CS 730/830: Intro AI

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"Thinking inside the box."

4 handouts: course info, schedule, slides, asst 1
1 online: project info

What is AI?

My Definition of AI





What is a Robot?

Artificial physical system that takes adaptive action.

- remote-controlled car
- power tool
- robotic surgery
- motion sensor
- thermostat
- anti-lock brakes
- automated delivery
- autopilot
- self-driving car
- Ava, Data...

What is Intelligence?

What behaviors require intelligence?
What makes an agent intelligent?

Different Goals in AI

How to understand **Intelligence**?

Cognitive modeling: behaves like a human
Engineering: achieve human performance
Rational: behaves perfectly, normative
Bounded-rational: behaves as well as possible

How to divide the problem?

Subfields: knowledge representation and reasoning, computer problem-solving, planning, machine learning, natural language processing, (autonomous) robotics, intelligent agents, multi-agent systems, distributed AI, intelligent user interfaces, machine vision
Other terms: computational intelligence
Related: adaptive behavior, complex adaptive systems, artificial life, cognitive modeling

Relations

- CS: algorithms
- Engineering: applications
- Cognitive psychology: modeling
- Philosophy: mind, rationality
- Math: logic, statistics
- Linguistics: language processing
- Operations research: optimization
- Economics: agents, incentives

