Artificial Intelligence

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1410 Team

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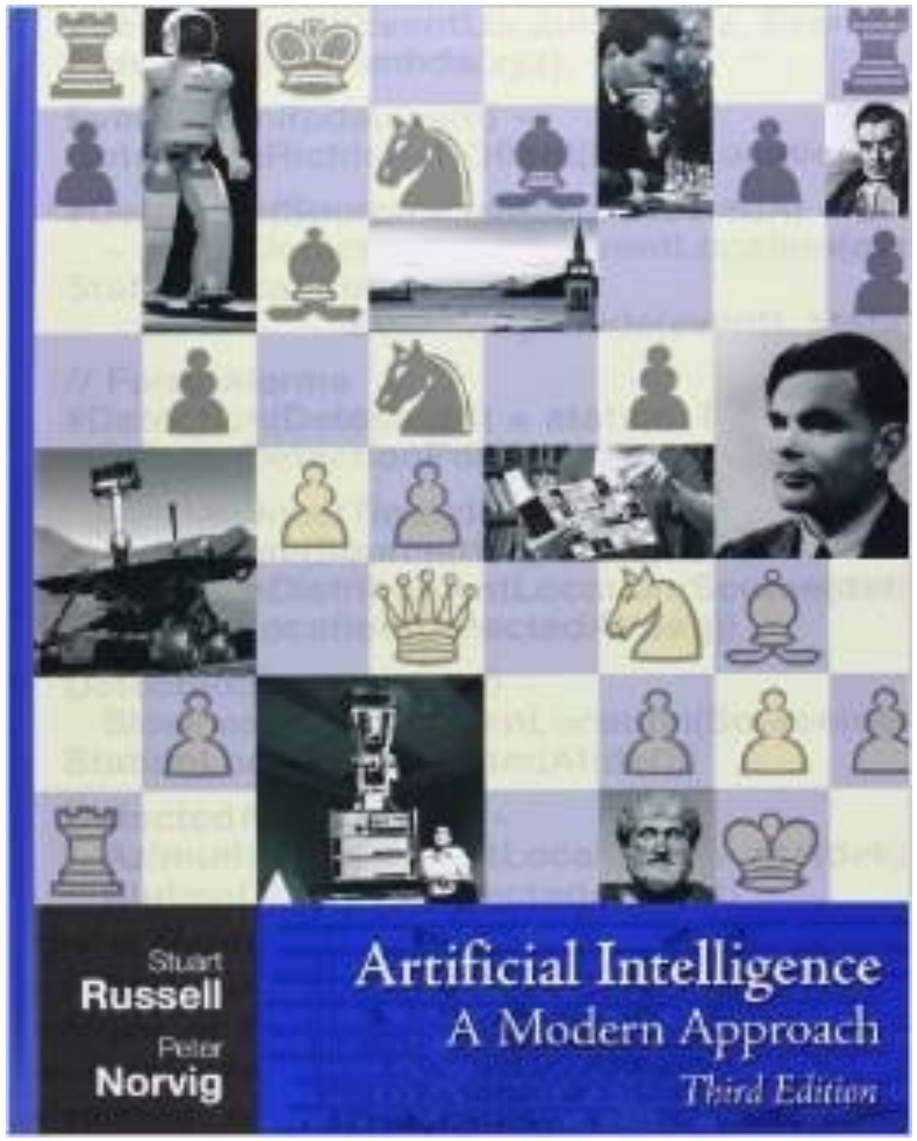
Major Topics Covered

Syllabus:

1. Agents and Agenthood
2. Search
   (a) Uninformed
   (b) Informed
   (c) Game Theory and Adversarial Search
3. Knowledge Representation and Reasoning
   (a) Logical Representations: Reasoning and Inference
   (b) Uncertain Knowledge
      i. Bayes' Rule
      ii. Probabilistic Reasoning
      iii. Bayes Nets
      iv. Hidden Markov Models
4. Planning
   (a) Classical Planning
   (b) Robot Motion Planning
   (c) Planning Under Uncertainty: Markov Decision Processes
5. Learning
   (a) Reinforcement Learnng
   (b) Supervised Learning
   (c) Unsupervised Learning
6. Advanced Topics
   (a) Natural Language Processing
   (b) Machine Vision
   (c) Robot Learning
   (d) Algorithmic Game Theory
7. Philosophy of AI
8. Social and Ethical Issues

Required Text

Artificial Intelligence, A Modern Approach
Russell & Norvig, **3rd** Edition.



On Lectures

The textbook contains everything you need to know.

Lectures contain everything you need to know.

Lecture notes **do not contain everything you need to know**.

Suggested approach:

- Come to lectures and pay attention.
- Revise via textbook (immediately).
- Clarify at office hours.

Logistics

Course webpage:
http://cs.brown.edu/courses/cs141/

- Syllabus
- Calendar - **office hours!**
- Assignments etc.

Written assignments and grades etc. via Gradescope
Comms (Q&A, announcements) via EdStem Discussion
Make sure to sign up!

Questions

EdStem: Quick question, or question many people may want to know the answer to.

Office Hours: Assignment and coding questions, material covered in lectures.

Grading

Six assignments

- 75% of grade.
- Python programming + report
- Generally 1-2 weeks long

Extended project: 25%.

Note: basic numpy/Python workshop on Monday from 5-6pm in Motorola.

Academic Honesty

I expect all Brown students to conduct themselves with the highest integrity, according to the *Brown Academic Code*.

It is OK to:

- Have high-level discussions.
- Google for definitions and background.

It is NOT OK TO:

- Hand in anyone else's **code**, or **work**, in part or in whole.
- Google for solutions.

ALWAYS HAND IN YOUR OWN WORK.

