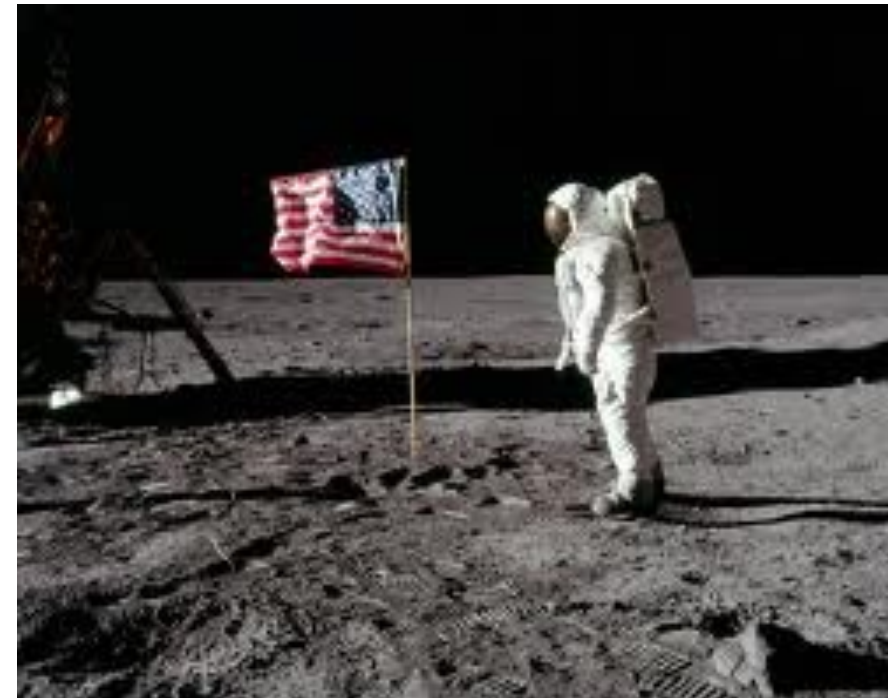
Apollo mission
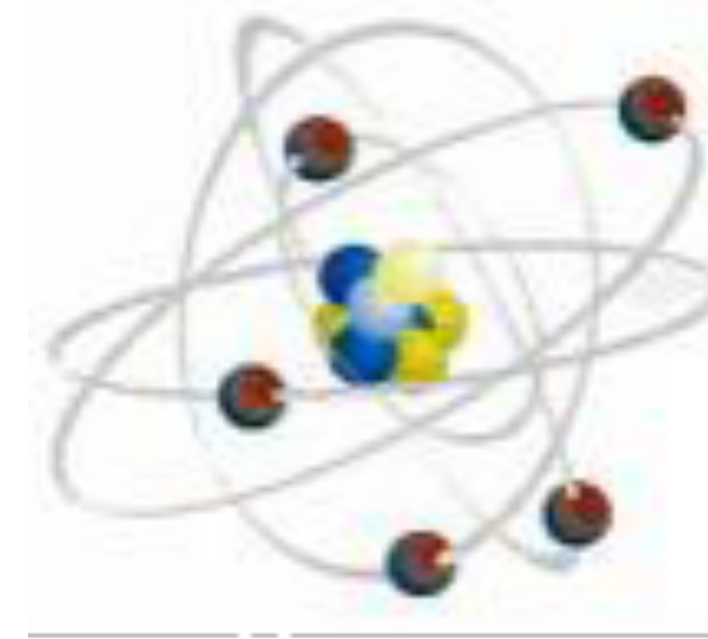
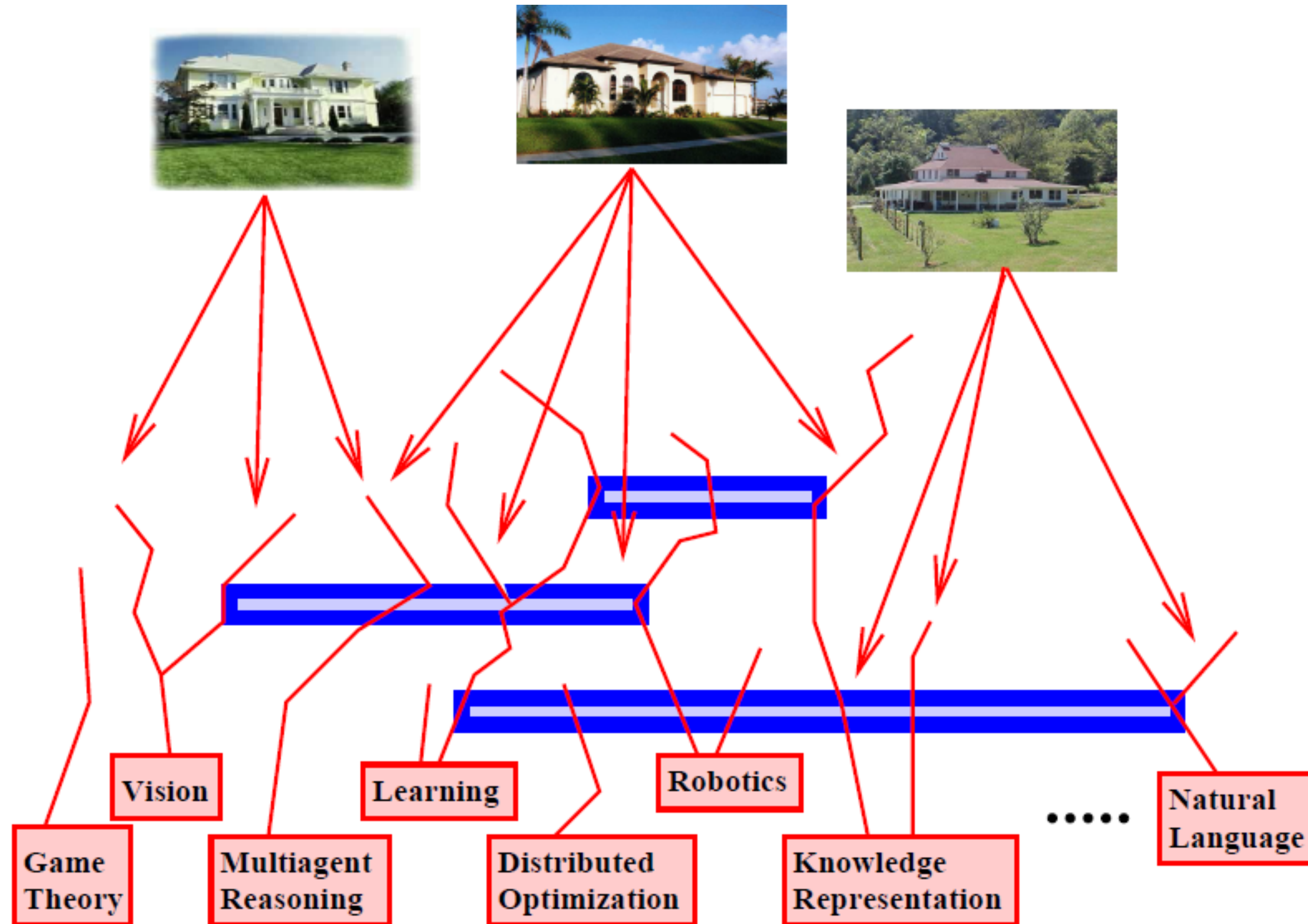Manhattan project

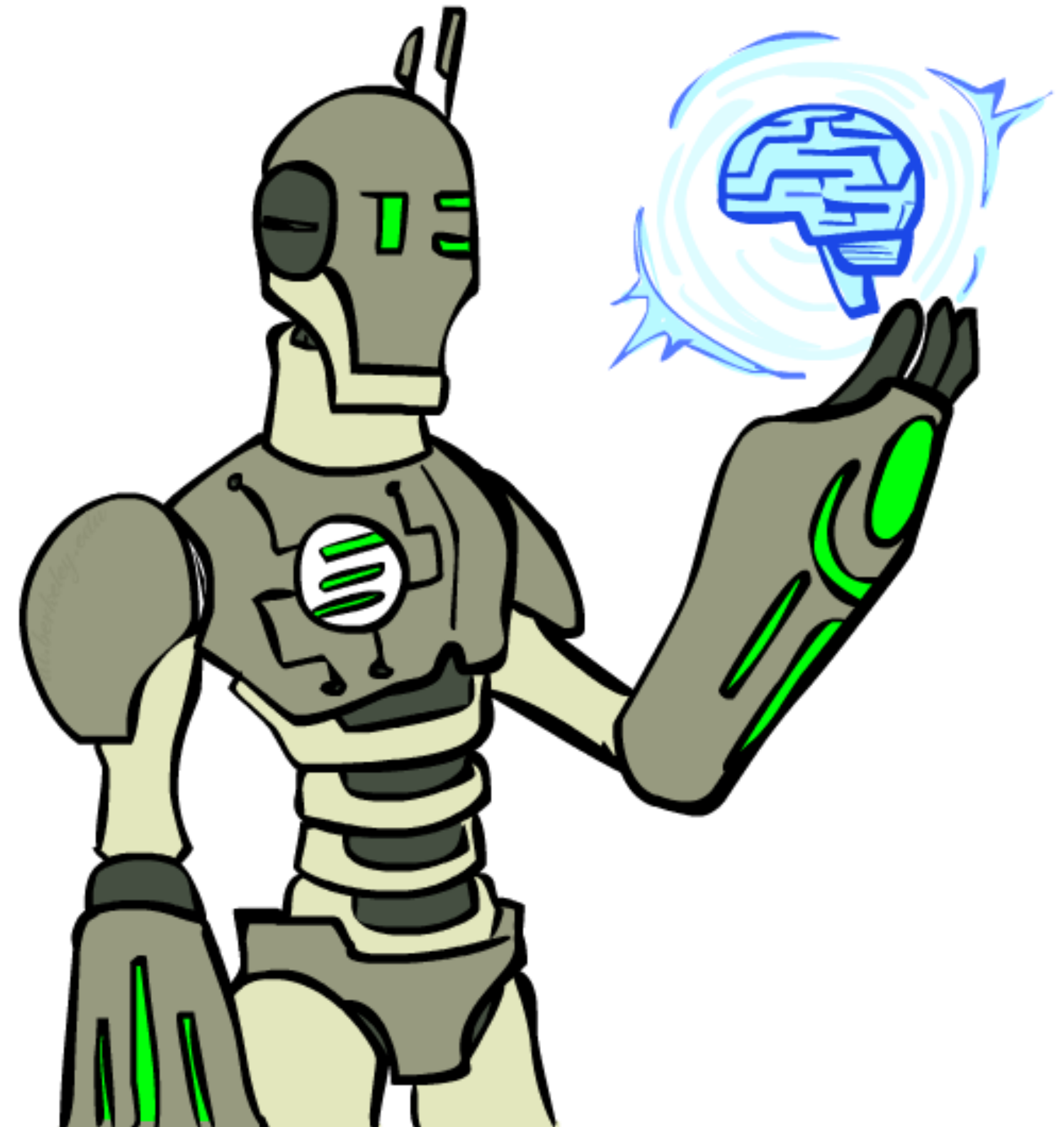Autonomous vehicles

RoboCup soccer
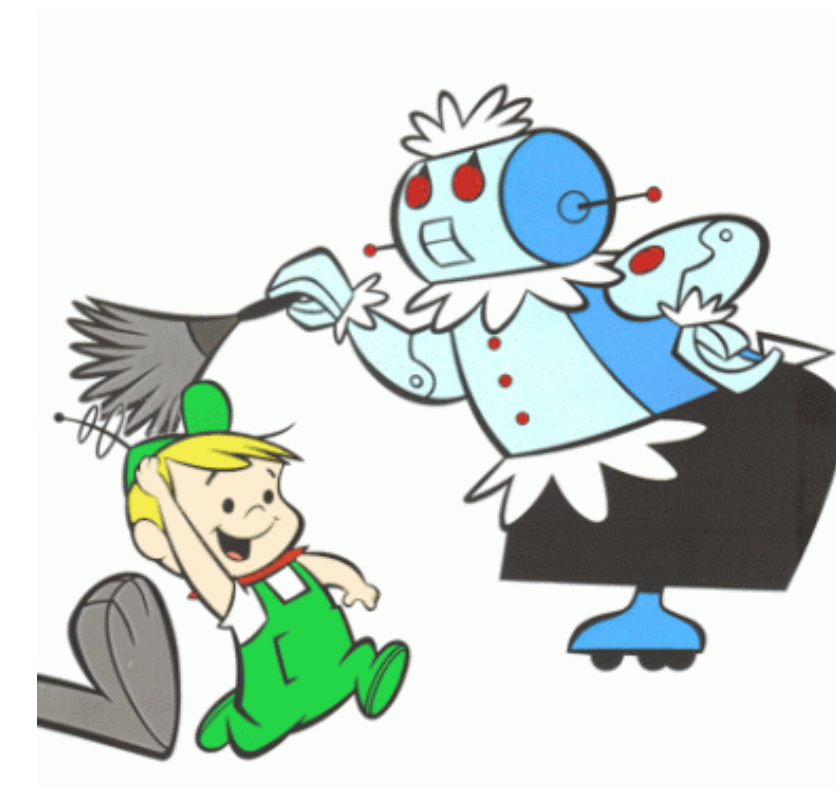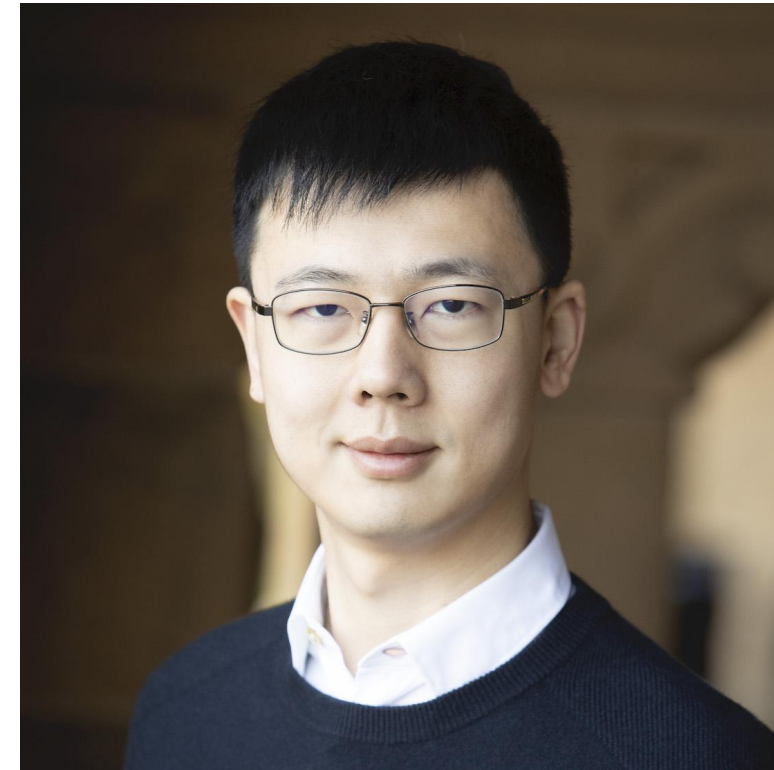

Assistive robots

Meeting in the middle

Today

- What is this course?