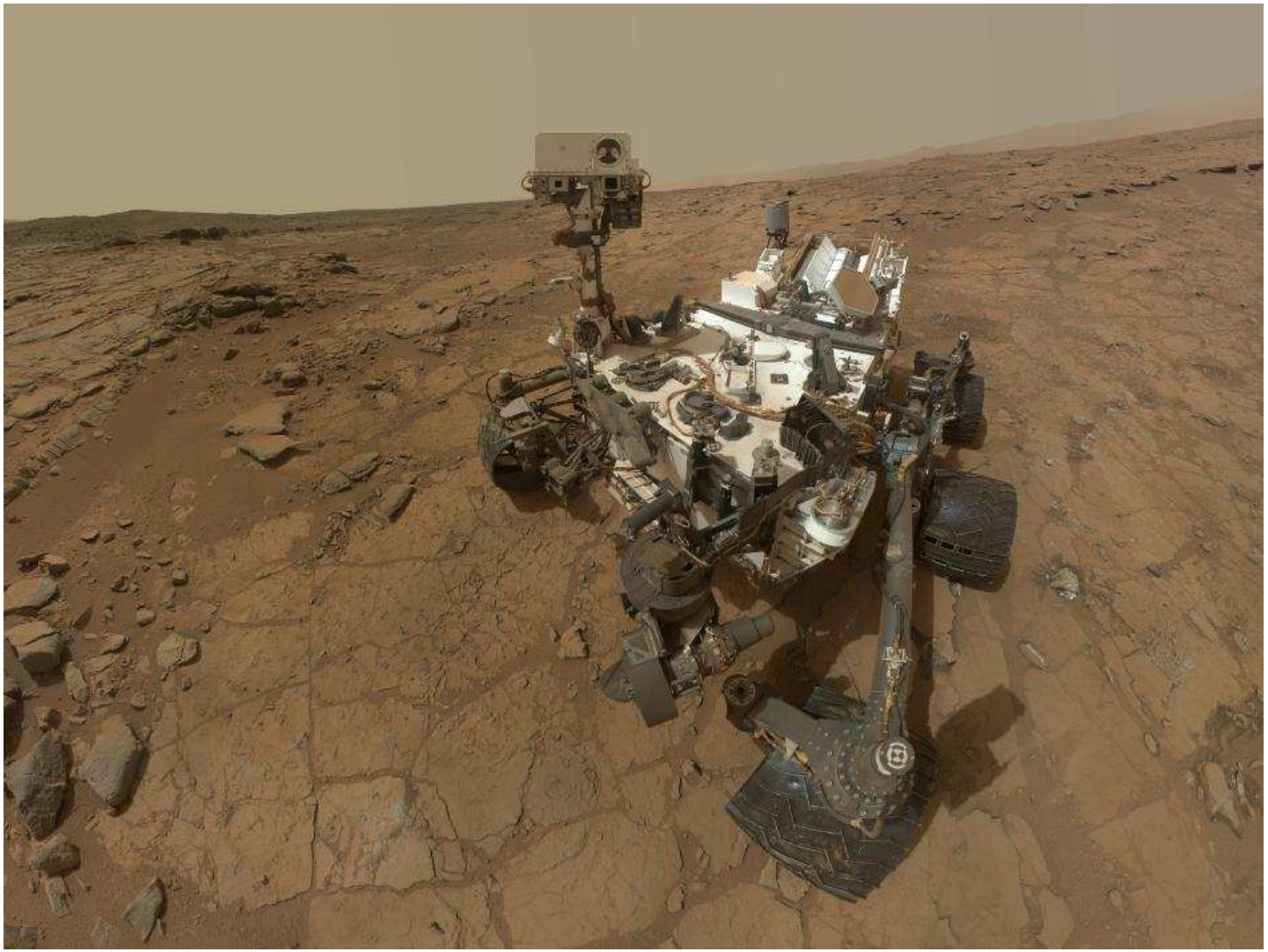
AI Today

- Game playing: chess, backgammon, Jeopardy!, crosswords, Go, StarCraft
- Design: VLSI, jet engines, painting, music
- Diagnosis: POS, NASD, loans, customer service, medical testing and classification, DS1
- Planning: airports, flight routes, Dell, DART, Expedia
- Recommendation: Amazon, Netflix, Walmart, Facebook
- Language: summarization (ChatGPT), voice recognition (Siri), translation (Google), wolf dialects
- Vision: scene descriptions, face recognition, individual animals
- Healthcare: prognosis, drug design
- Education: Kahnmigo, Aristo
- Robotics: ping-pong, beer fetch, driving, flying, laundry
- Hidden: logistics, data center control, distribution centers

Robots Today: Beautiful Hardware

Honda Asimo: virtually no autonomy.