Academic Honesty

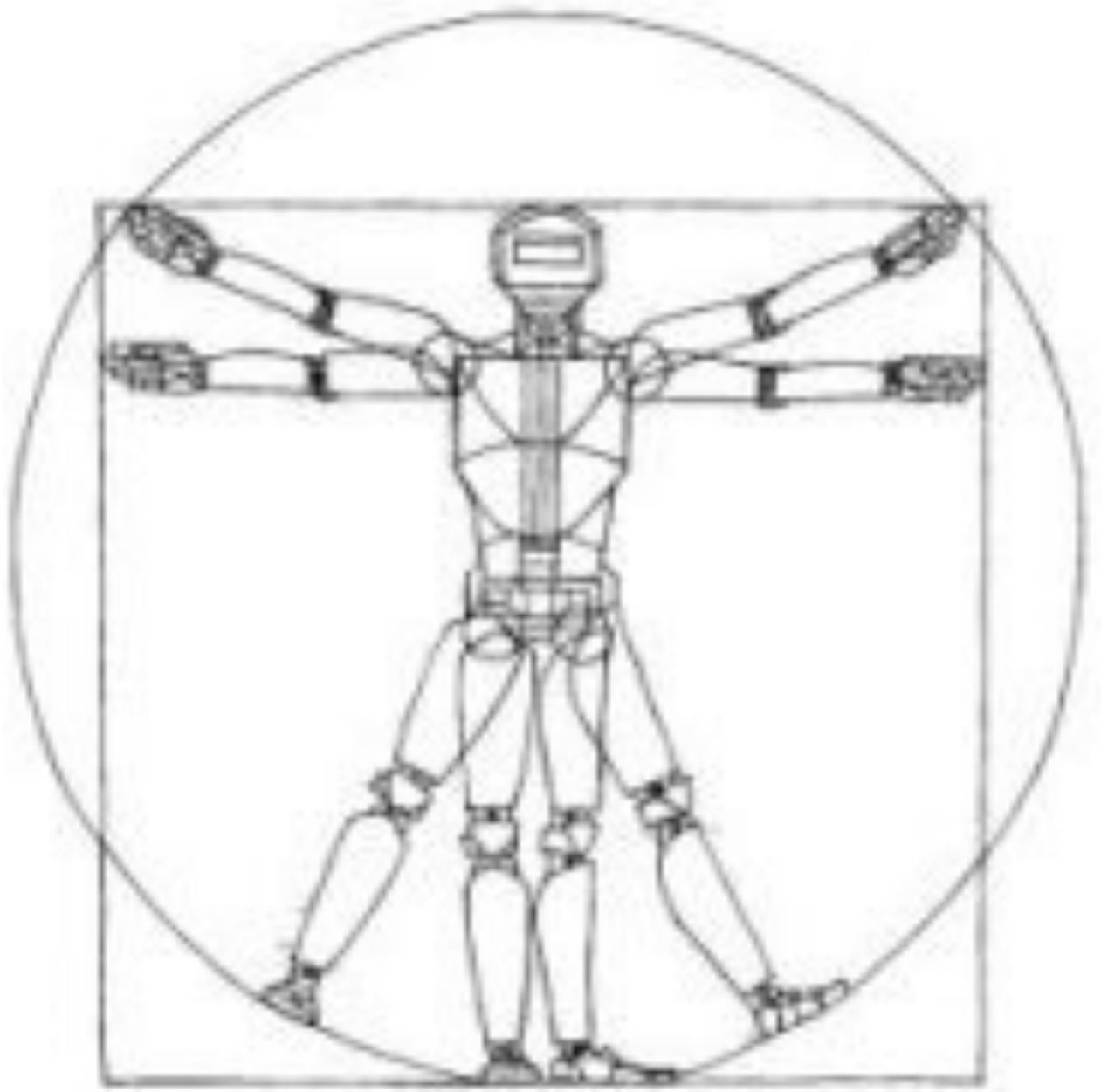
Consequences of cheating:

- Your case will be reported.
- Possible consequences include zeros on the assignment, suspension, failure to graduate, retraction of job offers.

If I catch you I **<u>will</u>** refer you to the Office of Student Conduct, and I **<u>will</u>** push for a hearing with the Standing Committee.