- What is artificial intelligence?

- (What can AI do?)

Course Staff

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Research Interest: Robot
Learning

Course Information

- Communication:
  - Announcements on webpage
  - Grades on Canvas / edX
  - Piazza for discussion

- Course technology:
  - edX for interactive homework (unlimited submissions!)
  - Autograded programming projects (submit via Canvas)
  - Make sure you have a CS Unix account IMMEDIATELY!
 - Create an edX account

Class website:

http://rpl.cs.utexas.edu/cs343_spring2021

(or Google "Peter Stone" and go to the Teaching tab)

Course Information

- Prerequisites:
  - Upper division standing
  - No formal class pre-reqs
  - There will be a lot of math (and programming)

- Coursework
  - Reading assignments with written responses
  - ~9 homework assignments:
    - ~2 weeks for each, but overlapping
    - Online, autograded, solve together, submit alone
    - No late submissions accepted
  - 6 programming projects
    - Python, groups of 1 or 2 (except Project 0)
    - ~2 weeks for each, non-overlapping
    - 5 late days for semester, (maximum 2 per project ?)
  - One midterm, one final
  - (Final Contest)

Textbook

Russell & Norvig, AI: A Modern Approach, 3rd Ed.
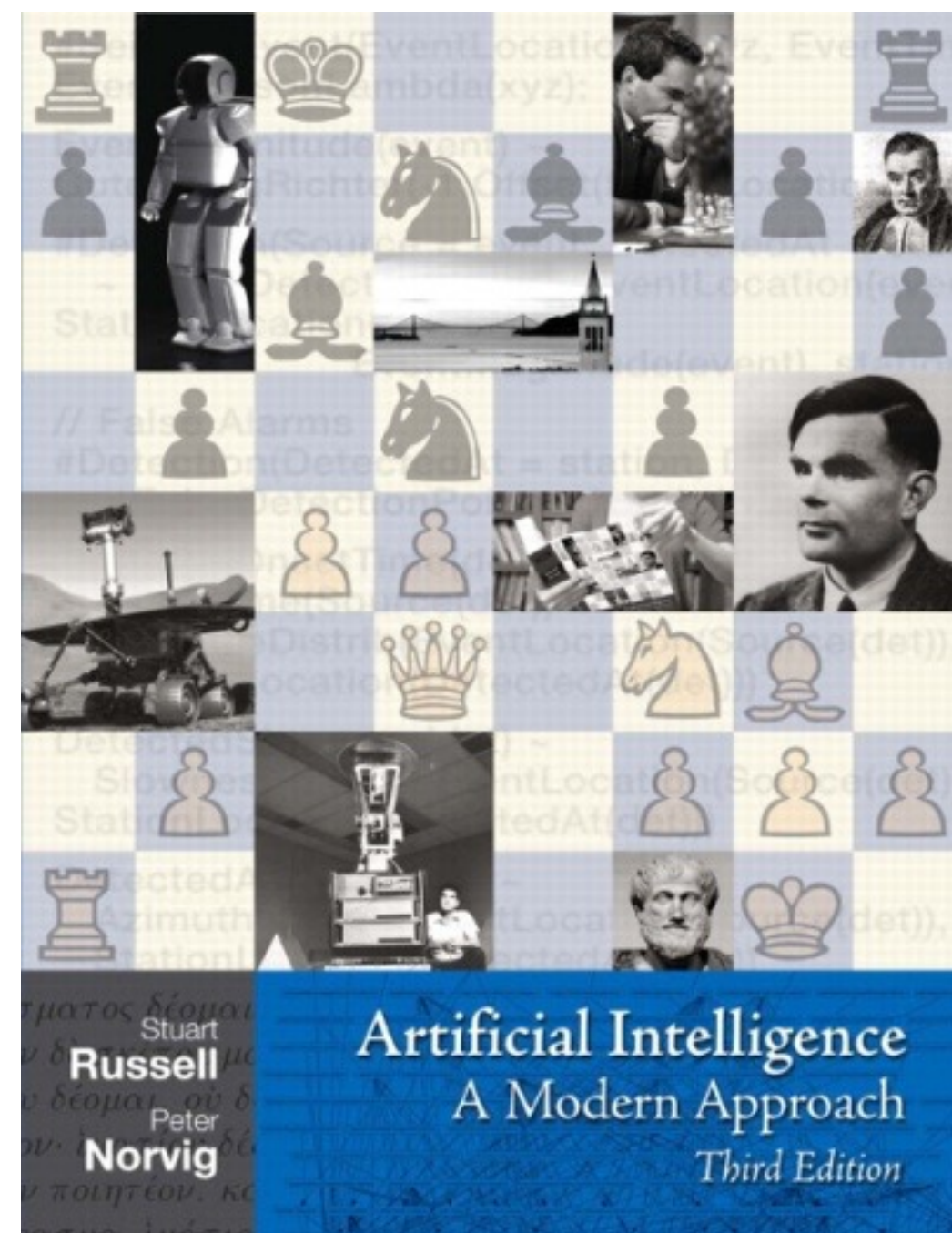
- After classes we'll post slides

- There will also be "step by step" videos posted for some topics

Warning: Not everything covered in the book will be covered in class
(and to a small extent, vice versa). You are responsible for both.

Course Topics

- **Part I: Making Decisions**
  - Fast search / planning
  - Constraint satisfaction
  - Adversarial and uncertain search
  - MDPs and Reinforcement learning
- **Part II: Reasoning under Uncertainty**
  - Bayes nets
  - Decision theory and value of information
  - Statistical mahchine learning
- **Part III: Additional Topics**
  - Neural networks
  - Planning
  - Ethics
- **Throughout: Applications**
  - Natural language, vision, robotics, games, …

Homework Exercises

- Online on edX

- Autograded text boxes / multiple choice

- Try as many times as you want!

  - (Might need to come to office hours

  - to unlock after a number of attempts)

- Goal: self-assess and prepare for tests

- Can discuss at high-level, but work alone
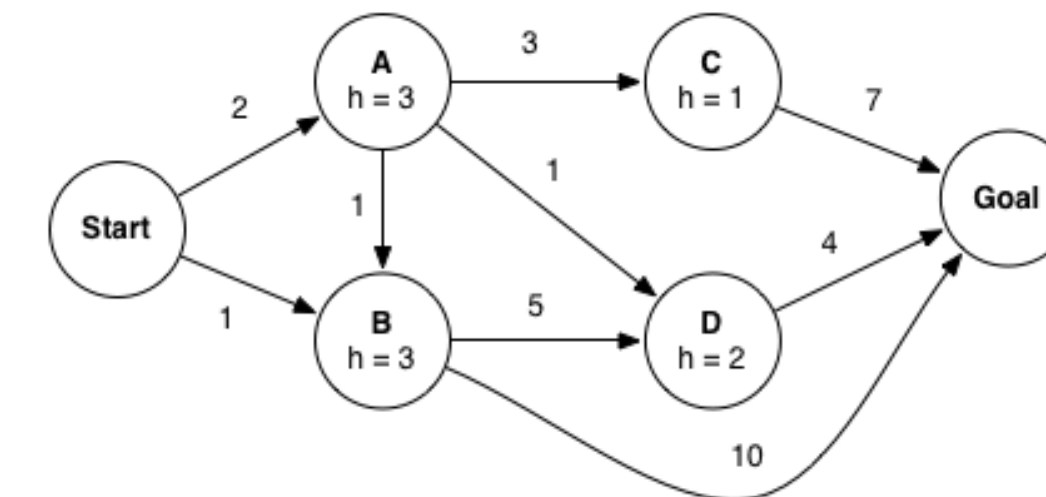
- No spoilers on Piazza discussions!

Programming Assignments

Pacman domain
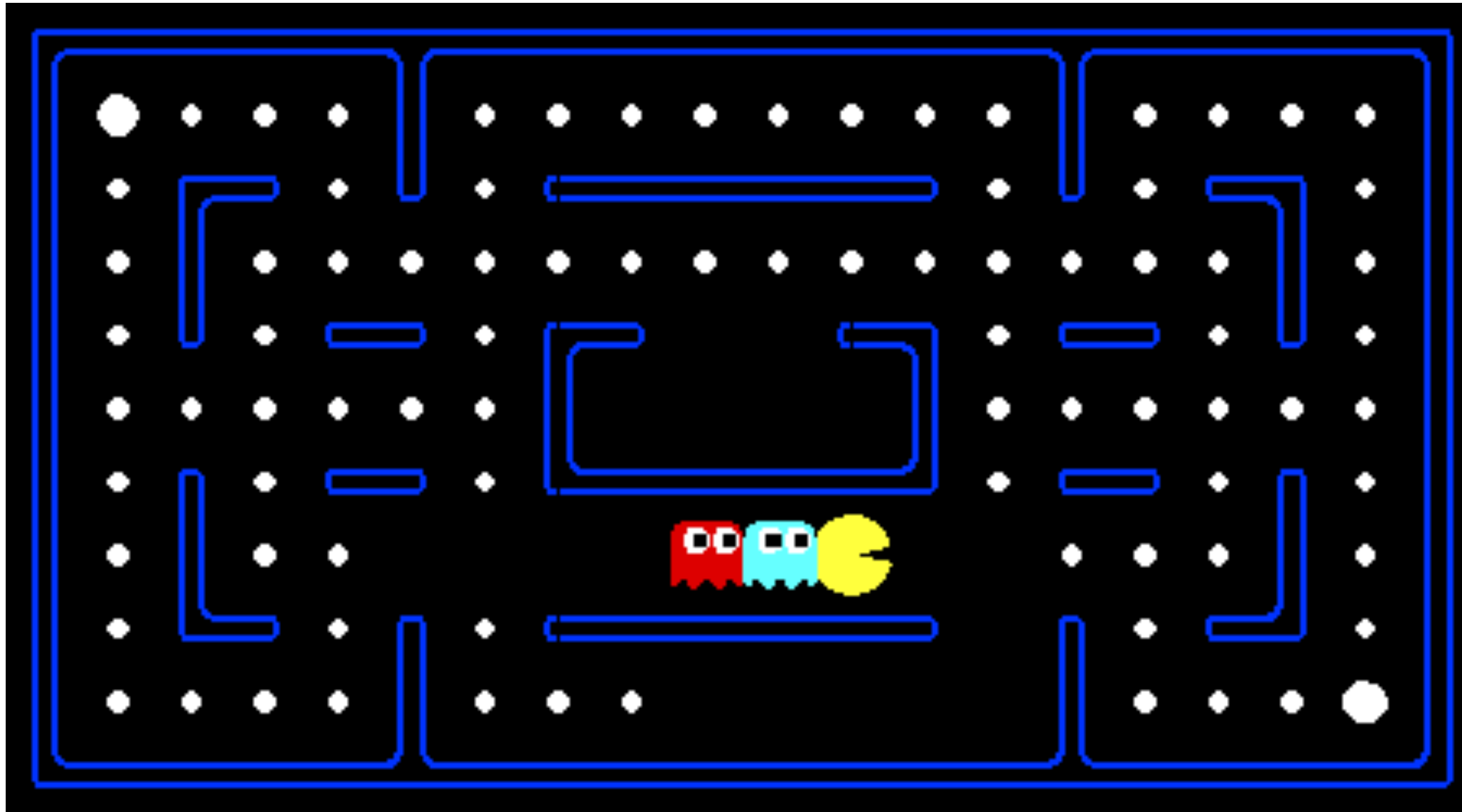
Projects include:

- path planning and search

- multi-agent game trees

- reinforcement learning

- state estimation

- classification

- final contest

Highly suggested: Pair programming
(switch "driver" and "observer" roles often)

Midterm and Final

- Midterm will cover roughly half the class material

- Final will be comprehensive

- (When it was in person: One page of notes, but not open book)

Syllabus

Official syllabus is online

Grades will be weighted as follows:

- Written responses to readings (5%)
- Class attendance and participation (10%)
- Homework Exercises (20%)
- Programming Assignments (25%)
- Midterm (15%)
- Final (25%)

Academic Honesty

- Discuss concepts, but don't share solutions or written work with other students

- Don't look for answers / code online or elsewhere

- Automated tools will be used to discover cheating

- If unsure, check departmental guidelines or ask — ignorance is not an excuse

- We will pursue the harshest penalties available, so please don't cheat!

- To be clear: you will fail the class automatically and be reported to the university

Important This Week

- Important this week:

  - **Read and respond** to AI 100 report (past due, but no late penalty)

  - **Read** the syllabus

  - **Reading assignment and email response** by Wednesday at 9:30am

  - **Register** for the class on edX (Click on link for HW1 to register for class after making account)

  - **Enroll and post something** on Piazza

  - **Be sure** that you have a usable CS Unix account - https://apps.cs.utexas.edu/udb/newaccount/

  - **P0: Python tutorial** is out (due on Thursday 1/21 at 9:30am via Canvas)

- Also important:

  - **If you are wait-listed,** you might or might not get in depending on how many students drop. Be patient if possible — many students often drop early in the course.