Robots Today: Beautiful Hardware

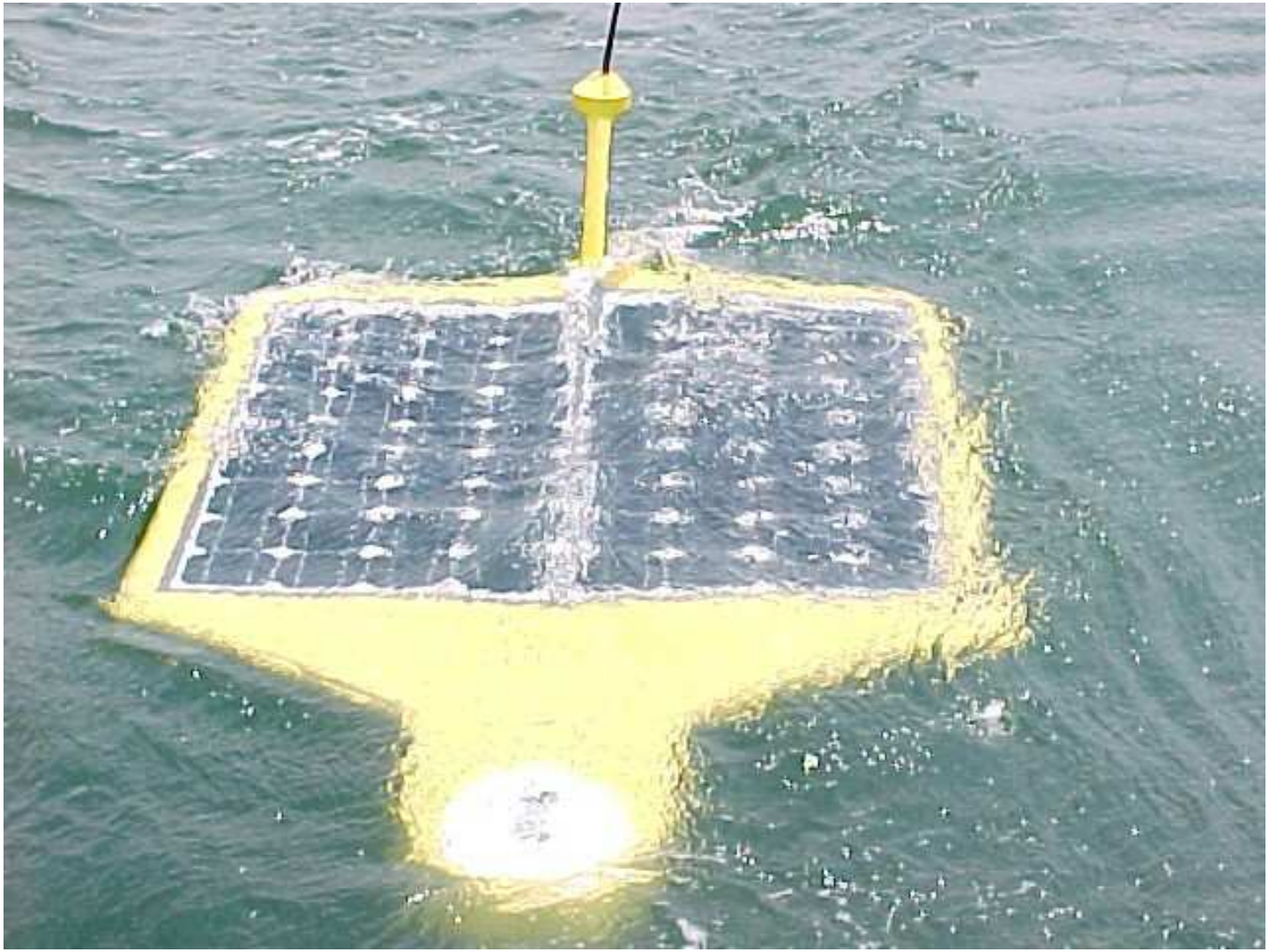


NASA Mars Science Lab: some navigation autonomy.