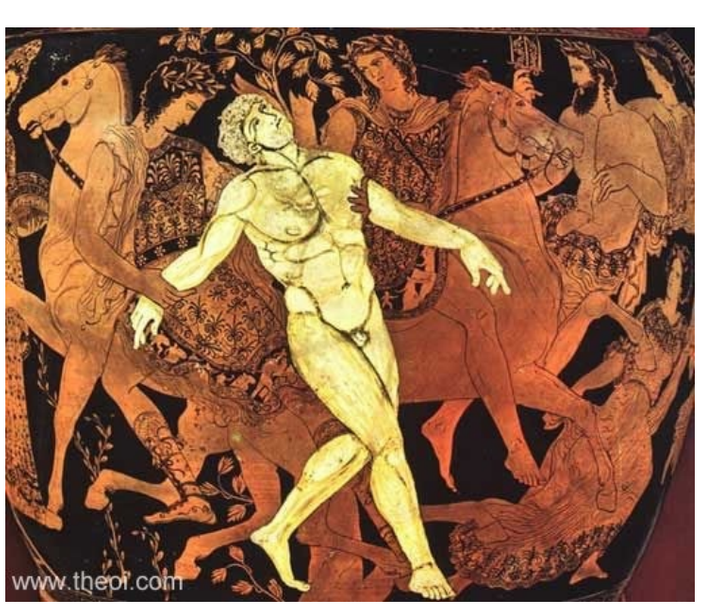
<u>DO NOT CHEAT.</u>

AI

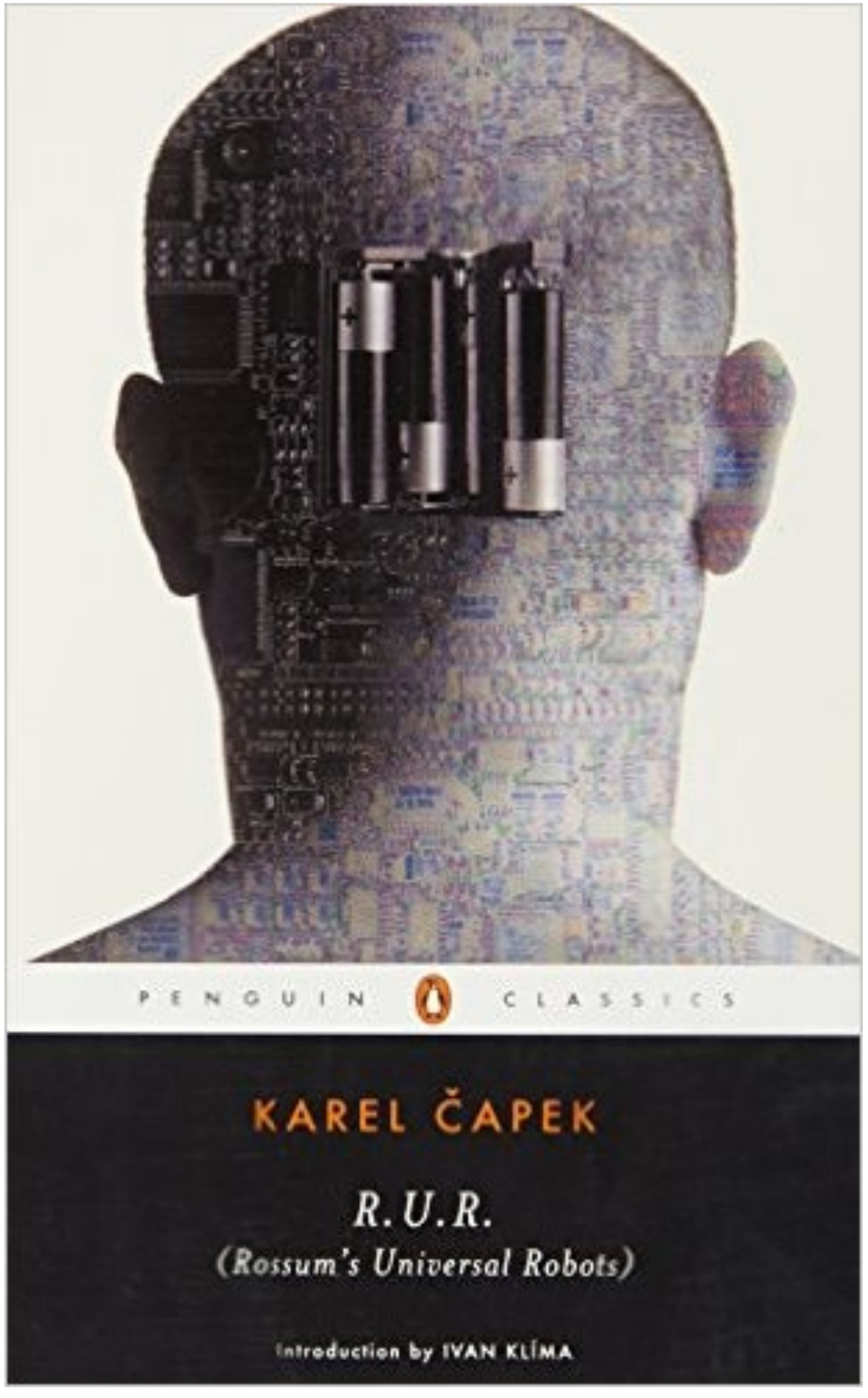


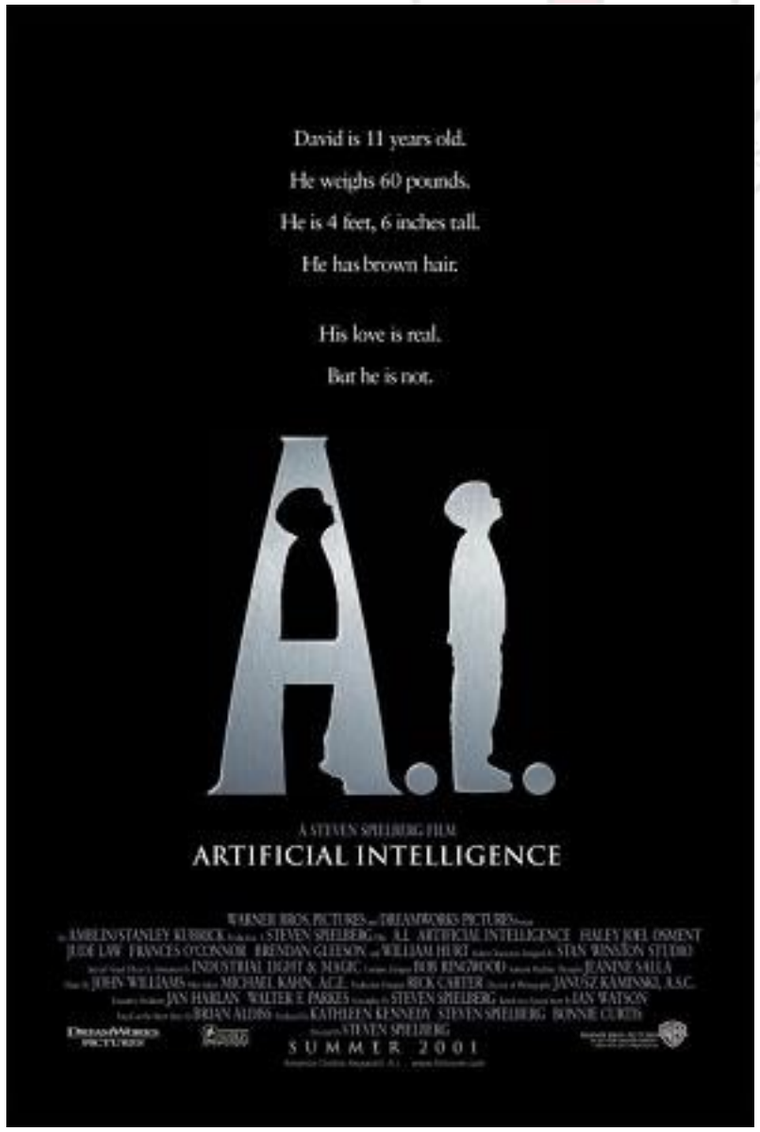
AI: The Very Idea

For as long as people have made machines, they have wondered whether machines could be made intelligent.

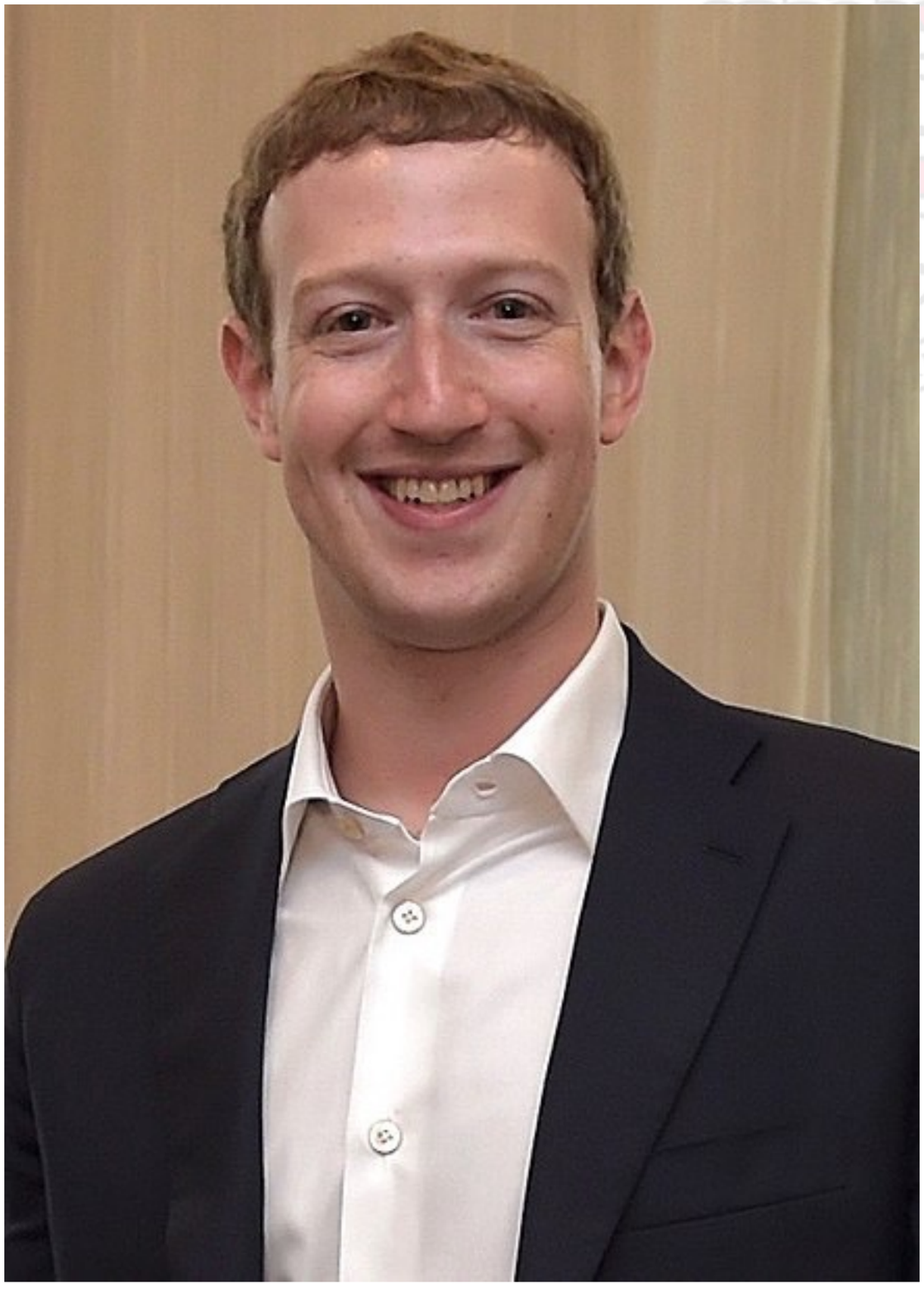


(pictures: Wikipedia)