  - **Office Hours** see website

How to Ace this Course

- Do the readings! – That's your primary source for the material

- Do all the assignments on time – That's a big chunk of the grade

- Prepare for the exams – Historically, have been difficult for some

  ➢ Come to class for practice

  ➢ Keep up with the material – don't cram

- Become known to the class staff – for class participation

  ➢ Come to class (with your camera on!) and be ready to interact
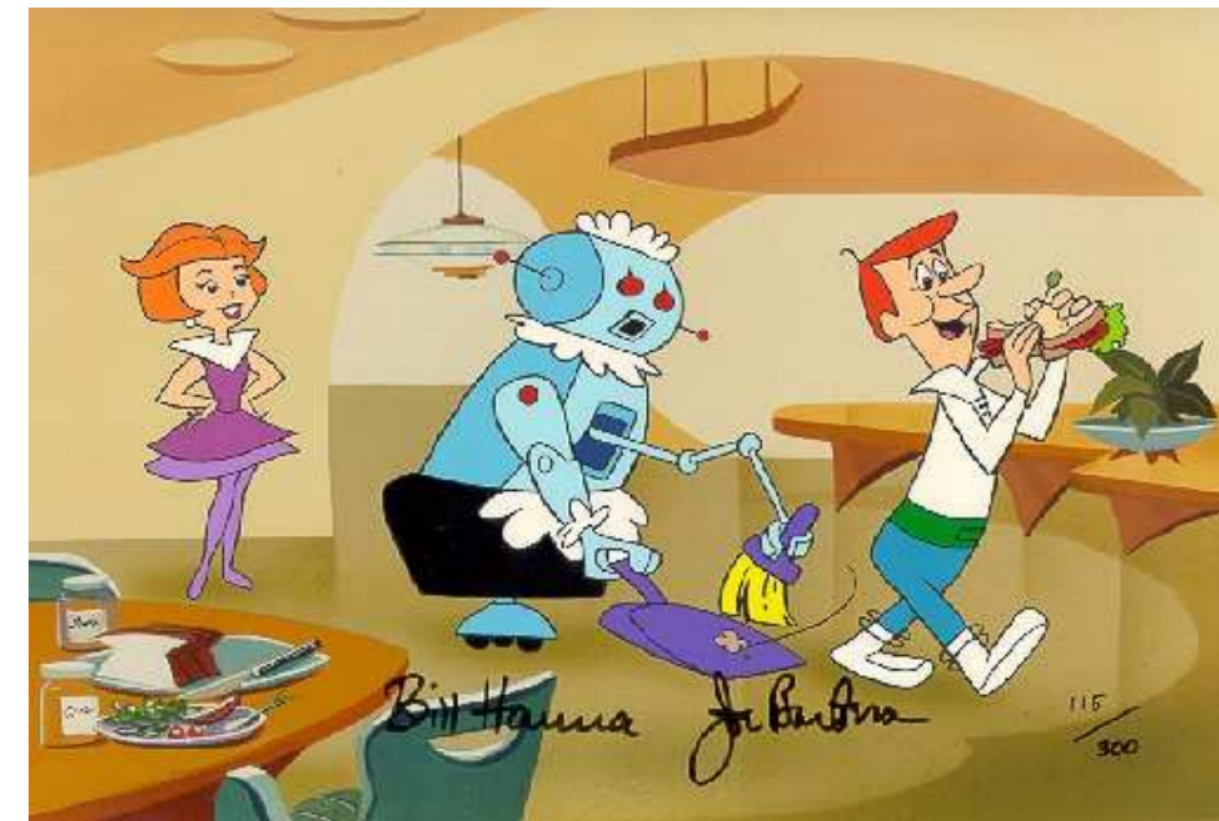
  ➢ Reading responses

  ➢ Piazza posts

Today

- What is this course?

- What is artificial intelligence?

- (What can AI do?)
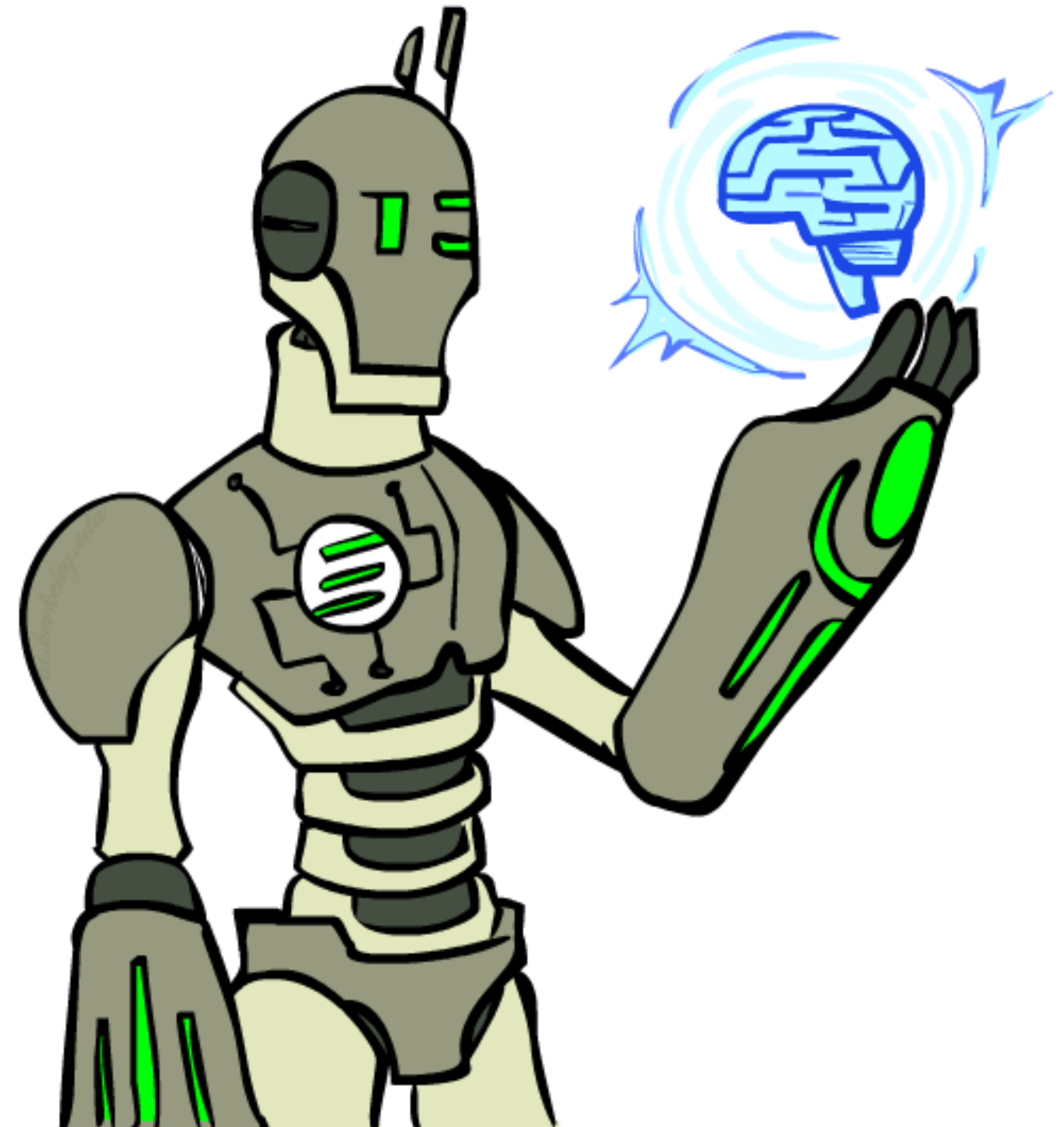
But First…. Implications

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

What happens when we achieve this goal?

 ? **?**

Is AI moving us in the right direction?

Discussion Question: Would you rather have been born:
– 50 years earlier? – 50 years later?

Other difficult questions…

- Who is liable if a robot driver has an accident?
- Will machines surpass human intelligence (in all ways)?
- Would such machines have conscious existence? Rights?
- What is a mind?
- How can a physical object have a mind?
- Can we build a mind?

.
▪

**AI is one of the great intellectual adventures
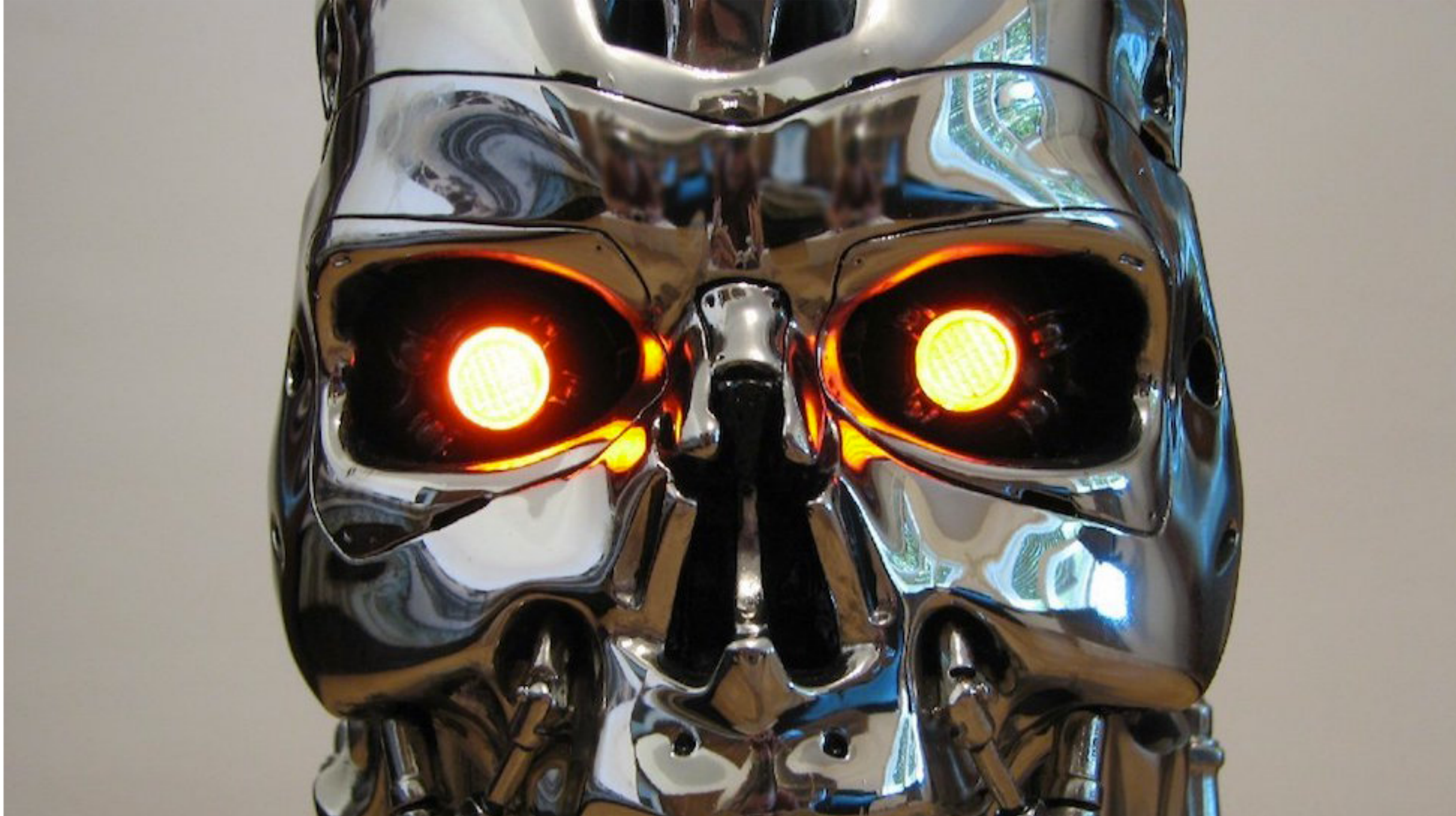of the 20th and 21st centuries!**

What is AI?

- Finding fast algorithms for NP-hard problems
- Getting computers to do the things they can't do yet
- Getting computers to do the things they do in the movies