Robots Today: Beautiful Hardware

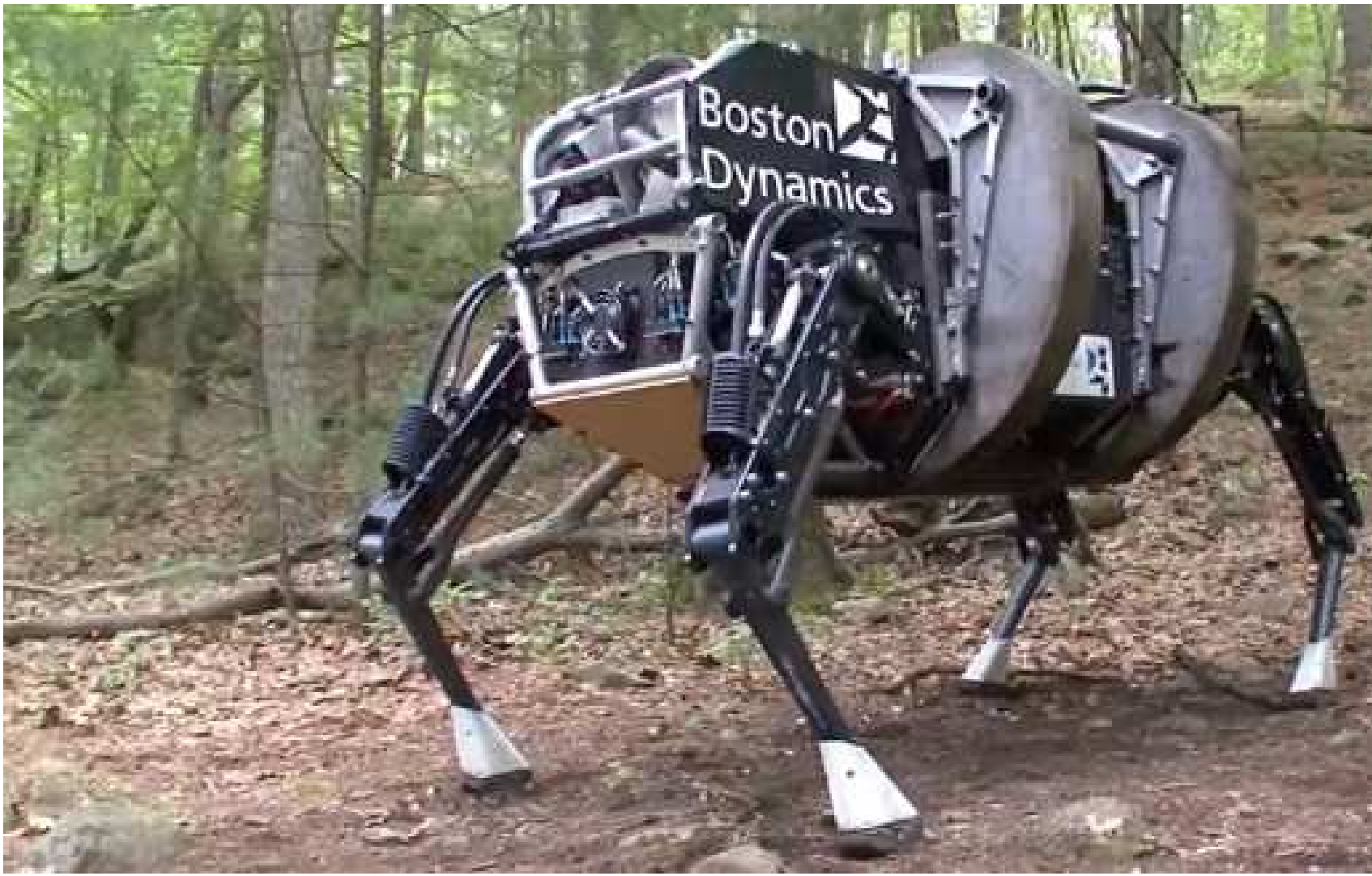
NASA Deep Space 1: temporarily self-commanded.