PENGUIN CLASSICS
KAREL ČAPEK
R.U.R.
(Rossum's Universal Robots)
Introduction by IVAN KLÍMA



(pictures: Wikipedia)



Turing

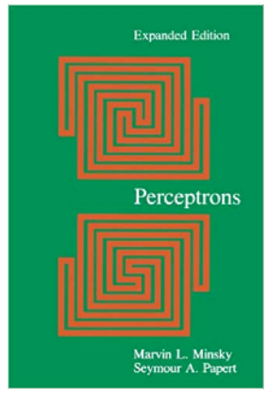
(picture: Wikipedia)

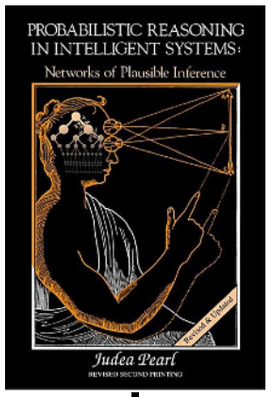
Computing machinery and intelligence. *Mind*, October 1950.

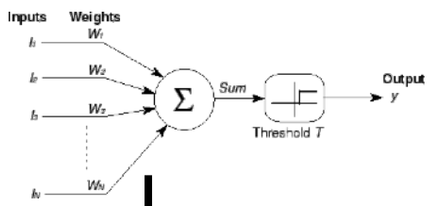
"Can machines think?"

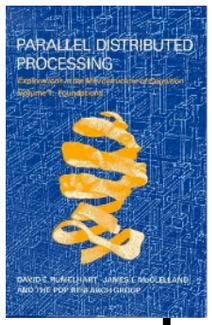
Dartmouth, 1956

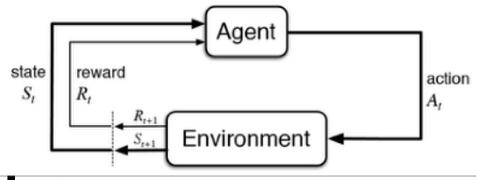
Trends











1940 1950 1960 1970 1980 1990 2000 2010 2020

Connectionism I

GOFAI

AI Winter

Connectionism II

Deep Learning
(C III)

Bayes

Reinforcement Learning

Modern AI

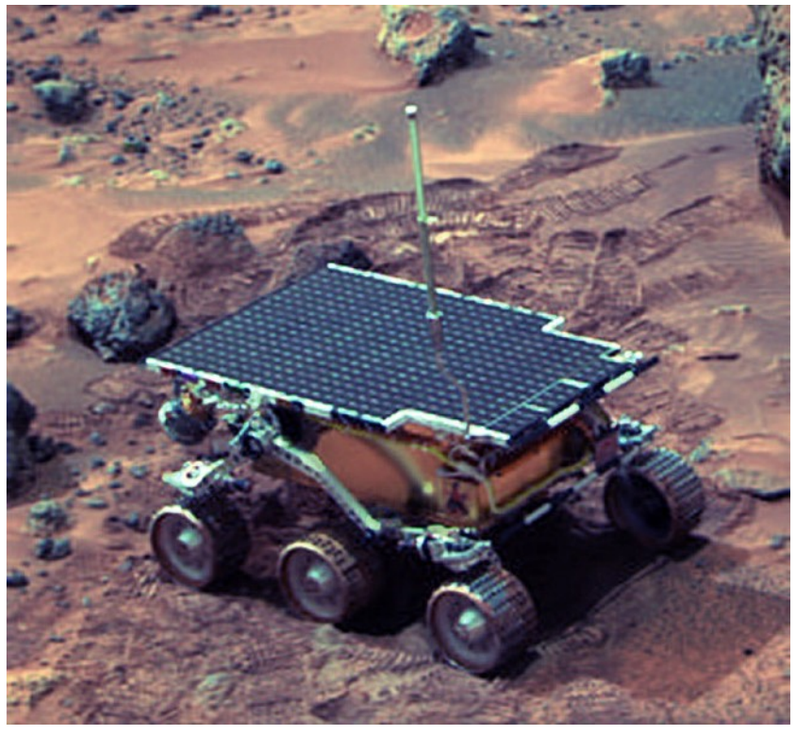
Subject of intense study:

- Nearly every CS department has at least 1 AI researcher.
- ~ 3000 PhDs a year in the US
- Tens of thousands of research papers written every year.

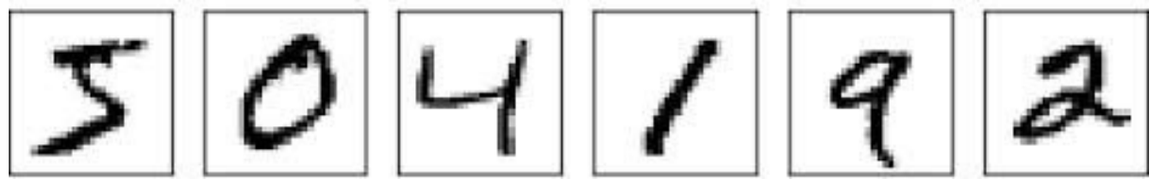
- Heavily funded (NSF, DARPA, EU, etc.).
  - Pays itself back fast (e.g., DART).

- Most major companies have efforts in this direction
  - Google,
  - Amazon
  - Microsoft, etc.

Modern AI



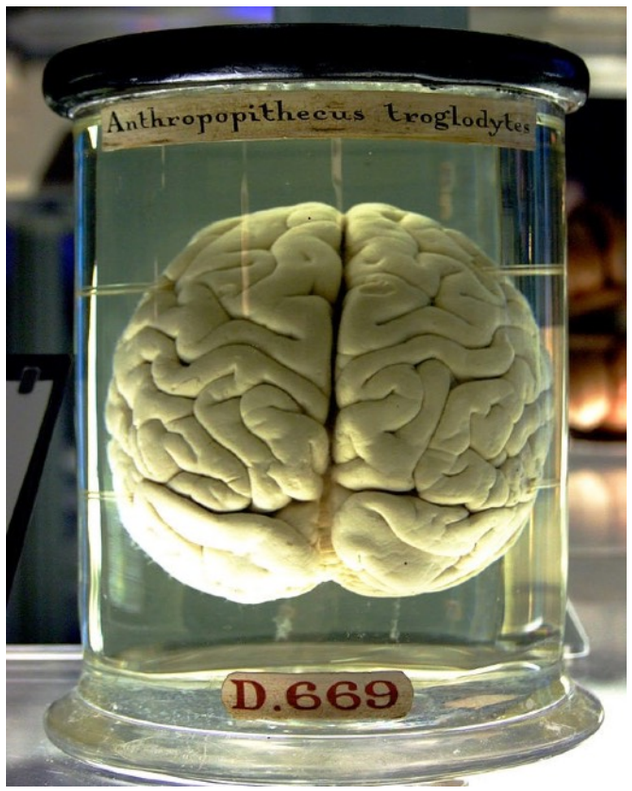
(picture: Wikipedia)



What *is* AI?

Fundamental Assumption

The brain is a computer.



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(picture: Wikipedia)

What is AI?