-

Sci-Fi AI
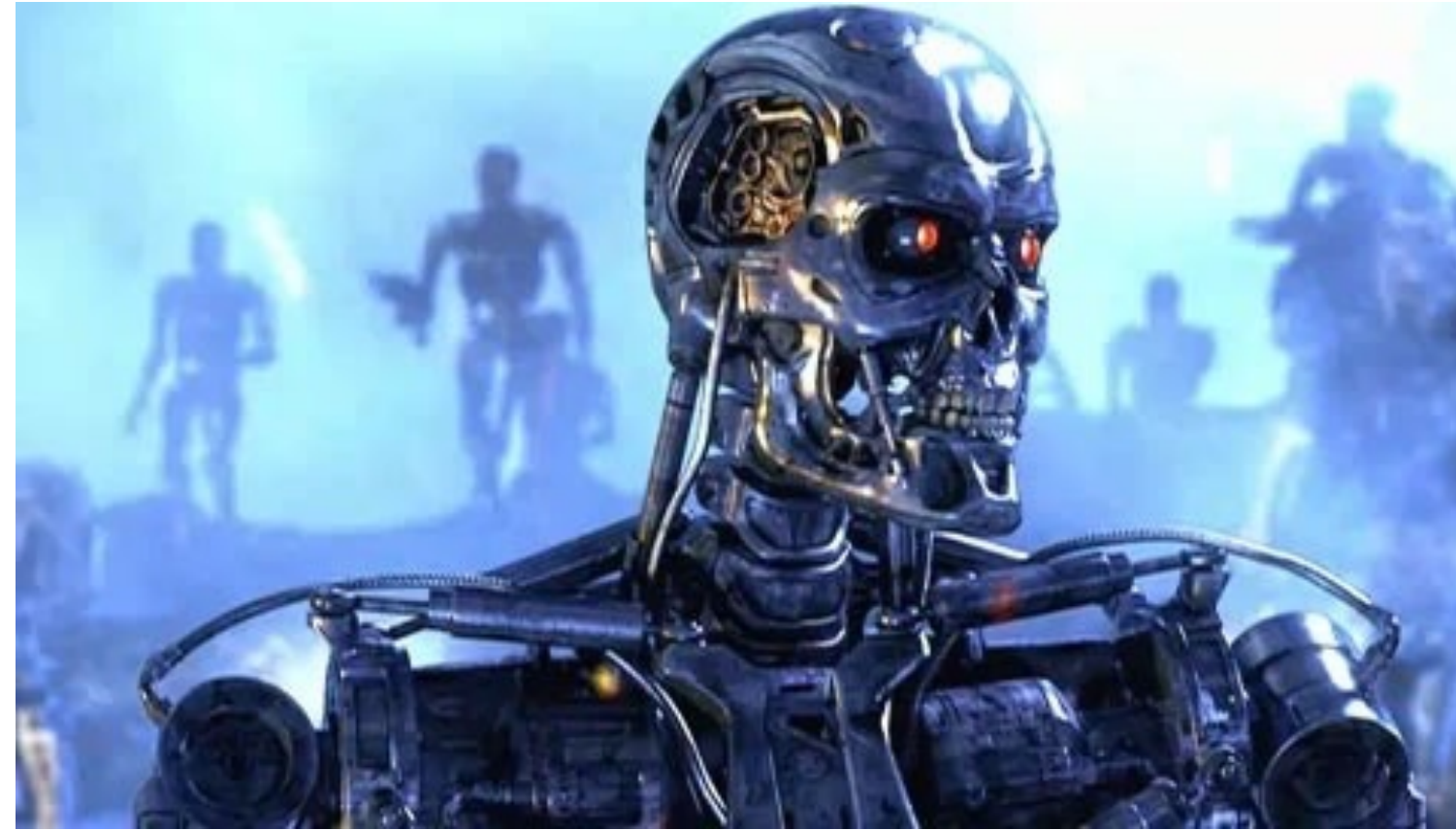
AI in the news

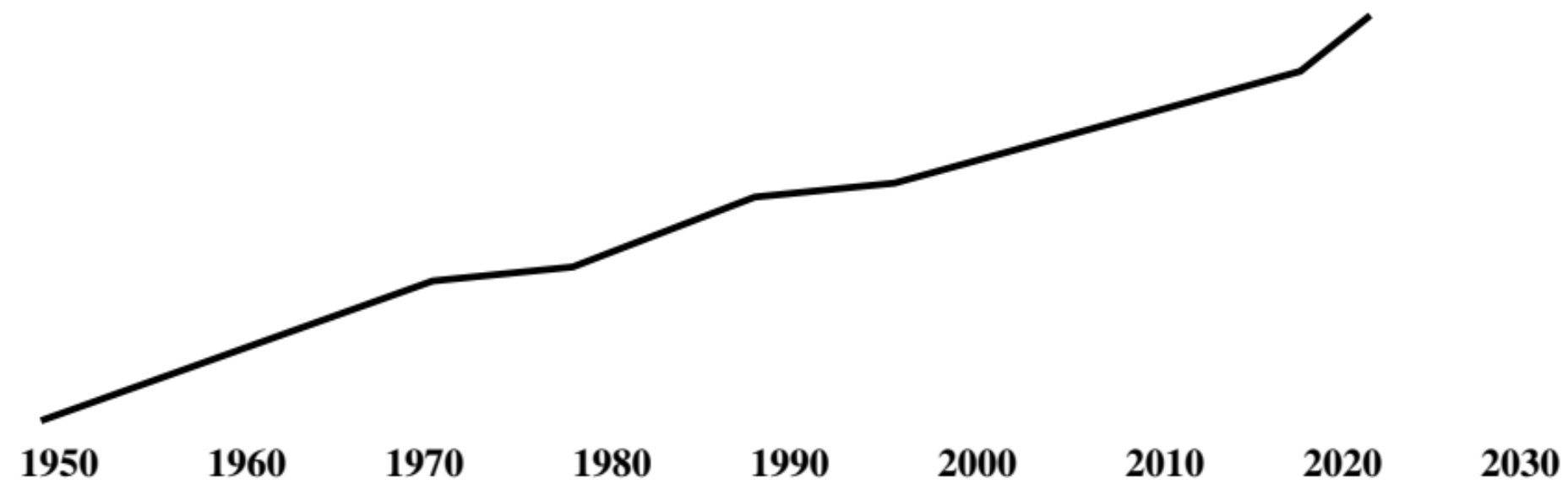Nerdist — PODCASTS · VIDEOS · ARTICLES · EVENTS · TWITCH · STORE

ELON MUSK ANNOUNCES OPEN AI: A NON-PROFIT TO HELP PREVENT SKYNET
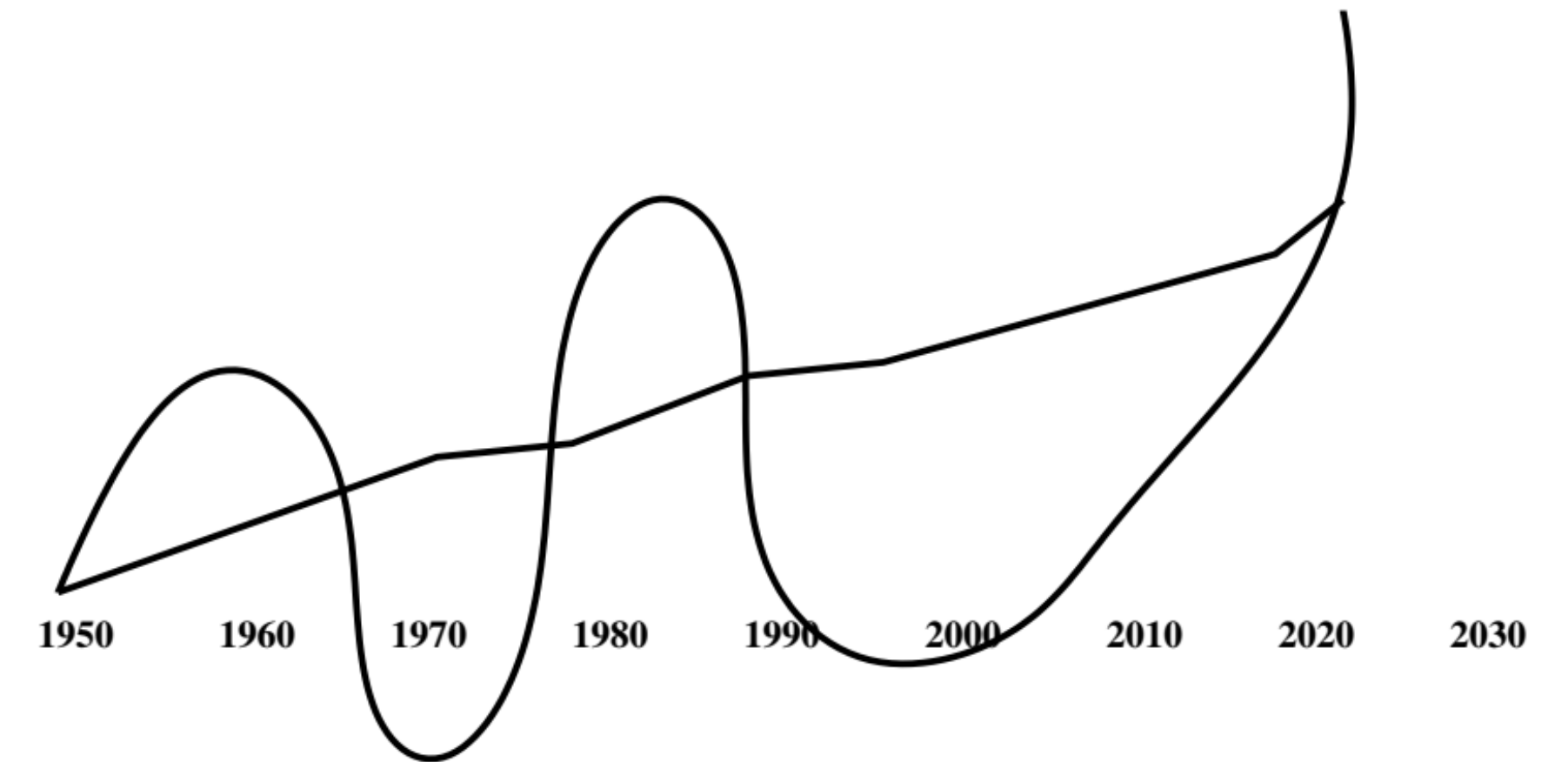
Advertisement

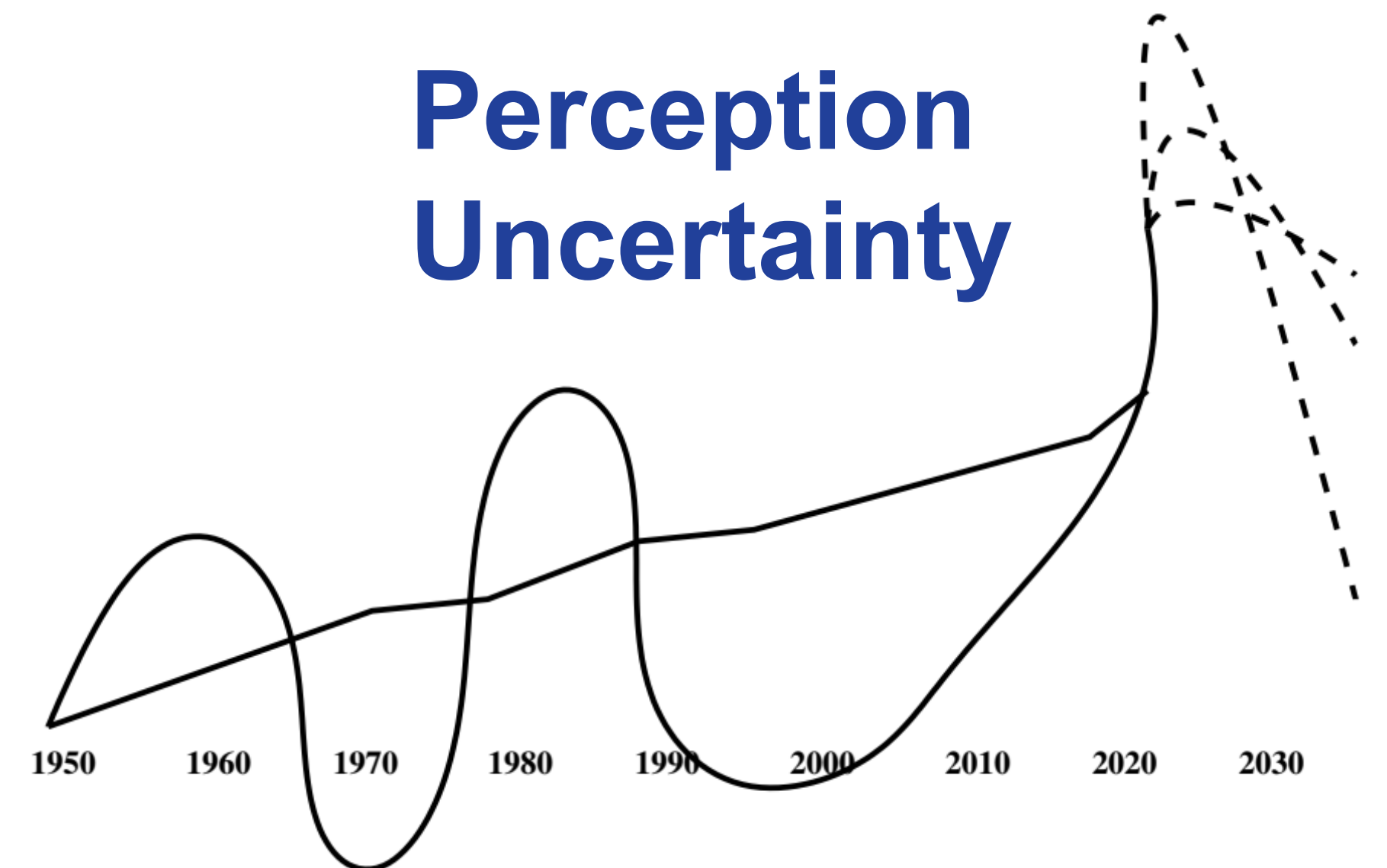MOST POPULAR ARTICLES
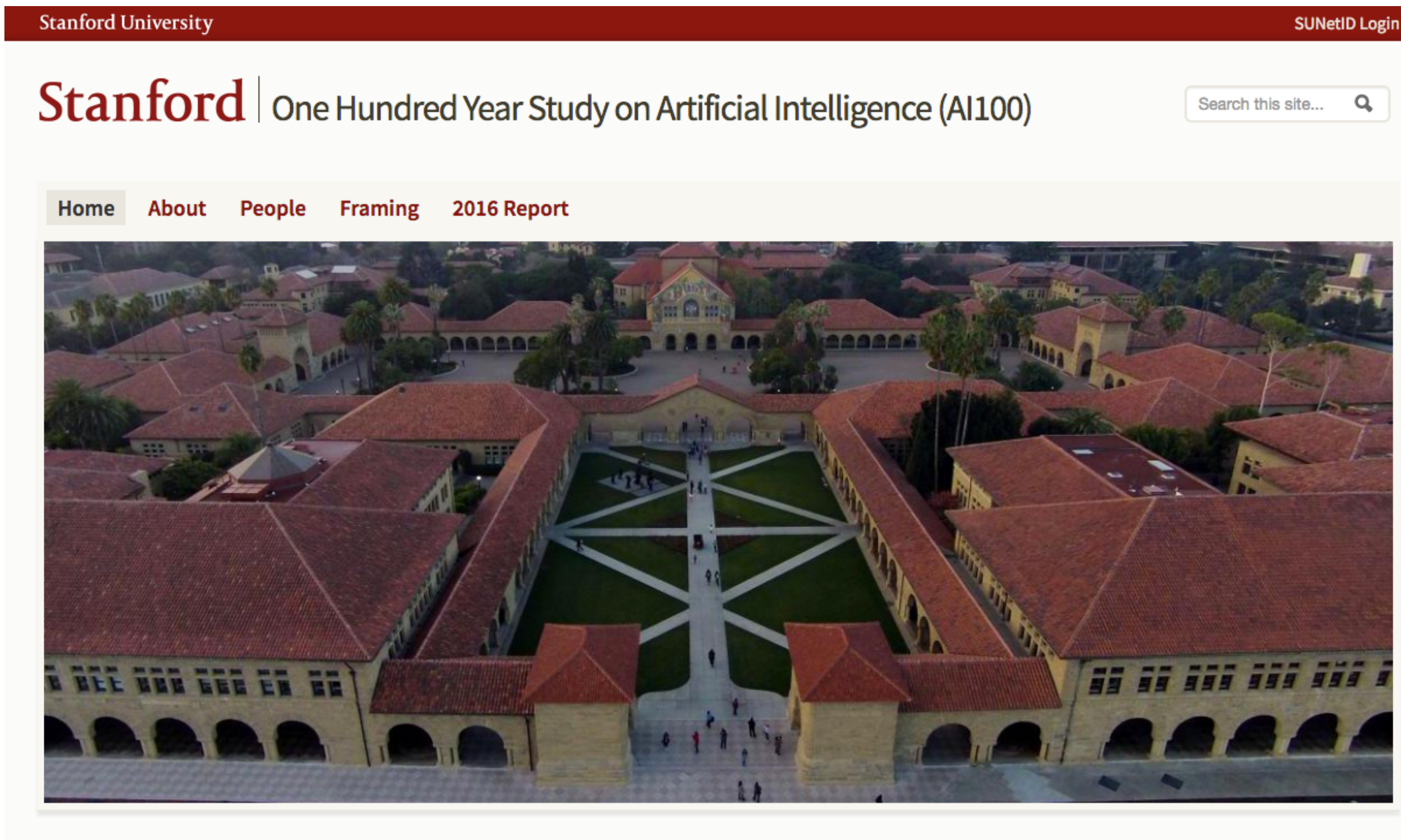
AI Hype

