ME 599/AA 546/EE 546: **Biology-inspired robot control**

Lecture 1

Sawyer B. Fuller

Goals:

- Answer: why “biology-inspired robot control”?
- Explain how this course works

UNIVERSITY of WASHINGTON

biology-inspired robot control

- WF 3:30-4:50 in MEB 234
- Instructor: Prof. Sawyer B. Fuller (minster@uw.edu)
- Office hours: Thursdays 3:30-4:30 in MEB 321
- Prereq's: an undergraduate degree in ME, EE, or Aero
- Website: http://faculty.washington.edu/minster/bio_inspired_robotics_2016/bio_inspired_robotics_2016.html (or Google "Sawyer Fuller" and look for the teaching section of my home page)
    - lecture slides, papers, and other materials will be posted there
    - submit coursework on Canvas (or in-class for problem set)

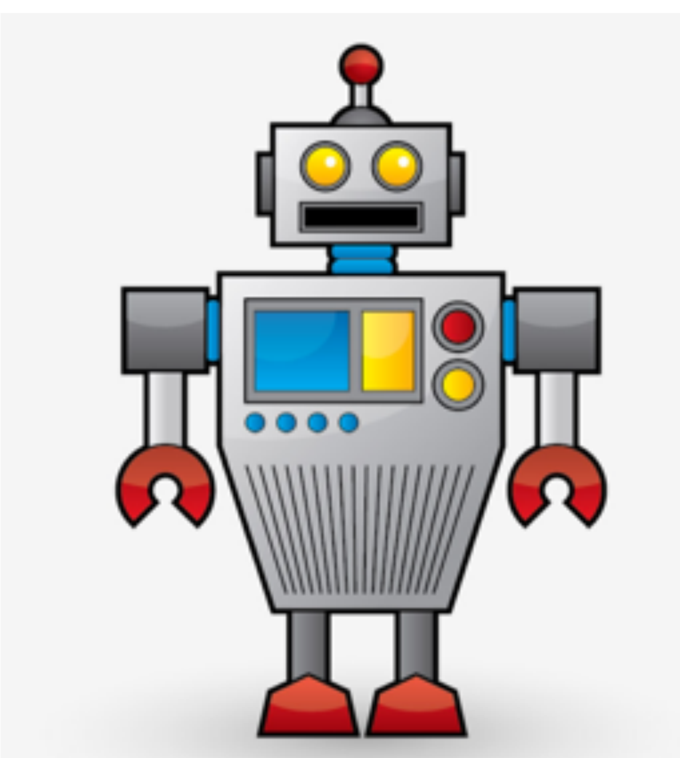
Other graduate courses at the UW in robotics and biomechanics

- ME599: Advanced Robotics: Perception and multi-robot control (Ashis Banerjee, offered this fall term)
- EE 543/544: Kinematics and dynamics of robot arms/manipulators
- EE 577: computer vision and robotics
- CSE 571 Probabilistic Robotics: Perception, localization, mapping (Dieter Fox, offered this fall term)
- AMATH / CSE 579: Intelligent control through learning and optimization (Emo Todorov)
- CSE 590: Robotics colloquium seminar (weekly speakers)
- BI 427: Animal biomechanics (Tom Daniel, offered this quarter)

“biology-inspired robot control”

Robot (*noun*)