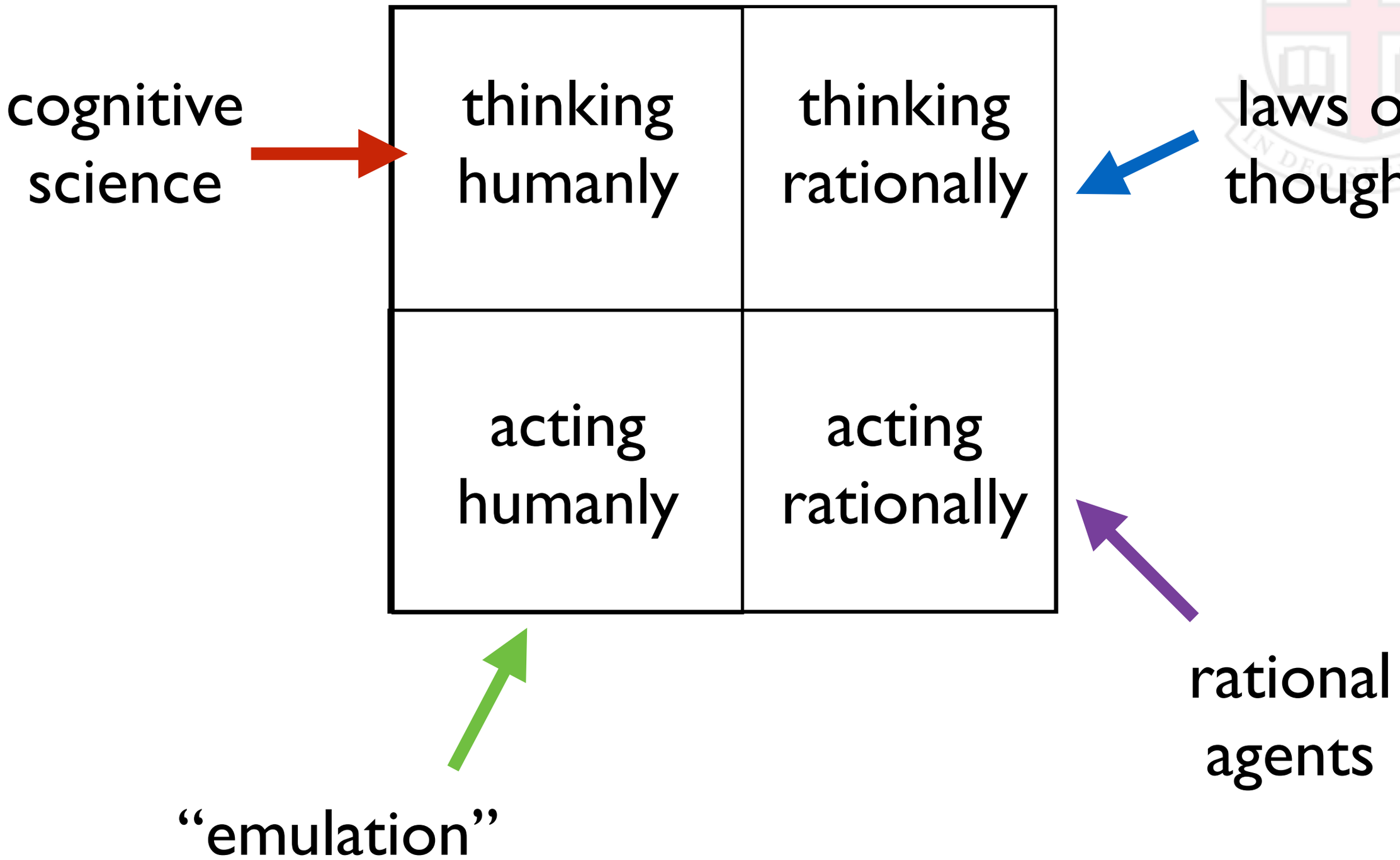
This turns out to be a hard question!

Two dimensions:

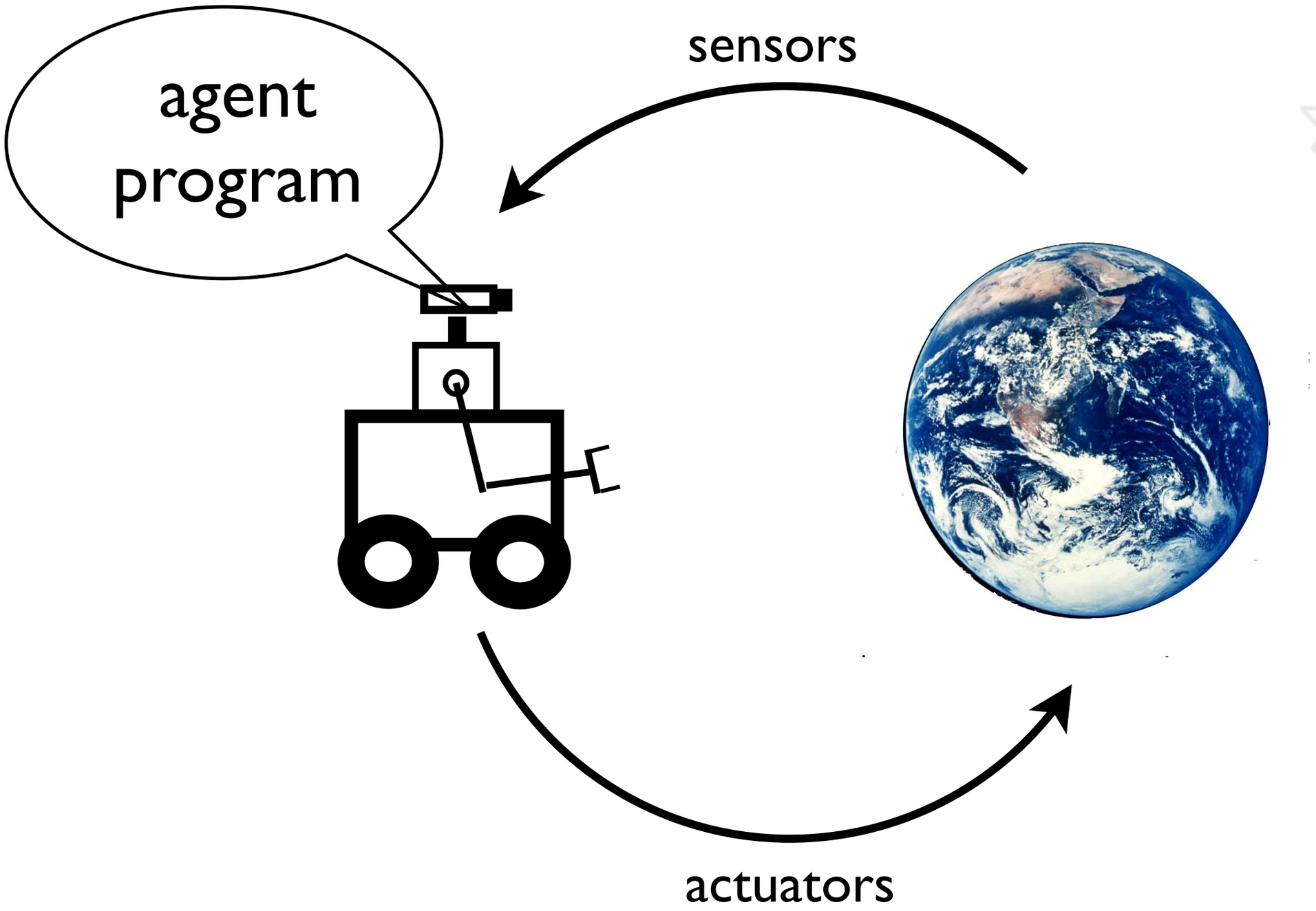
- "Humanly" vs "Rationally"
- "Thinking" vs. "Acting".

thinking humanly	thinking rationally
acting humanly	acting rationally

What is AI?