Reality
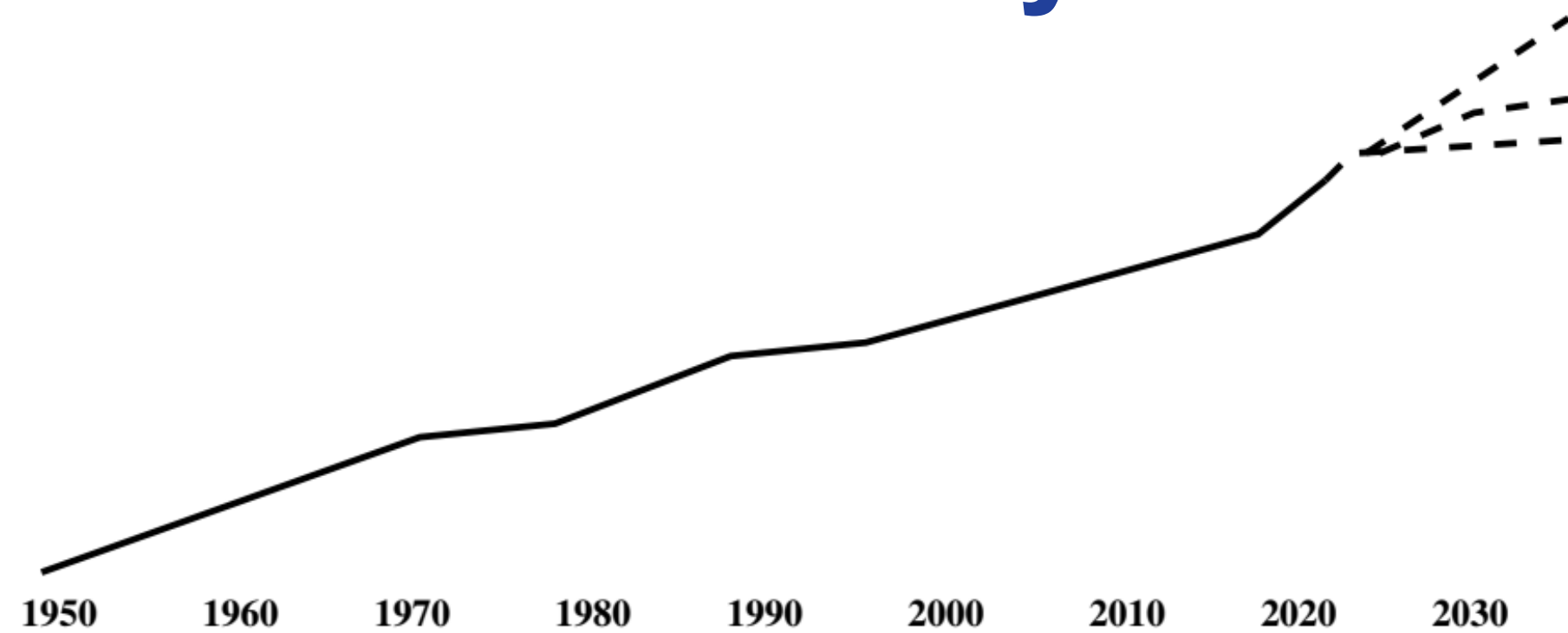
Perceptions

Uncertainty

Perception Uncertainty

A definition of AI

"Artificial Intelligence (AI) is a science and a set of computational technologies that are inspired by — but typically operate quite differently from — the ways people use their nervous systems and bodies to sense, learn, reason, and take action."

Your Reactions

- **Self-driving cars not yet widely adopted** (Madeline Huang)
- **Bias may be unavoidable in data and usage** (Winnie Chang)
- **No mention of implicit bias leaking into systems** (Esther Yeum)
- **No oath for software engineers** (Ramya Prasad)
- **Policy recommendations not actionable** (Shrivastava Shankar)
- **Musk/Hawking predictions of AI getting out of control vs. "…there is no race of superhuman robots on the horizon or probably even possible."** (Daniel Deng)
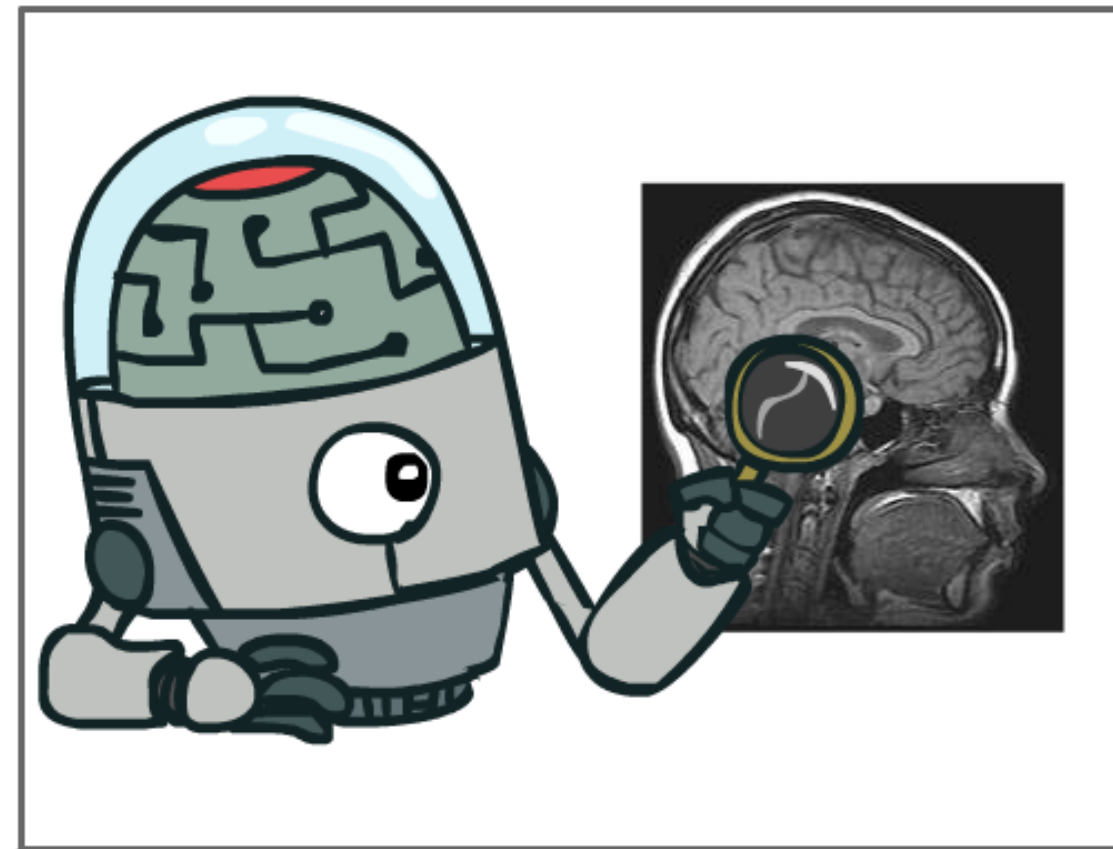
What is AI?

The science of making machines that:
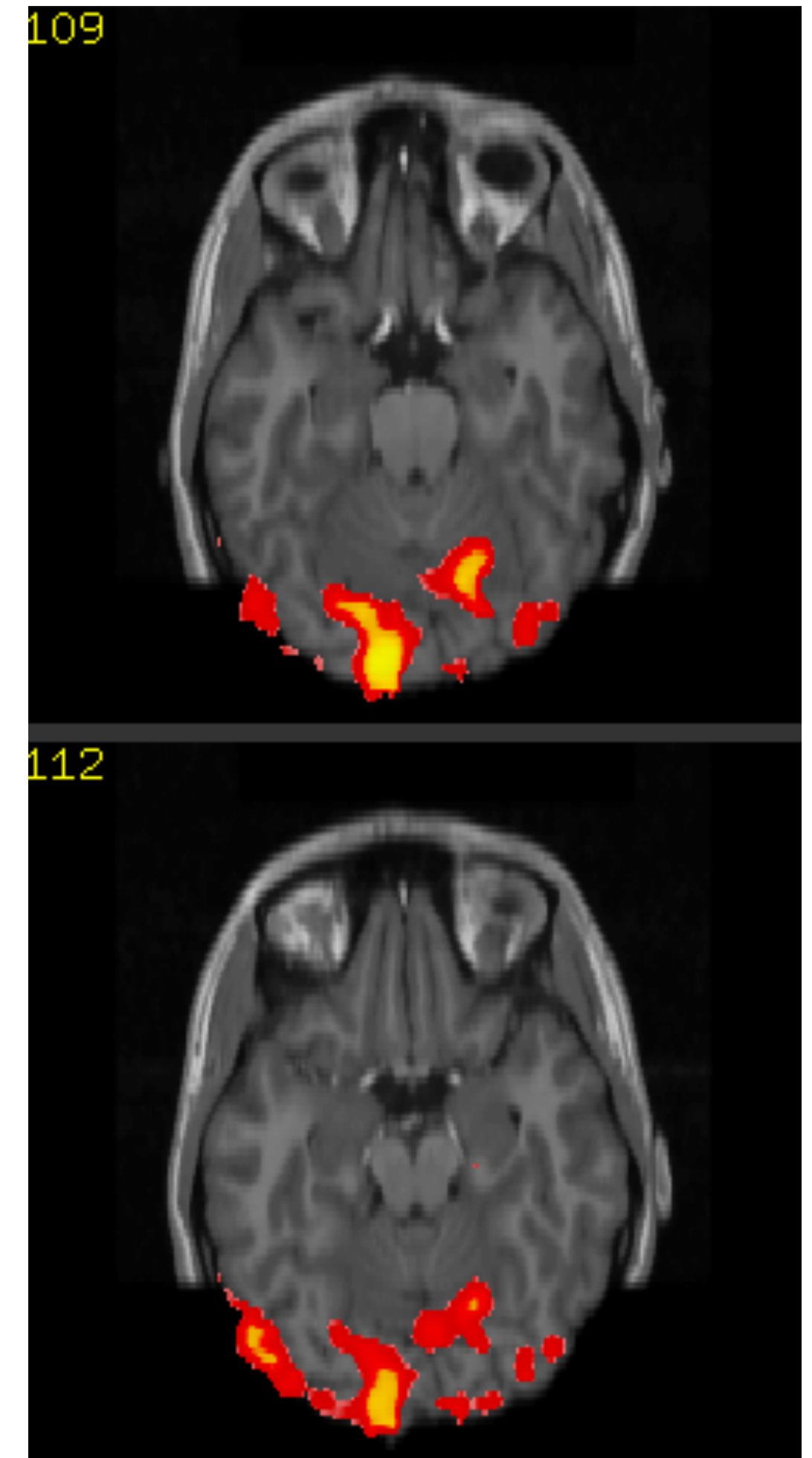
What is AI?

The science of making machines that:

Think like people

Thinking Like Humans?

- The cognitive science approach:
  - 1960s ``cognitive revolution'': information-processing psychology replaced prevailing orthodoxy of behaviorism (reflexive behaviors, classical conditioning, etc.)
- Scientific theories of internal activities of the brain
  - What level of abstraction? "Knowledge'' or "circuits"?
  - **Cognitive science:** Predicting and testing behavior of human subjects (top-down)
  - **Cognitive neuroscience:** Direct identification from neurological data (bottom-up)
  - Both approaches now distinct from AI
  - Both share with AI the following characteristic:
  The available theories do not explain (or engender) anything resembling human-level general intelligence
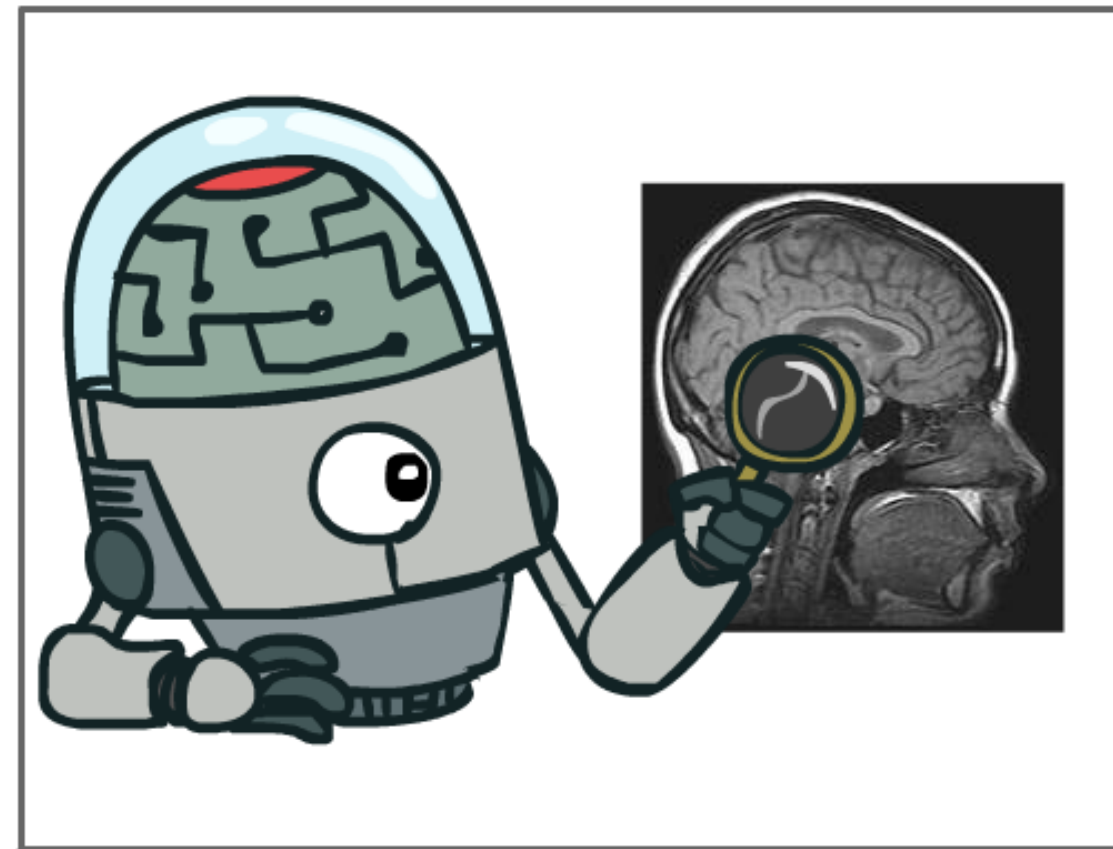