Robots Today: Beautiful Hardware



AUVs: dynamic environment, poor communication.

Robots Today: Beautiful Hardware

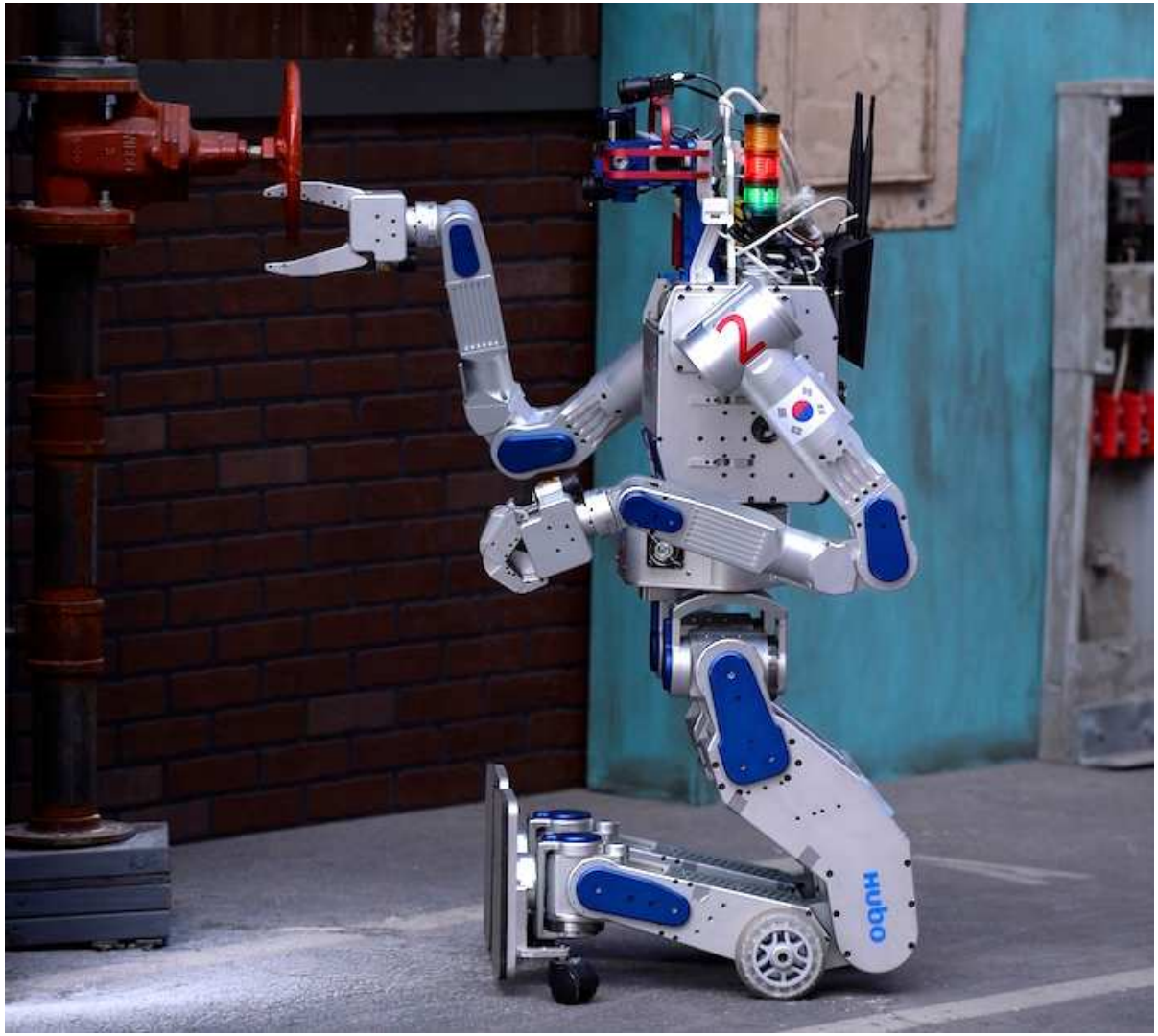


Boston Dynamics LS3: follow me.

Robots Today: Beautiful Hardware

Kiva Systems: bring inventory to pickers.

Robots Today: Beautiful Hardware



KAIST Hubo: winner of the 2015 DRC.

Robots Today: Beautiful Hardware

Willow Garage PR2: 22 degrees of freedom.

Robots Today: Beautiful Hardware

Yamaha RMax at Linköping University: autonomous.

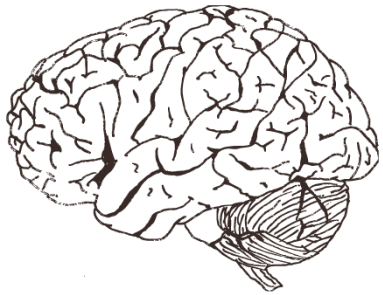
Robots Today: Beautiful Hardware

Waymo: 7.14 M miles, 85% lower crash rate (0.41/Mm vs 2.78)