a machine capable of carrying out a complex series of actions *automatically*

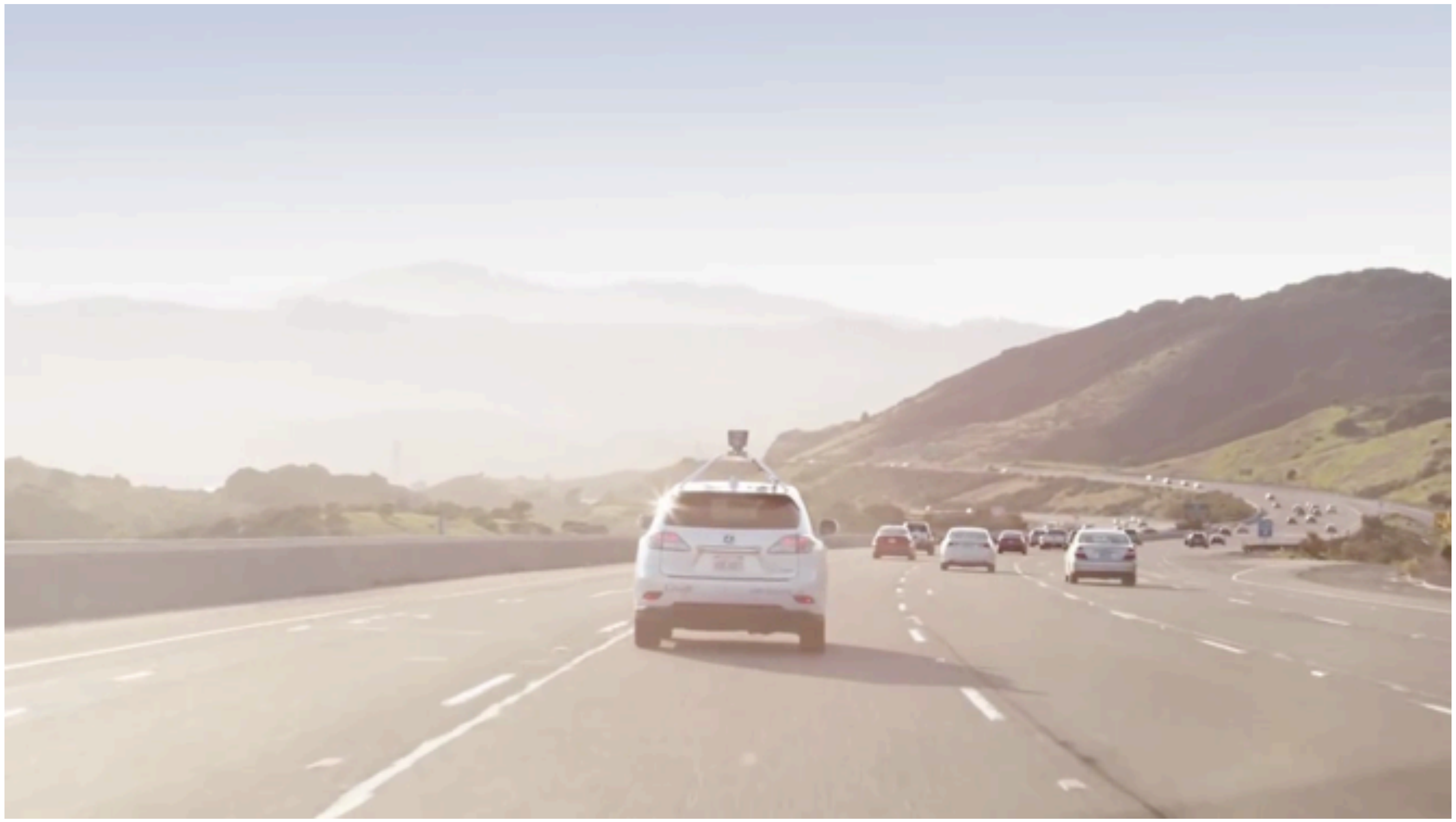


current state of the art

Honda's Asimo

- very power hungry (20x human of same weight)
- only in controlled environments

current state of the art



Google's self-driving car

- power hungry - requires a bank of computers
- only in controlled environments

animal locomotion

- rich behavioral repertoire

animal locomotion

Animal locomotion

- aggressive, dynamic motions

Animal locomotion