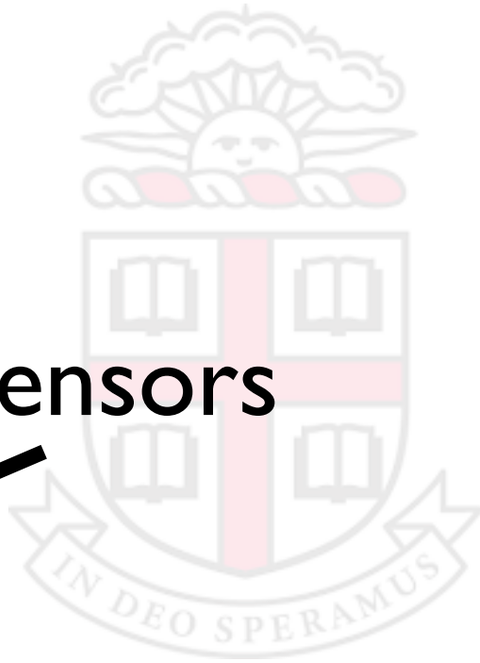

cognitive science
thinking humanly
thinking rationally
laws of thought
acting humanly
acting rationally
"emulation"
rational agents

What is a Rational Agent?



Performance measure.

Rational Agents



A rational agent:

- **acts in its environment**
- according to **what is has perceived**
- in order to **maximize**
- **its expected performance measure**.

actuators

sensors

agent program

given

Example: Chess

Performance measure?

Environment?

Prior knowledge?

Sensing?

Actions?

(picture: Wikipedia)

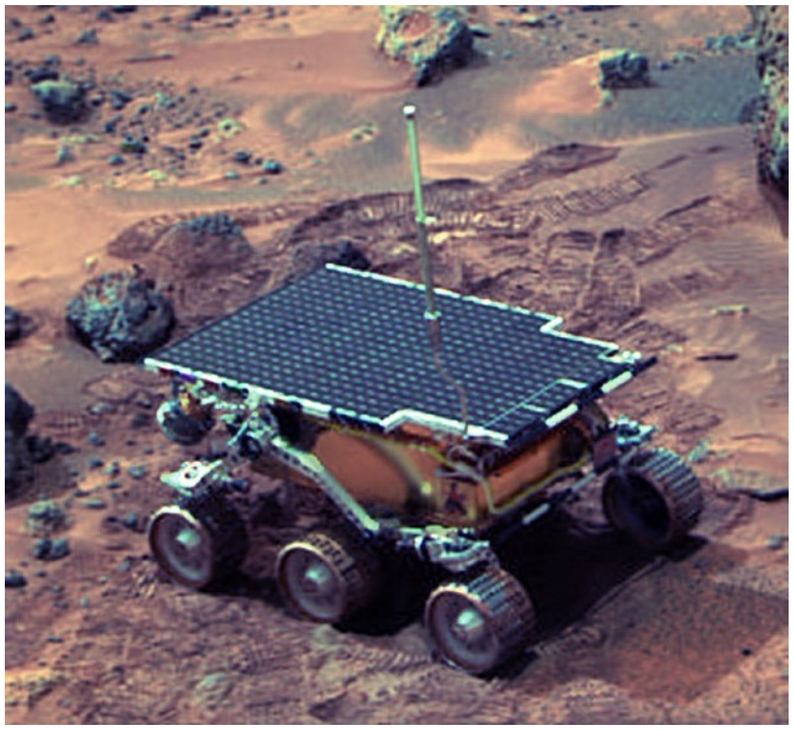
Chess

The chess environment is:

- Fully observable.
- Deterministic.
- Episodic.
- Static.
- Discrete.
- “Known”.

(picture: Wikipedia)

Example: Mars Rover



Performance measure?

Environment?

Prior knowledge?

Sensing?

Actions?

(picture: Wikipedia)

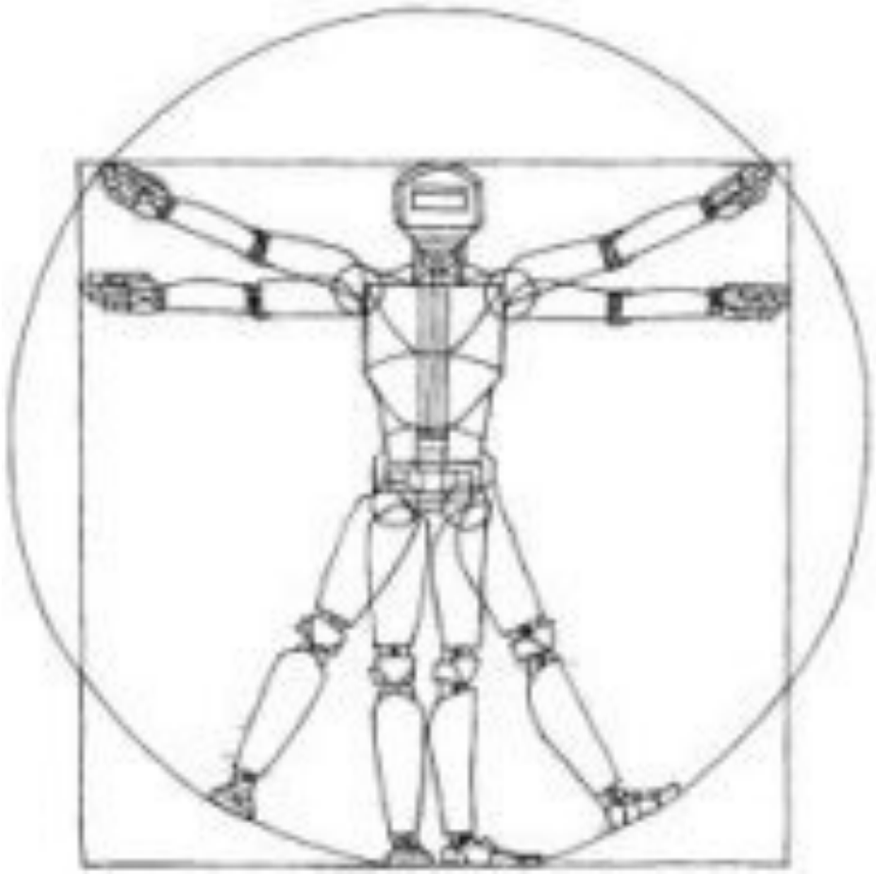
Mars Rover

The Mars Rover environment is:

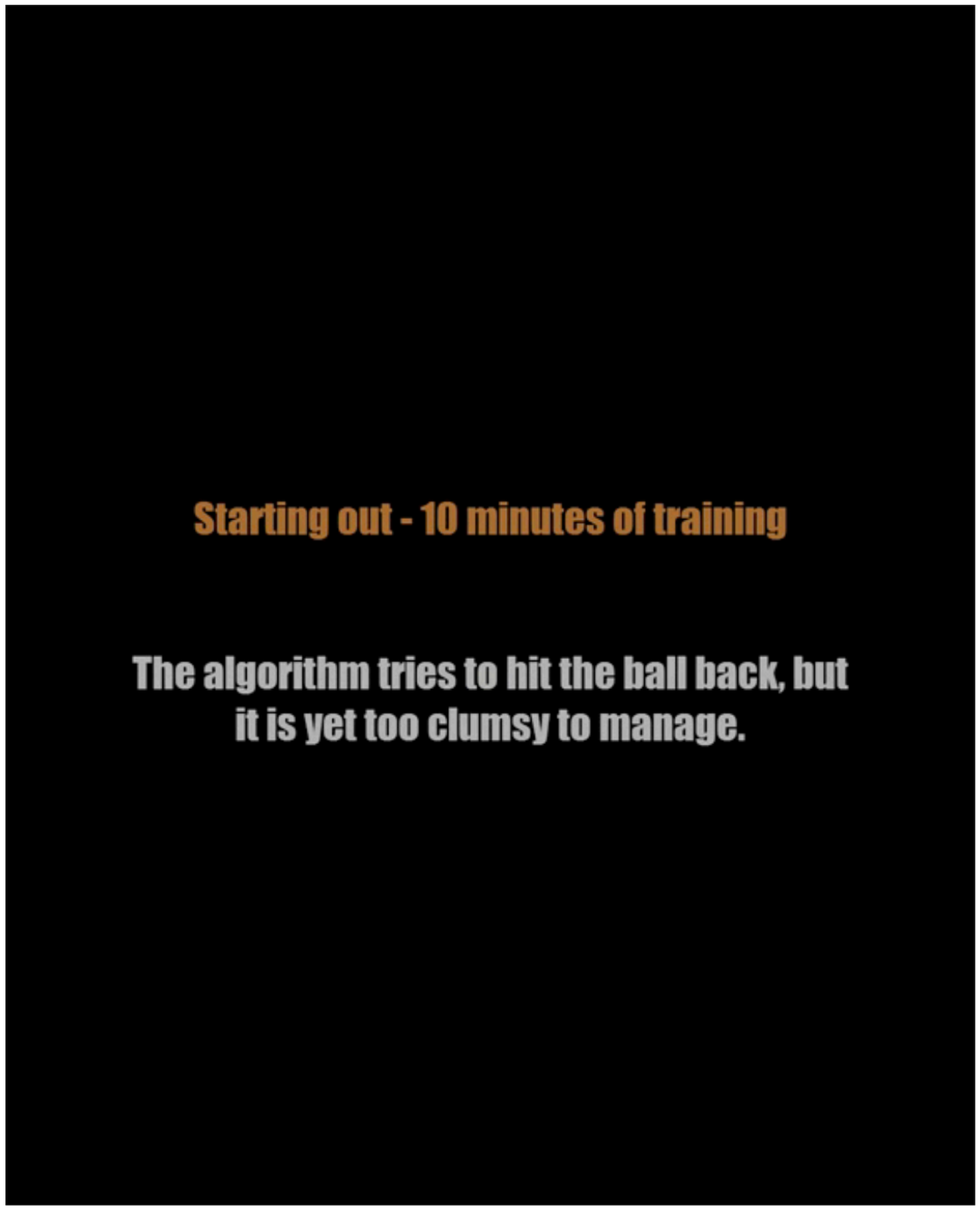
- Partially observable.
- Stochastic.
- Continuing.
- Dynamic.
- Continuous.
- Partially known.

Are We Making Progress?