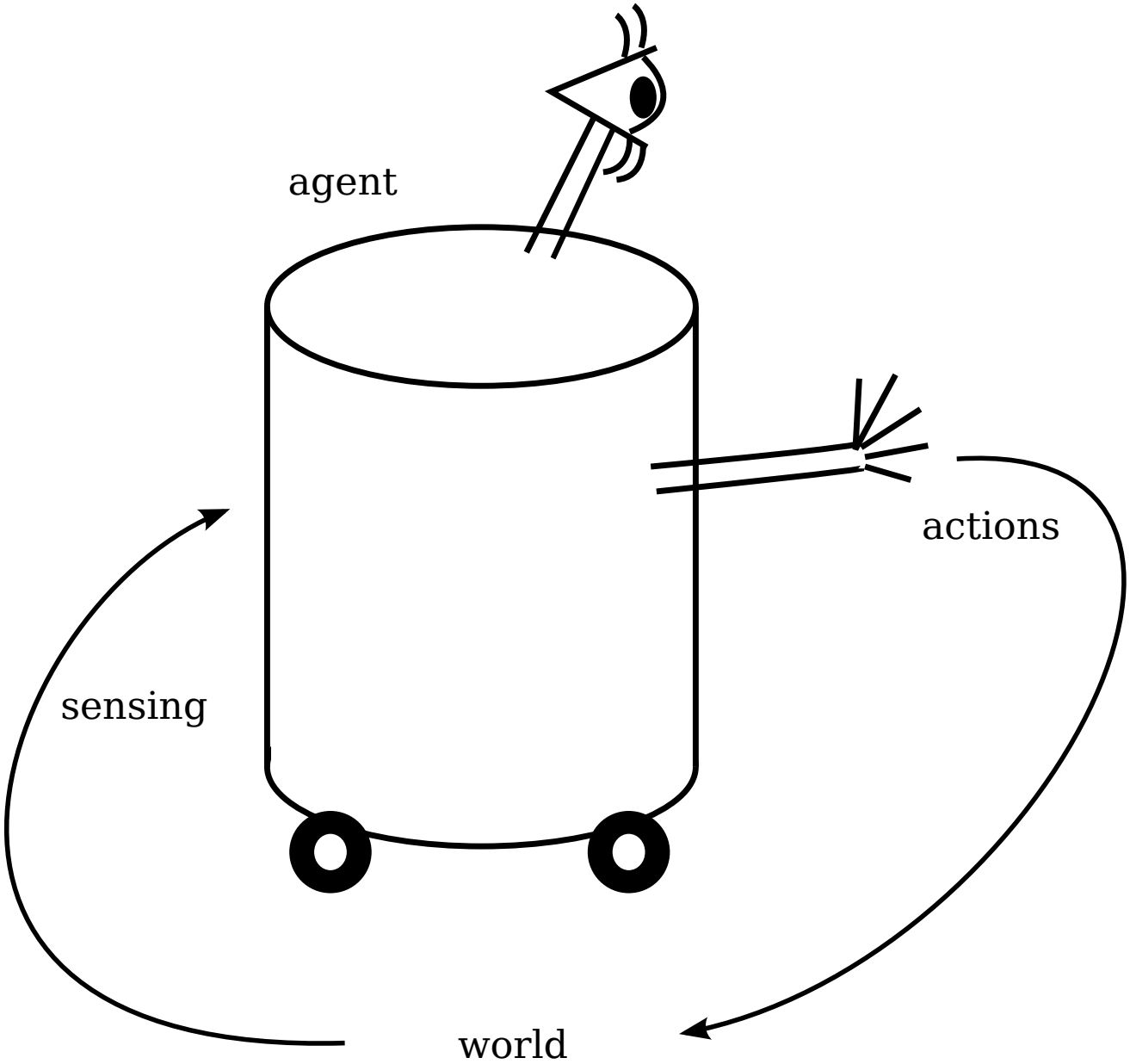
This class

The AI View of An Agent

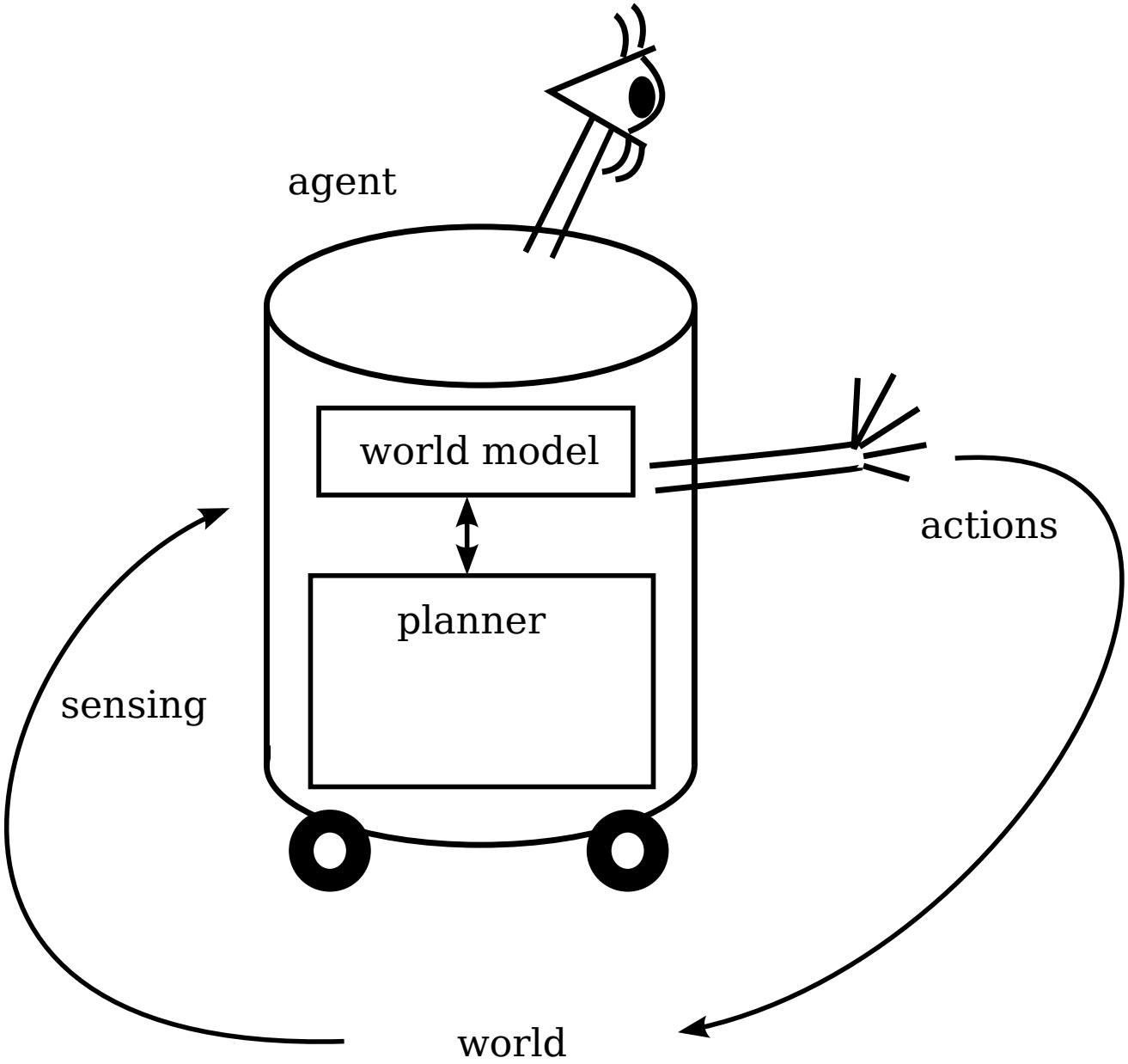
The AI View of An Agent

percepts →  → actions

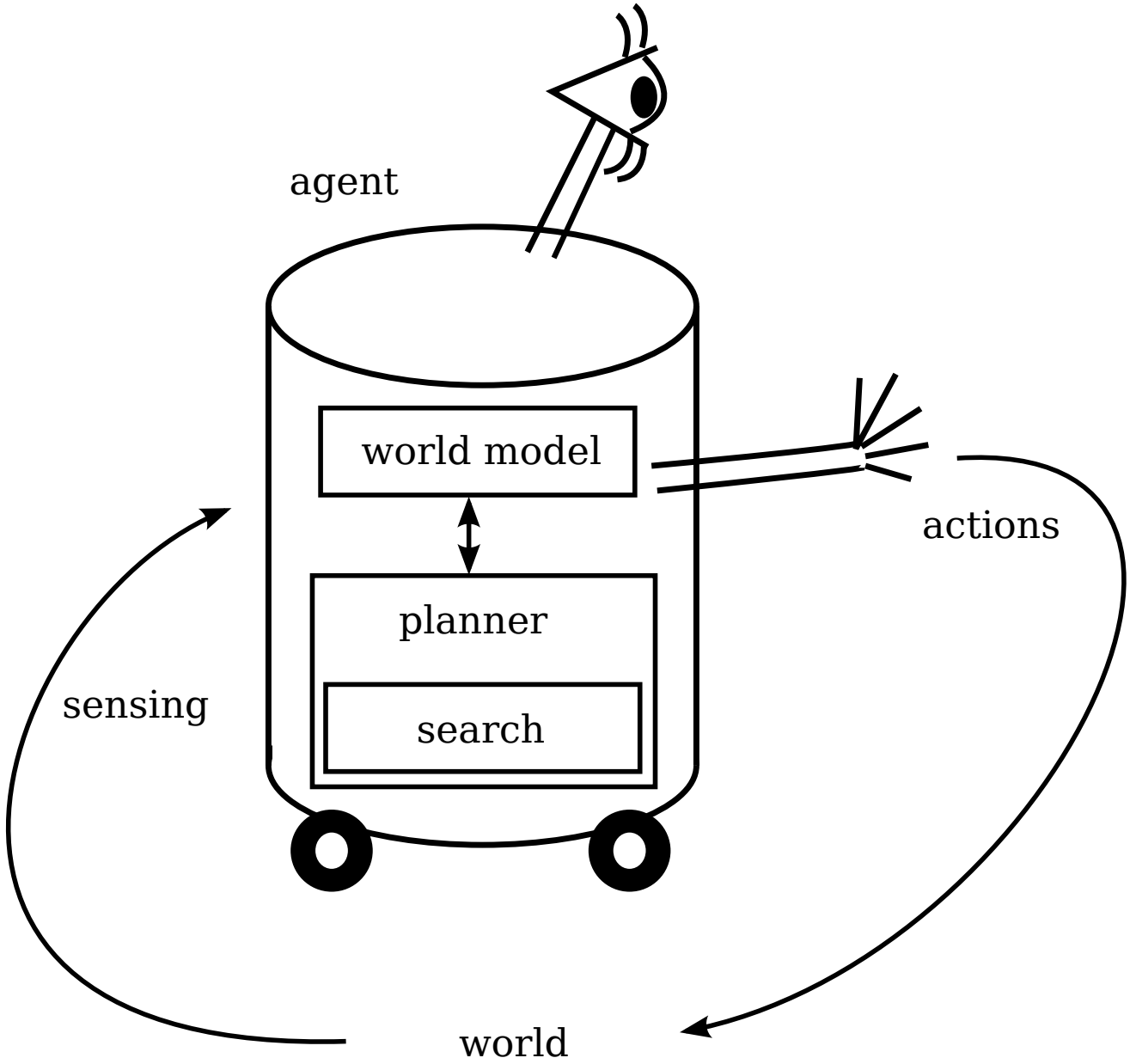
An AI Agent



An AI Agent



An AI Agent



Schedule

1. planning: vacuum tasks, hovercraft motion, puzzle
   - state-space search
   - constraint satisfaction
   - combinatorial optimization
2. KR: theorem provers
   - propositional logic
   - first-order logic
3. more planning: general planner, probabilistic planner
   - domain-independent planning
   - Markov decision processes
4. perception: digits, shapes, localization
   - supervised and unsupervised learning
   - hidden Markov models

See also: Intro to Mobile Robotics, Intro to Machine Learning
Not: NLP, cognitive modeling, philosophy

Course Mechanics

- General information
- Schedule
- Project
- Asst 1
- Names

Problems in AI

Agent Designs

Agent $\Leftrightarrow$ Environment

Perception: vision, state estimation
Planning: low/high-level, on/off-line, incremental/repair
Acting: dispatching, monitoring, diagnosis

Reflex: sensors $\rightarrow$ effectors