- complex environments
- minimal energy expenditure on computation

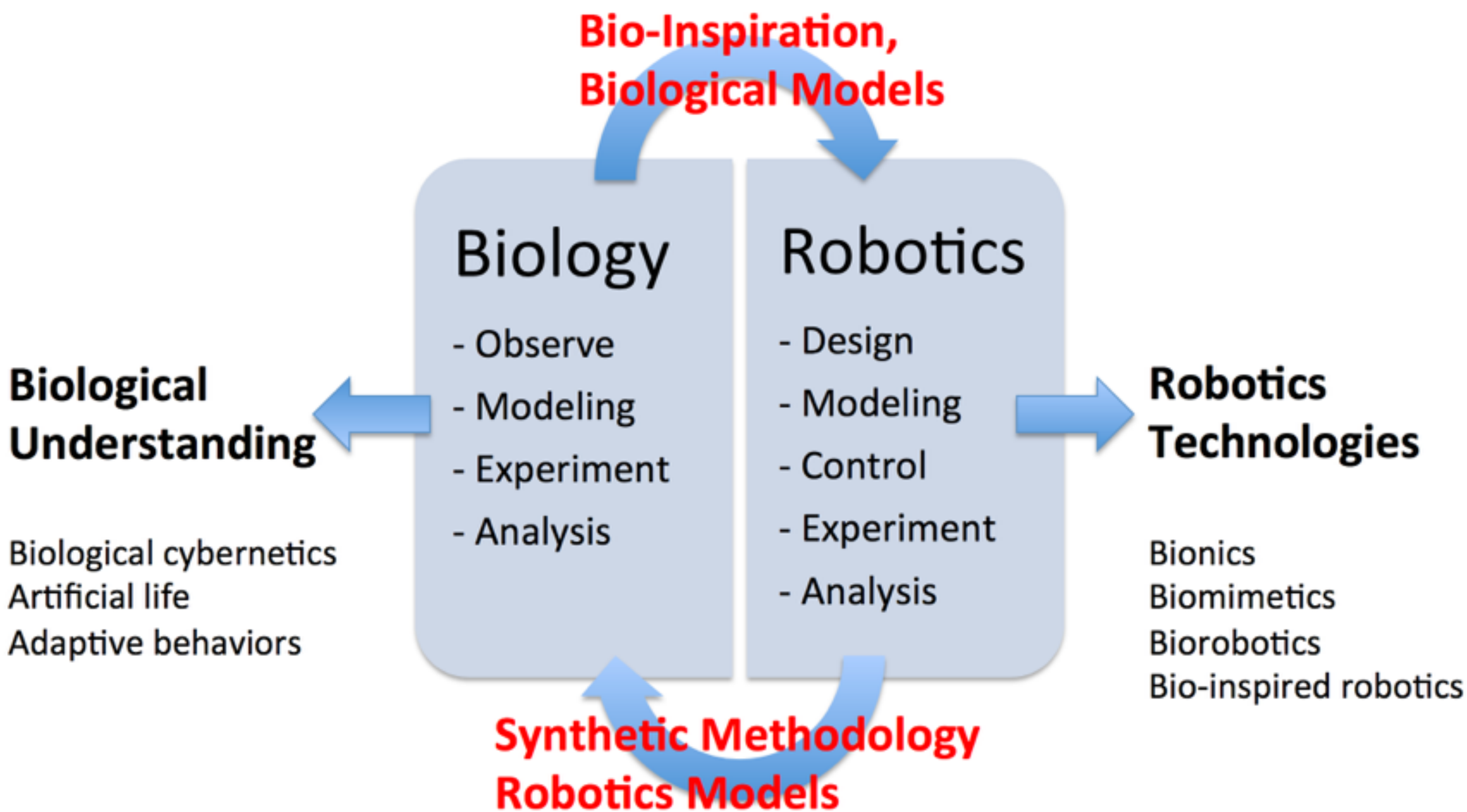
why are animals so much more capable (agile, robust) than current robots?

answer: we are still finding out!

this course is about training you to find the answers

- course objective: learn tools and concepts that will help you to do this

biology-inspired robotics



this course: two areas where biology excels

1. mechanical intelligence
2. reflexive or model-free control

mechanical intelligence

this fish is dead!