Images from Oxford fMRI center

What is AI?
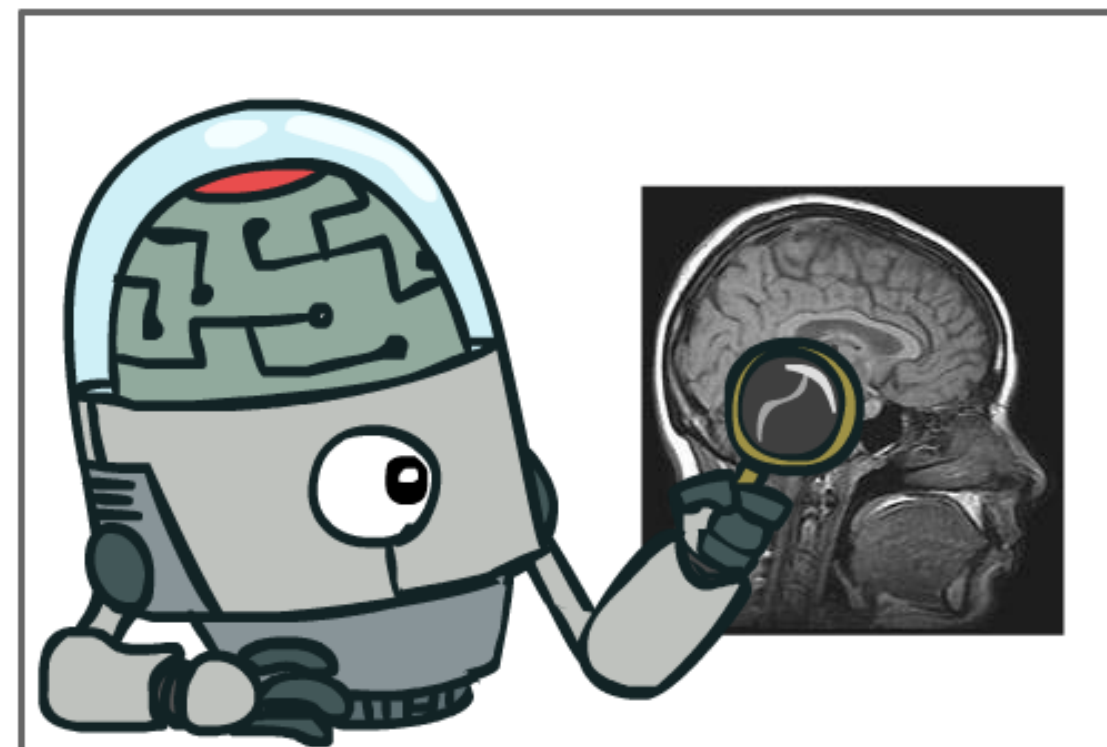
The science of making machines that:
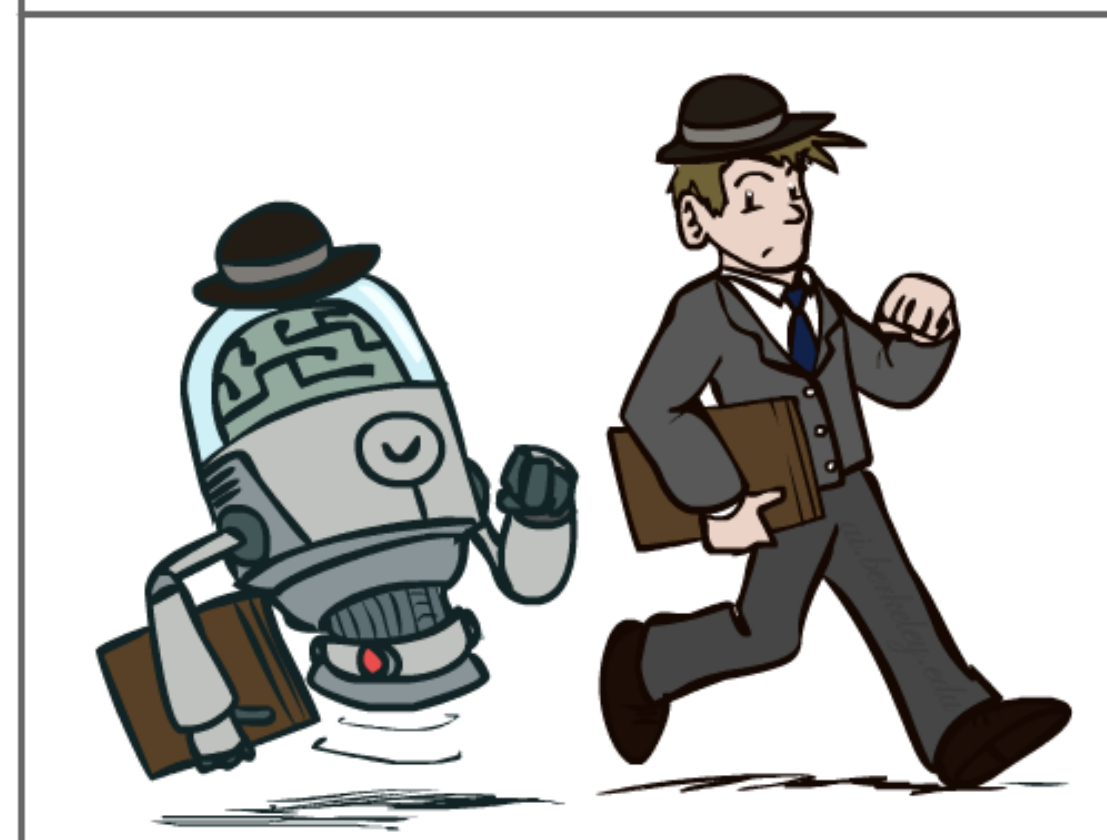
Think like people

What is AI?

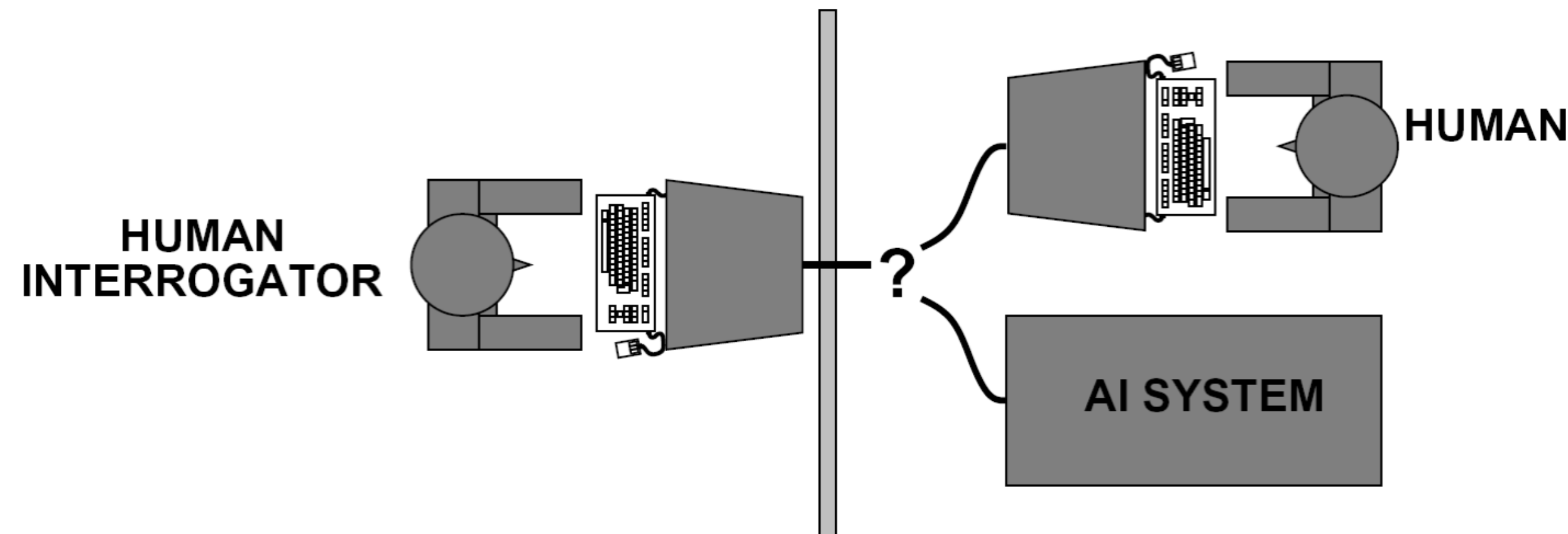The science of making machines that:

Think like people

Act like people

Acting Like Humans?

- Turing (1950) "Computing machinery and intelligence"
  - "Can machines think?" $\rightarrow$ "Can machines behave intelligently?"
  - Operational test for intelligent behavior: the *Imitation Game*
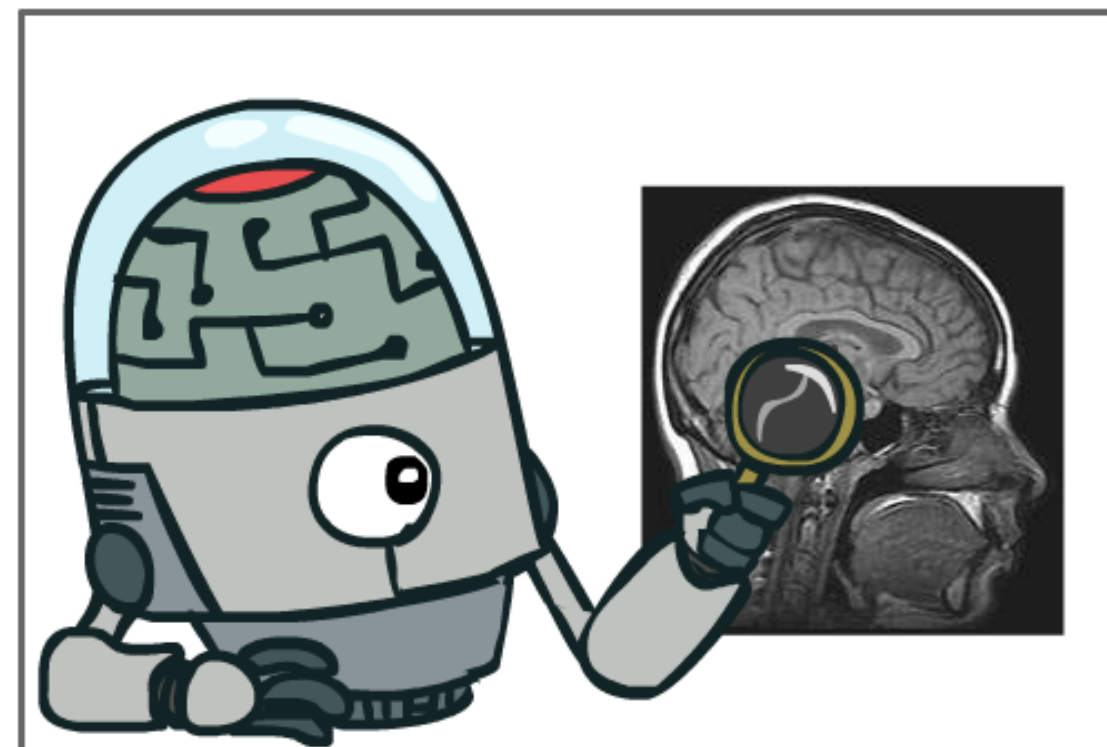

  - Predicted by 2000, a 30% chance of fooling a lay person for 5 minutes
  - Anticipated all major arguments against AI in following 50 years
  - Suggested major components of AI: knowledge, reasoning, language understanding, learning
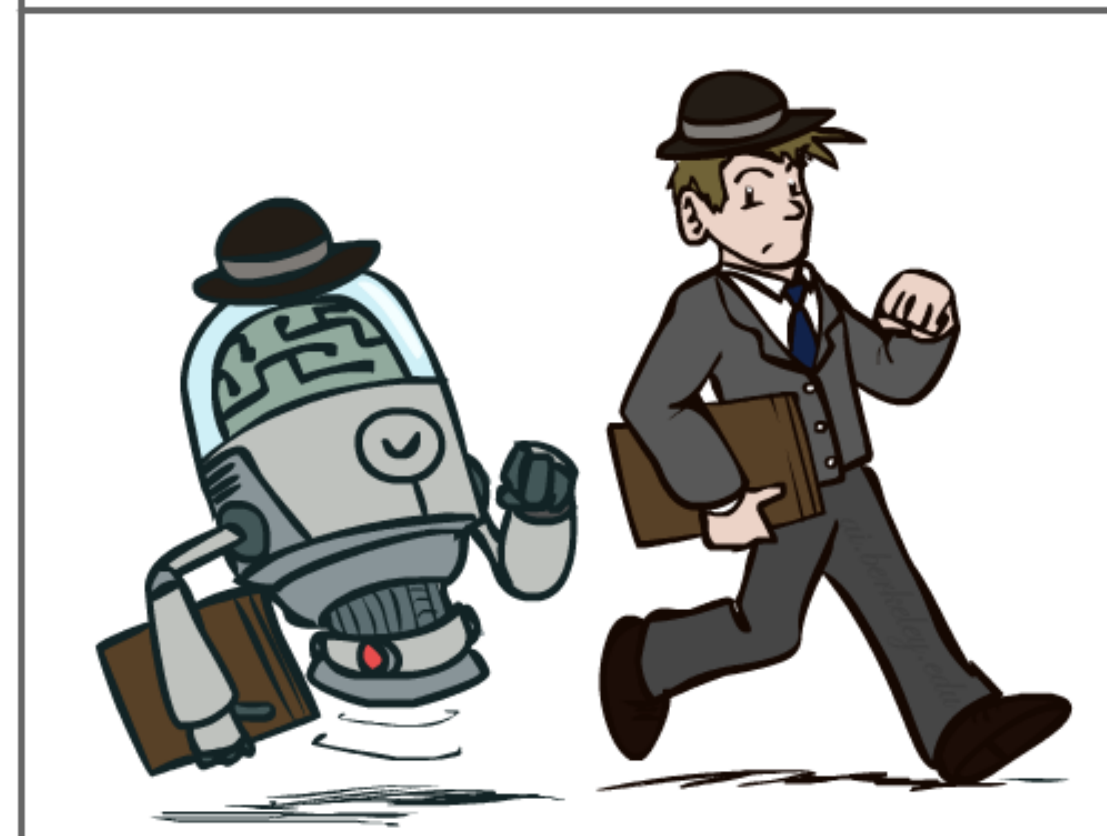- Problem: Turing test is not reproducible or amenable to mathematical analysis

What is AI?