Specific vs. General



Progress

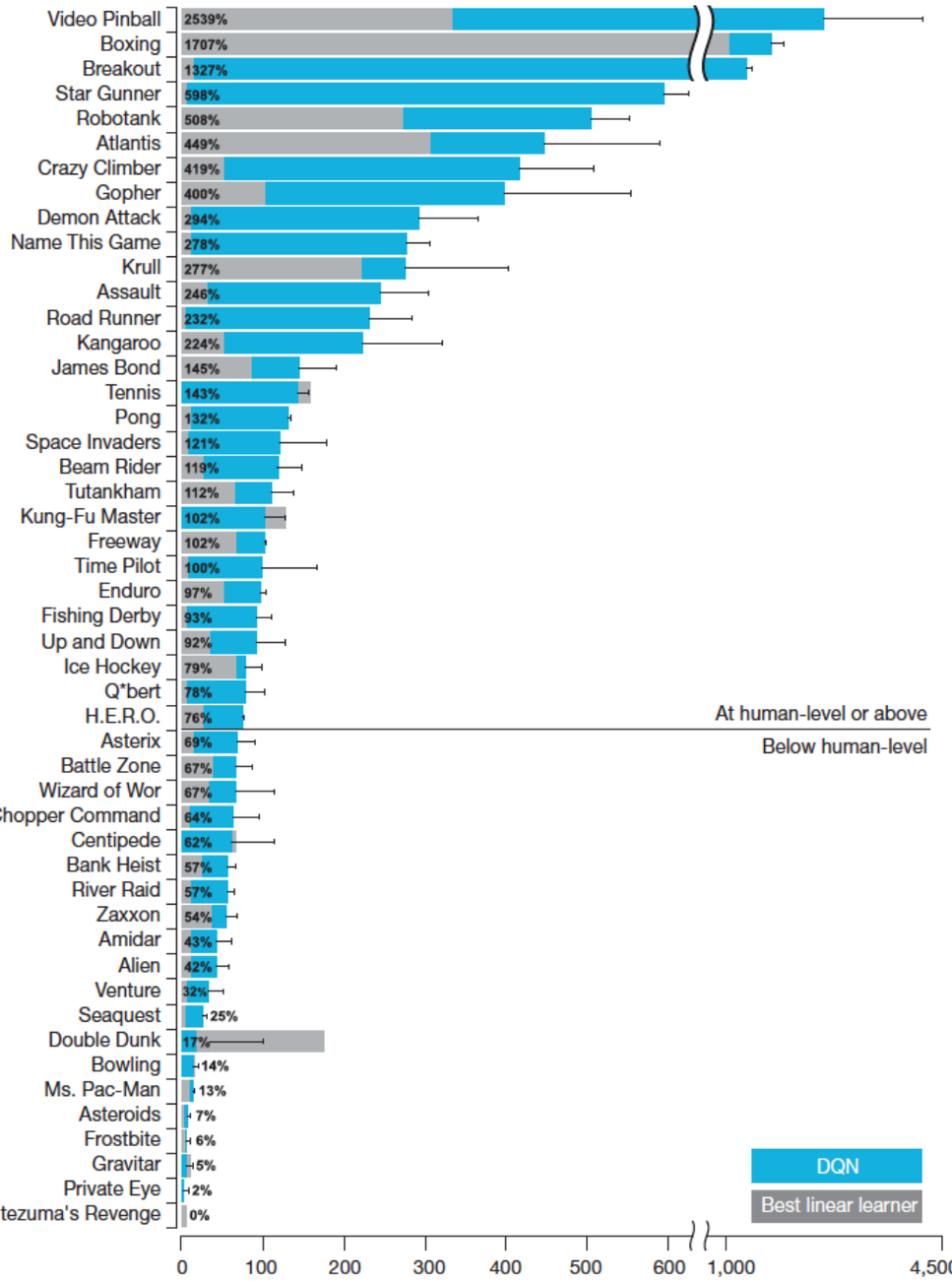


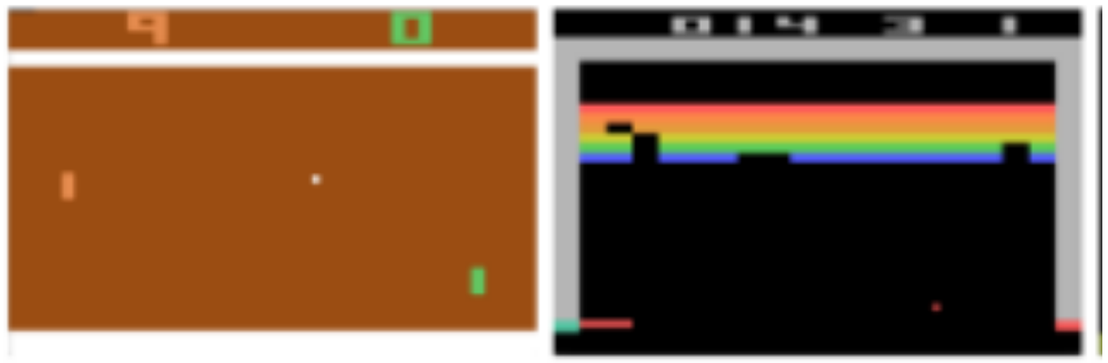
[Mnih et al., 2015]

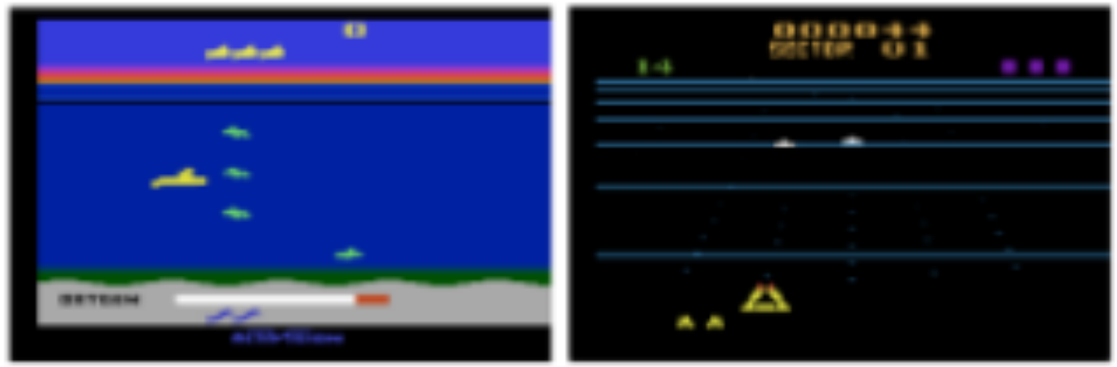
video: Two Minute Papers

Atari

[Mnih et al., 2015]



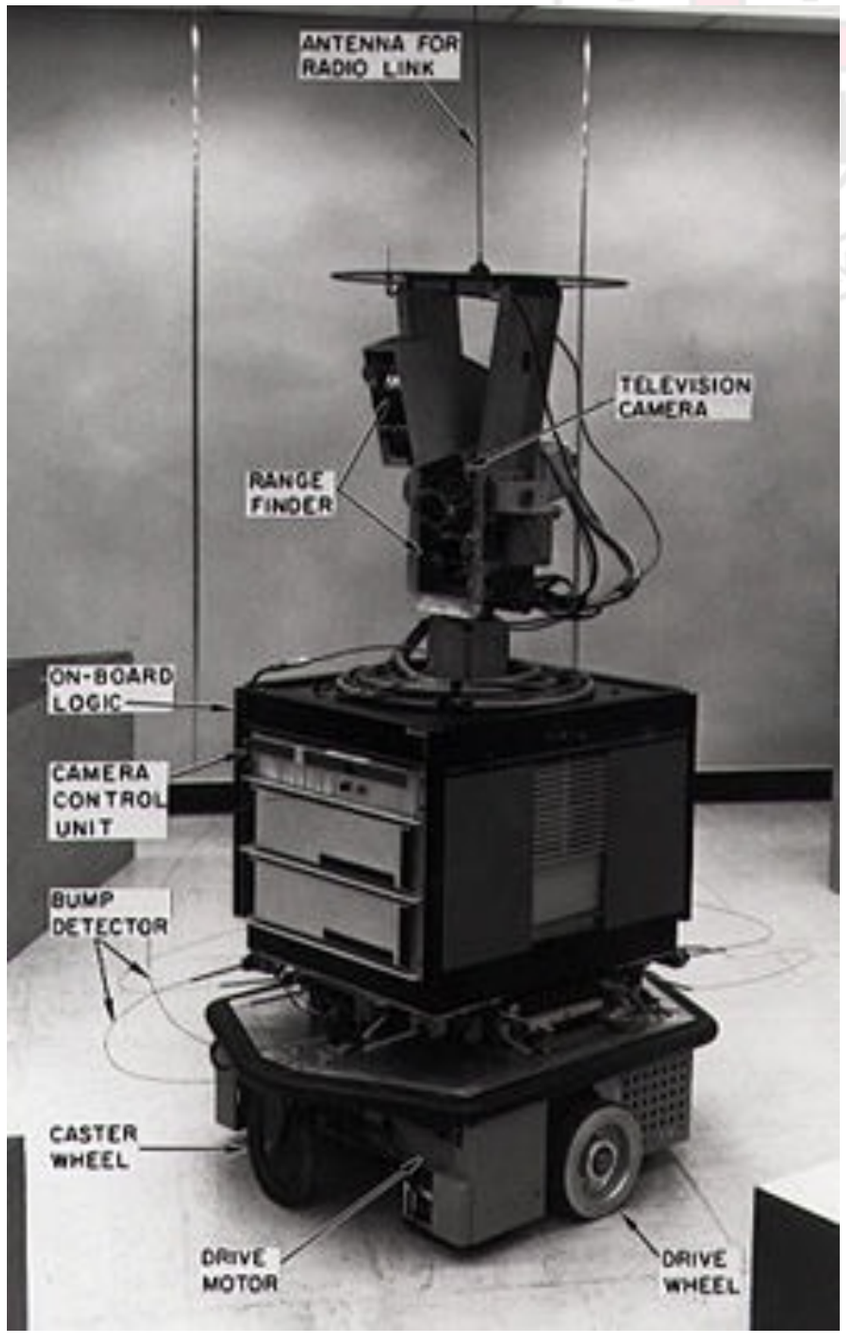




Structure of the Field

AI is fragmented:

- Learning
- Planning
- Vision
- Language
- Robotics
- Reasoning
- Knowledge Representation
- Search



Progress

Progress in AI:

- Clear, precise models of a *class of problems*
- Powerful, general-purpose tools

- A clear understanding of what each model and tool can and cannot do

- Occasionally: *vividly illustrative applications*.
- *Arduous and slow*

- *Huge opportunity*