- system is stable without active feedback

Liao, 2004

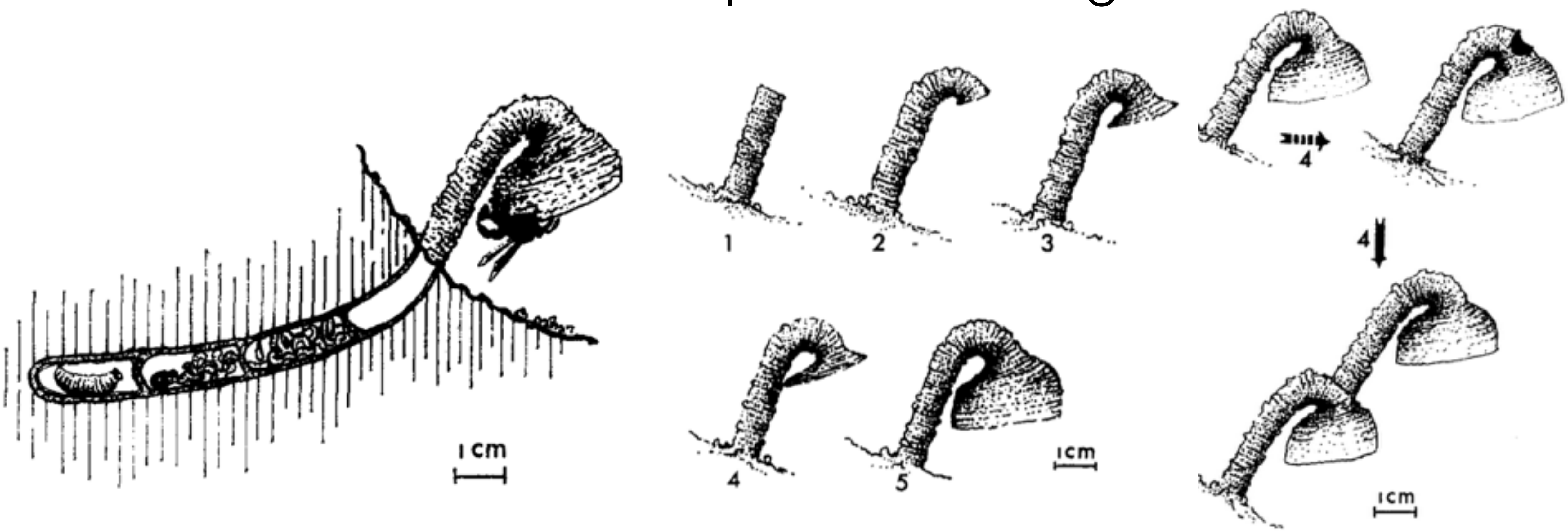
example of robot mechanical intelligence