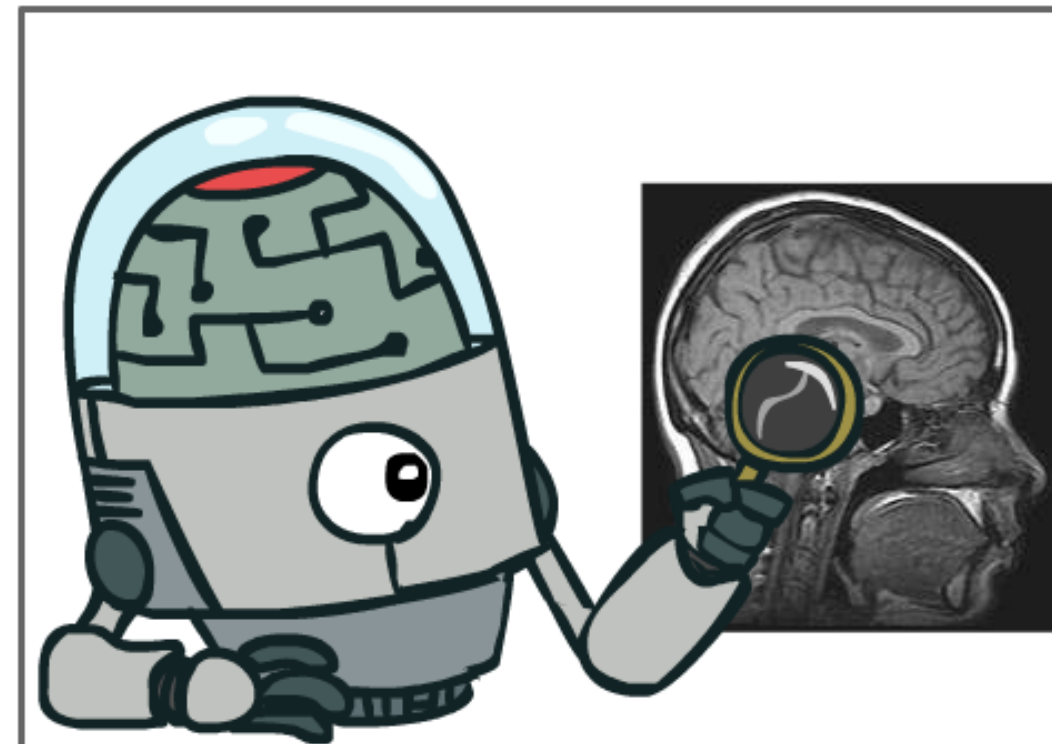The science of making machines that:
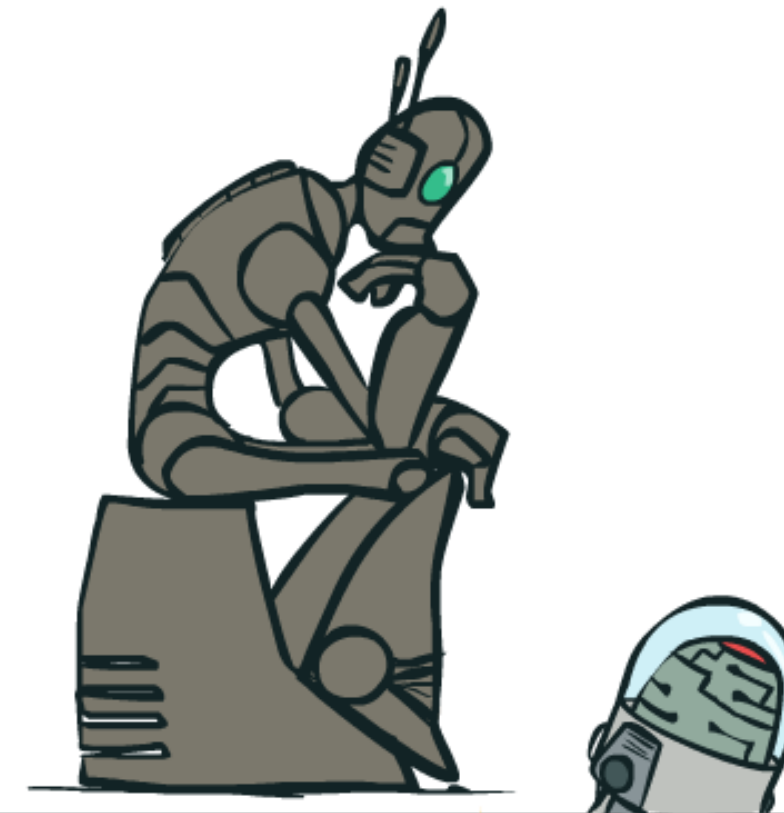
Think like people

Act like people

What is AI?

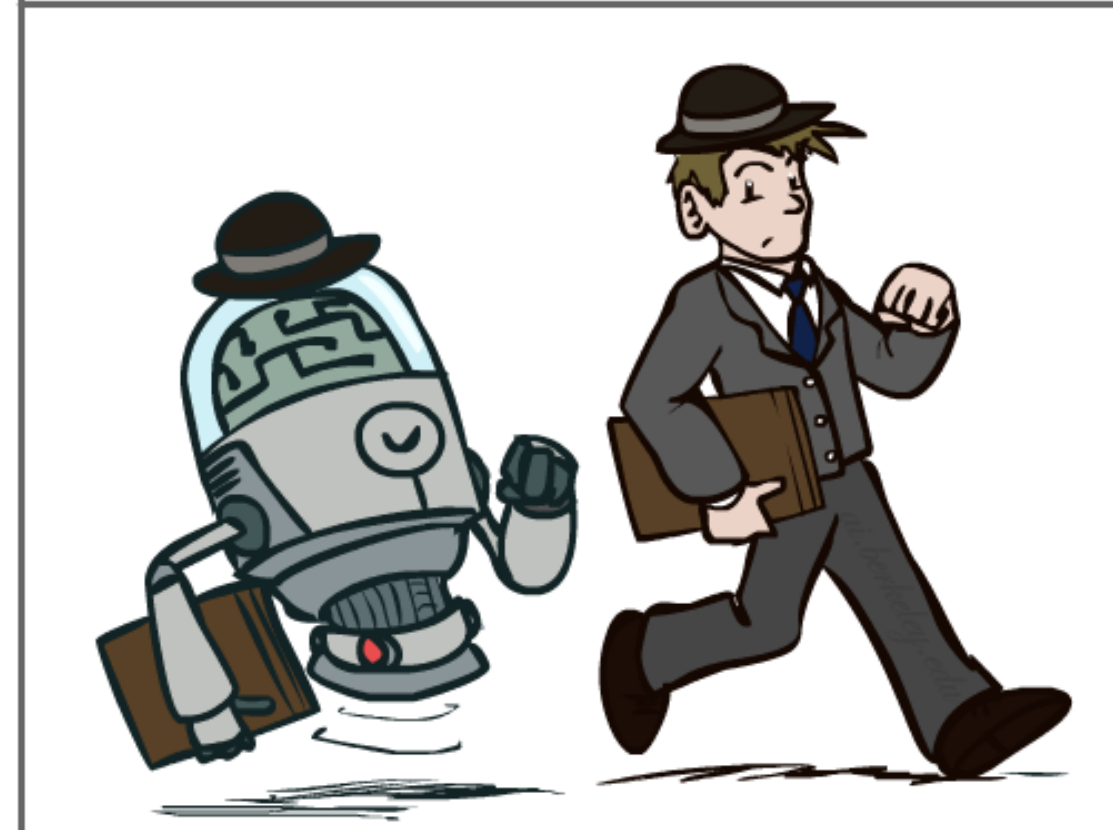The science of making machines that:

Think like people

Think rationally

Act like people
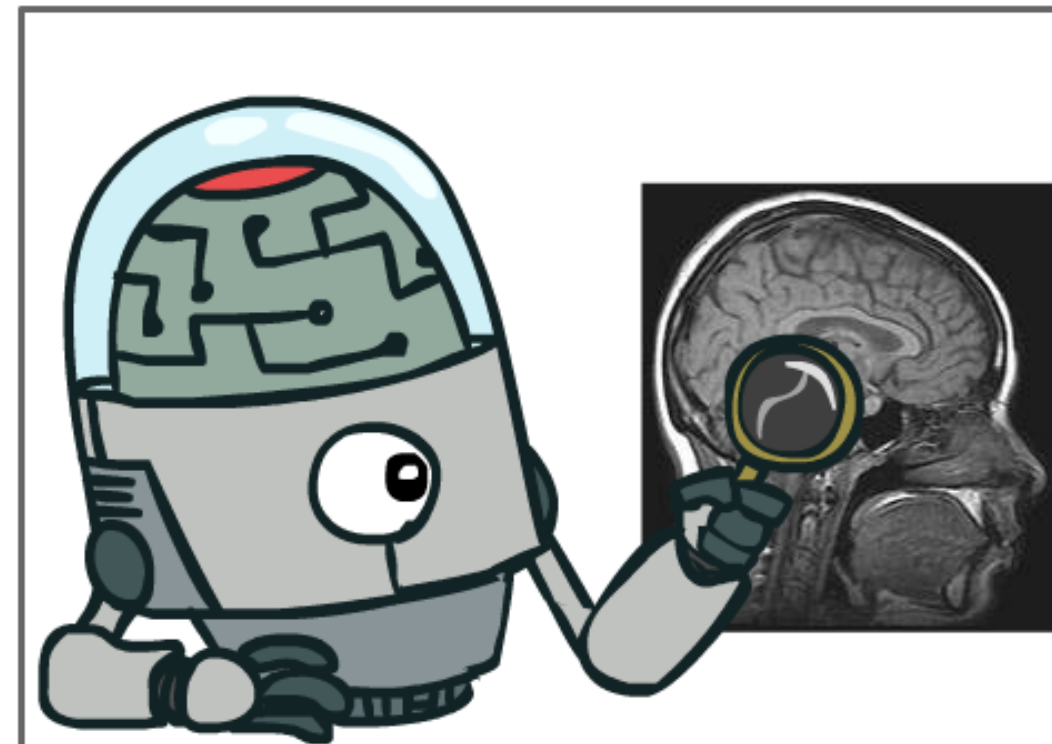
Thinking Rationally?

- **The "Laws of Thought" approach**
  - What does it mean to "think rationally"?
  - Normative / prescriptive rather than descriptive

- **Logicist tradition:**
  - Logic: notation and rules of derivation for thoughts
  - Aristotle: what are correct arguments/thought processes?
  - Direct line through mathematics, philosophy, to modern AI