Reflex with state: sensors + state $\rightarrow$ effectors + new state
Goal-based: reason from goals to means
Utility-based: use quantitative measure of happiness

What kind of agent?

1. thermostat
2. autonomous armed drone
3. mail delivery robot
4. medical diagnosis system

Environments

Observability: complete, partial, hidden
Predictability: deterministic, strategic, stochastic
Interaction: one-shot, sequential
Time: static, dynamic
State: discrete, continuous (also time, percepts, and actions)
Agents: single, multiagent (competitive, cooperative)

State-Space Search

Contents

This particular pattern of molecules known as a 'human being' has evolved an amazing depth of consciousness: an ability to internally model the reality beyond the senses, to imagine futures that have never happened, to use language, to use rationality to build and test theories about our universe, to become self-aware.
—Jeff Lieberman (artist, roboticist)

Cognitive Science

The ability to think is perhaps the most distinctive of human capacities. Typically, thinking involves mentally representing some aspects of the world (including aspects of ourselves) and manipulating these representations or beliefs so as to yield new beliefs, where the latter may aid in accomplishing a goal.
—Edward E. Smith (Psychology, U Michigan)

The ability to solve problems is one of the most important manifestations of human thinking. ... We might therefore suspect that problem solving depends on general cognitive abilities that can potentially be applied to an essentially unlimited range of domains.
—Keith Holyoak (Psychology, UCLA)

Plants?

There are all of these calculations plants are constantly making by taking in every aspect of their environment and adjusting their lives accordingly, and it starts to look an awful lot like what we might consider intelligence — in a totally alien life form. That's kind of how you have to treat it. Intelligence won't show up in the way we expect ourselves to be intelligent. It'll show up in ways that are evolutionarily appropriate for plans.
— Zoë Schlanger

A Search Space

EOCQs

Please write down the most pressing question you have about anything related to the course (no need to include your name) and put it in the box on your way out.

Thanks!