walks with no feedback and very little power

collins 2001

reflexive/model-free control

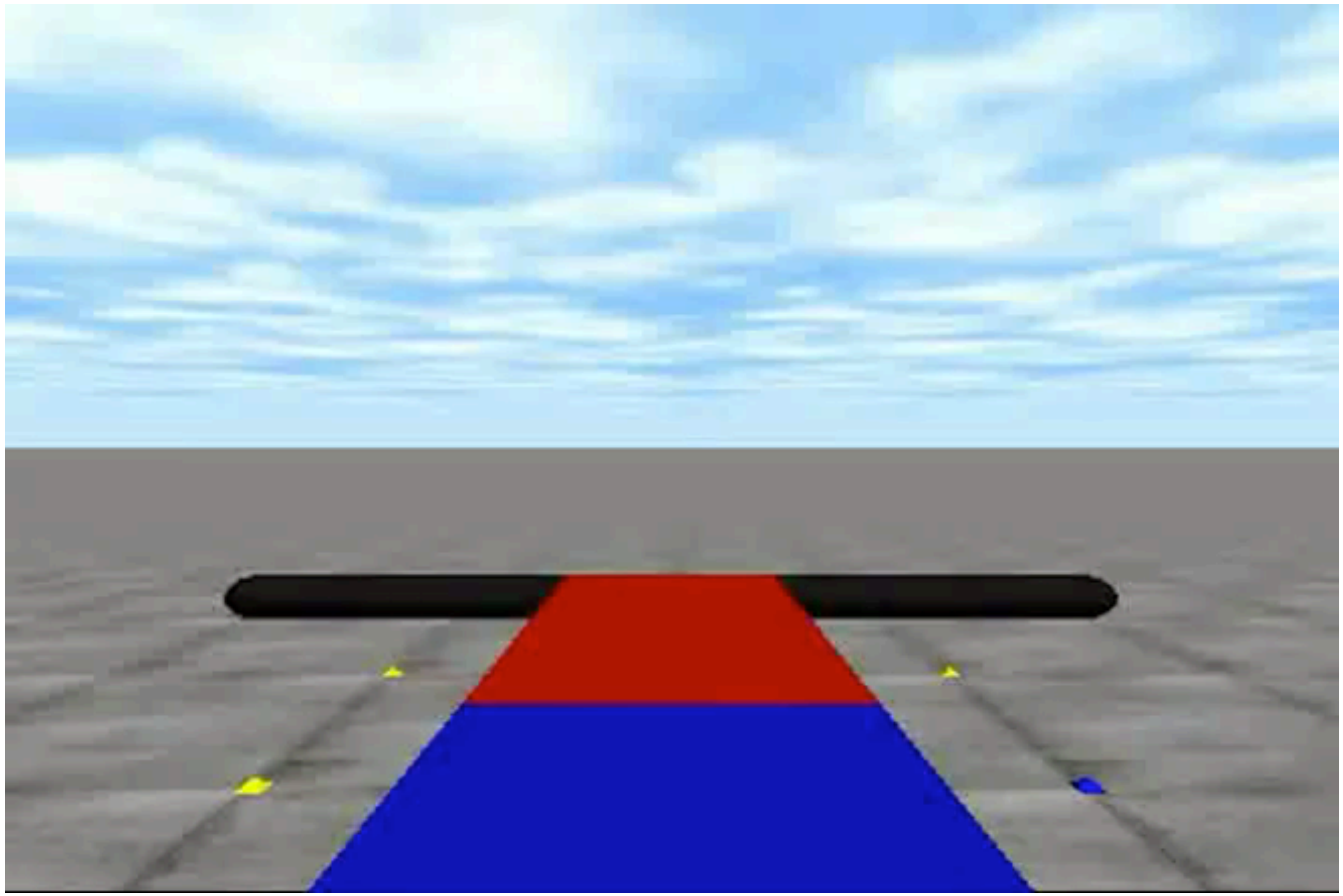
mud wasp nest building



- minimal internal representation
- cascaded behaviors

Smith, 1978

example of reflexive/model-free control



a gait learned by a neural network

bongard 2011

where robotics *really* needs these ideas

tiny robots
(minimal computation,
limited sensing)

complex environments and robots
(models are inadequate
and behavior must be learned)

agile robots
(limited time to compute)

the point of this course

- to have fun while building your “toolbox” of ways to think about and solve these problems.

how this course works

- Advanced research-oriented course!
- Three parts to the coursework:

1. **Reviewing and discussing** 1-2 assigned papers per class session (40% of grade)
2. **Presenting** 1-2 papers to the class (20% of grade)
    - assigned based on a lottery and your preferences (return survey/preferences sheet at end of class today)
3. **Simulation-based final project** (40% of grade)
    - more information coming next lecture: example ideas for inspiration, skeleton code examples

(going over syllabus)

Calendar (subject to change)

Week	Dates	Topic	Paper reviews	Project
1	Sept 28, 30	**Course overview**		
2	Oct 5, 7	Paper 0, Mechanical Intelligence Introduction	paper 0 review	pset 1
3–5	Oct 12–26	**Mechanical Intelligence** passive dynamic stability, open-loop legged locomotion, insect robot control, wasp nest building, termite bots	paper reviews	proposal due
5–6	Oct 28, Nov 2	**Project updates**		presentation
6–10	Nov 4–30	**Reflexive and Learning control** subsumption architecture, insect visual flight control, central pattern generators, neural networks	paper reviews	
10-11	Dec 2–9	**Final Project Presentations**		presentation, paper due

Guest lectures this quarter

- Sam Burden - EE (multi-legged locomotion)
- Eric Rombucas - ME and VA hospital (insect flight control, neuromuscular rehabilitation)

Friday

- Review of dynamics, introduction to course project

next week

- paper 0 review due Tuesday
- problem set 1 due Friday