- **Problems:**
  - Not all intelligent behavior is mediated by logical deliberation
  - What is the purpose of thinking? What thoughts should I (bother to) have?
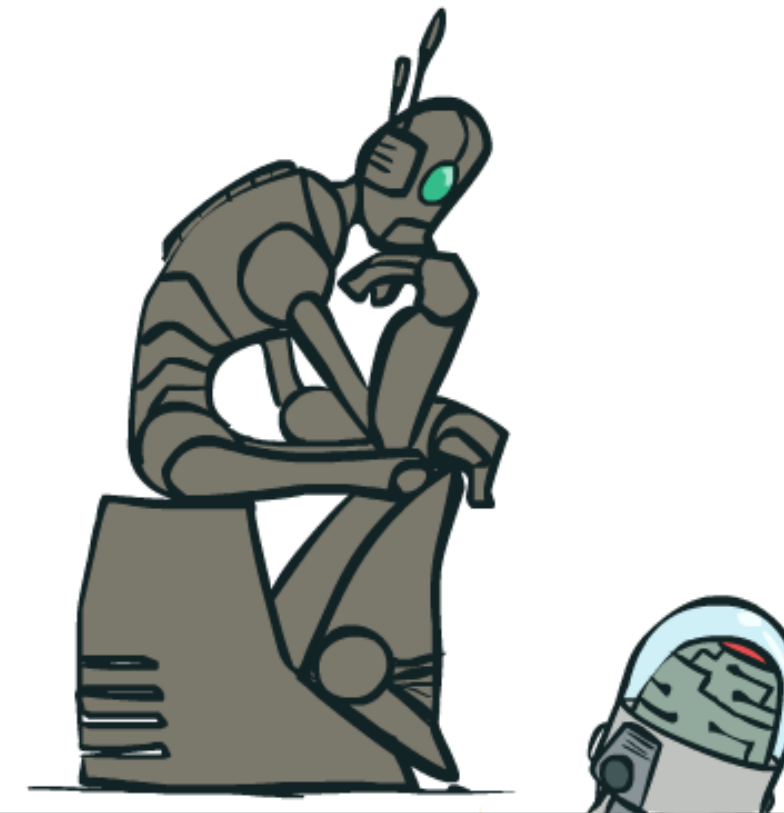 - Logical systems tend to do the wrong thing in the presence of **uncertainty**
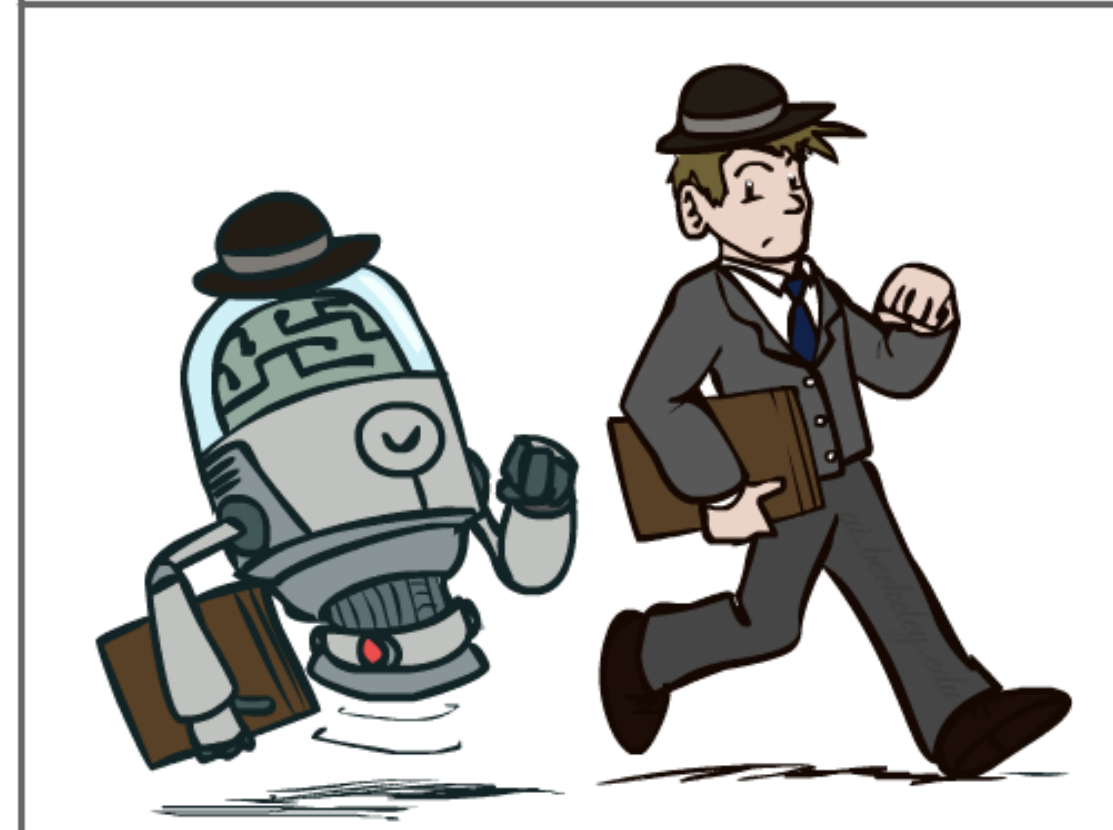
What is AI?

The science of making machines that:
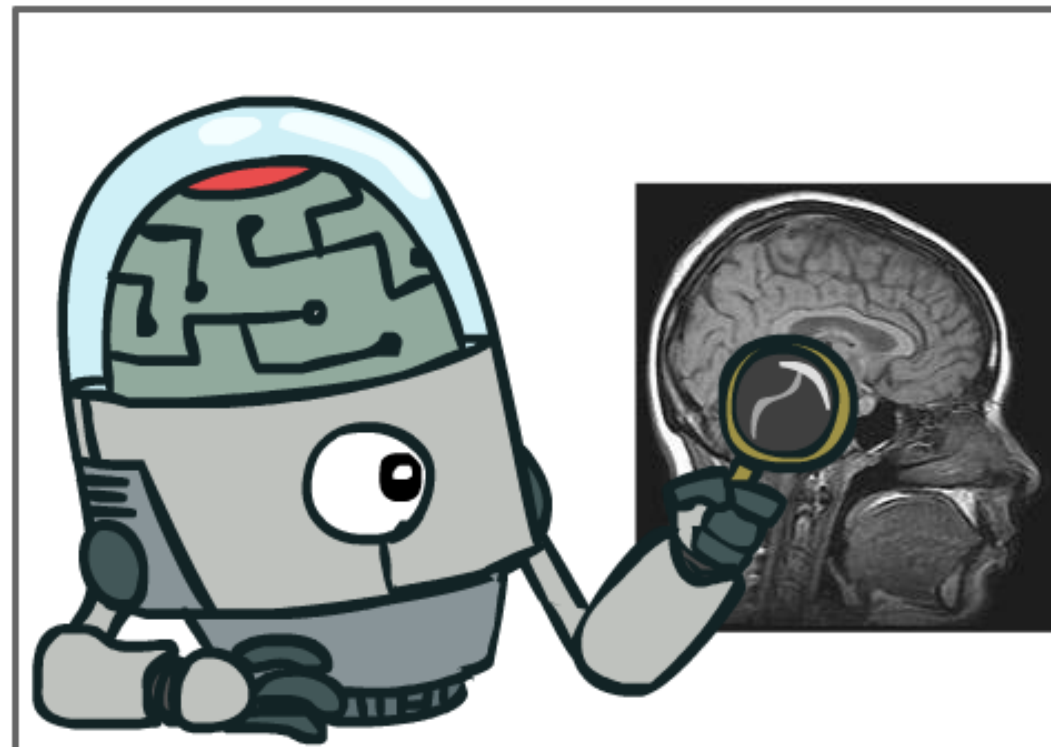
Think like people

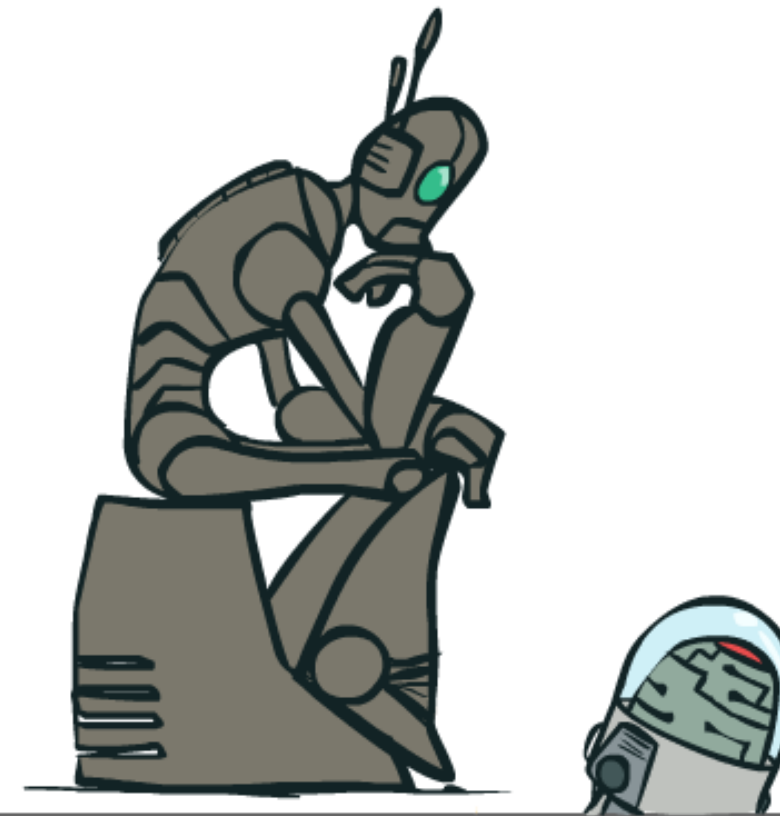Think rationally

Act like people

What is AI?

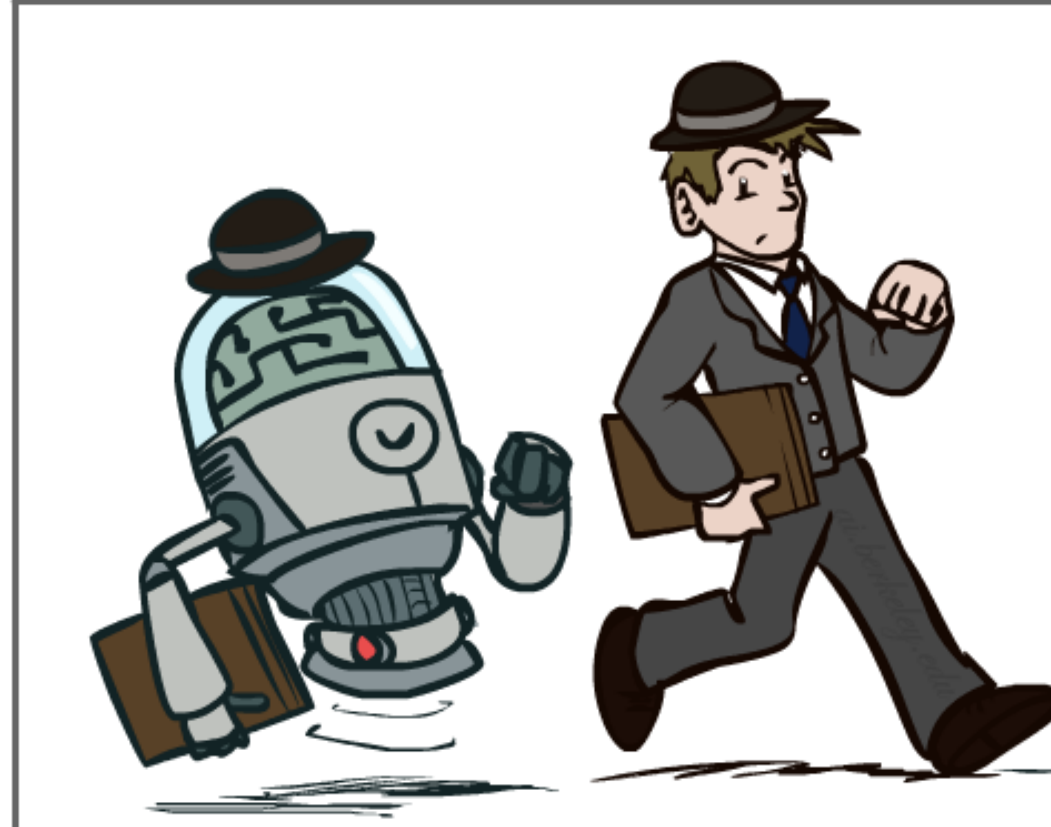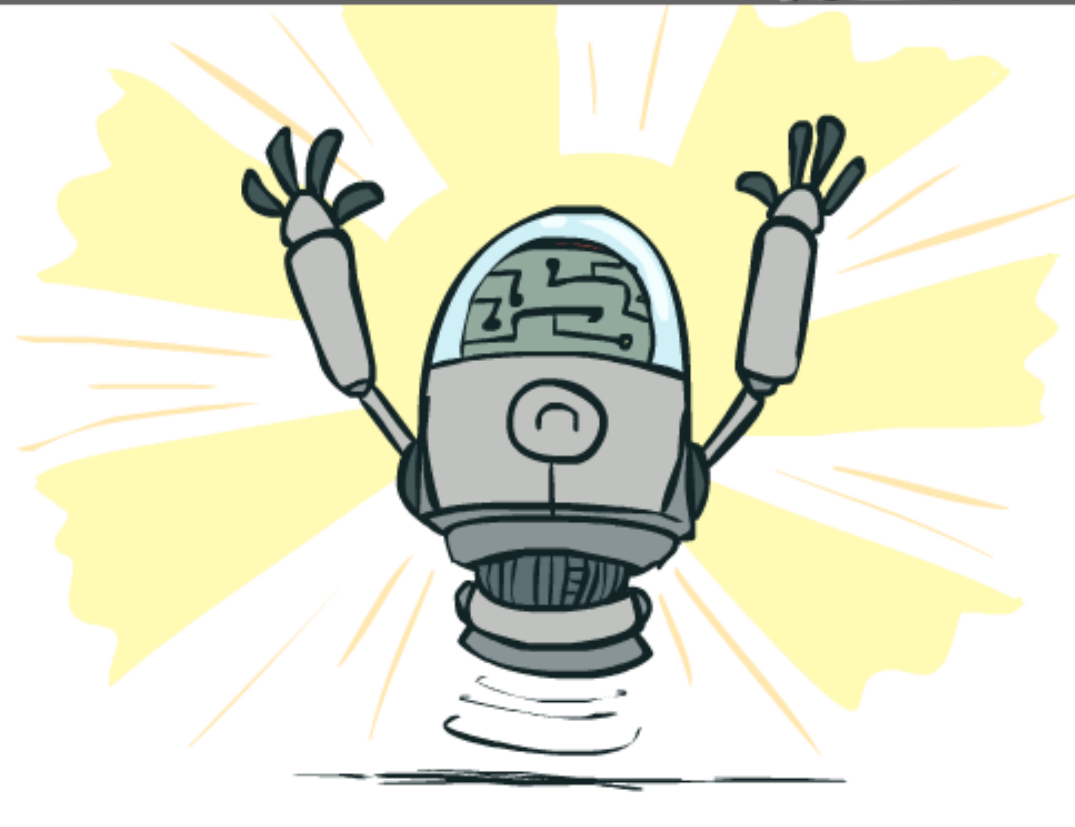The science of making machines that:

Think like people

Think rationally

Act like people

Act rationally

Acting Rationally

- Rational behavior: doing the "right thing"
  - The right thing: that which is expected to maximize goal achievement, given the available information
  - Doesn't necessarily involve thinking, e.g., blinking
  - Thinking can be in the service of rational action
  - Entirely dependent on goals!
  - Irrational ≠ insane, irrationality is sub-optimal action
  - Rational ≠ successful

- Our focus here: rational agents
  - Systems which make the best possible decisions given goals, evidence, and constraints
  - In the real world, usually lots of uncertainty
    - … and lots of complexity
  - Usually, we're just approximating rationality

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**

Another title for this course could be:

Computational Rationality

Maximize Your Expected Utility