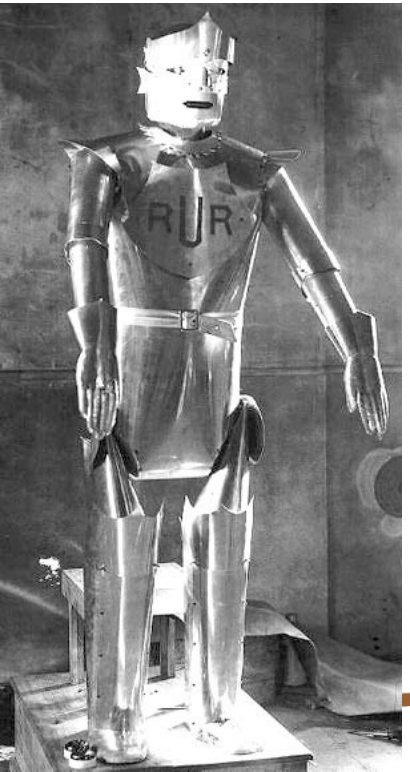
Introduction to Robotics

To Begin

- Syllabus
- Class layout and expectations

Where did Robot come from

- Karel Capek
  - czech playwright
  - created the term from czech words for forced labor and serf (1921)



Robotics in the American Consciousnesses

- Robotics
  - Asimov 1940s
  - (in)famous Three Laws
    - A robot may not injure a human being or, through inaction, allow a human being to come to harm.
    - A robot must obey the orders given to it by human beings, except where such orders would conflict with the First Law.
    - A robot must protect its own existence as long as such protection does not conflict with the First or Second Law.
    - Issues?

What is a robot?

- Maja Matarić
  - a robot: An autonomous system which exists in the physical world, can sense its environment, and can act on it to achieve some goals.
- pretty good definition
  - need all parts

Autonomous

- acts on its own
  - makes own decisions to carry out actions
  - not directly controlled by human
  - not either of these:

Human Controlled

- Two ways of human control of robot-like constructs
  - Remote control
    - human uses own senses to control device
    - By our definition not really a robot.
  - Tele-operation
    - human uses robots sensors to control it for a while.

Exists in the world

- A proper robot exists in the world
  - has to get sensor data from world and make sense of it.
    - big challenge
  - some people don't like this requirement
    - means simulated “robots” aren't robots
    - they aren't
      - beware simulations generally
    - as one who has done both – simulations useful, but gloss over too much important stuff.
    - Tale of the robotics student a couple years ago and the robot that curved when told to go forward

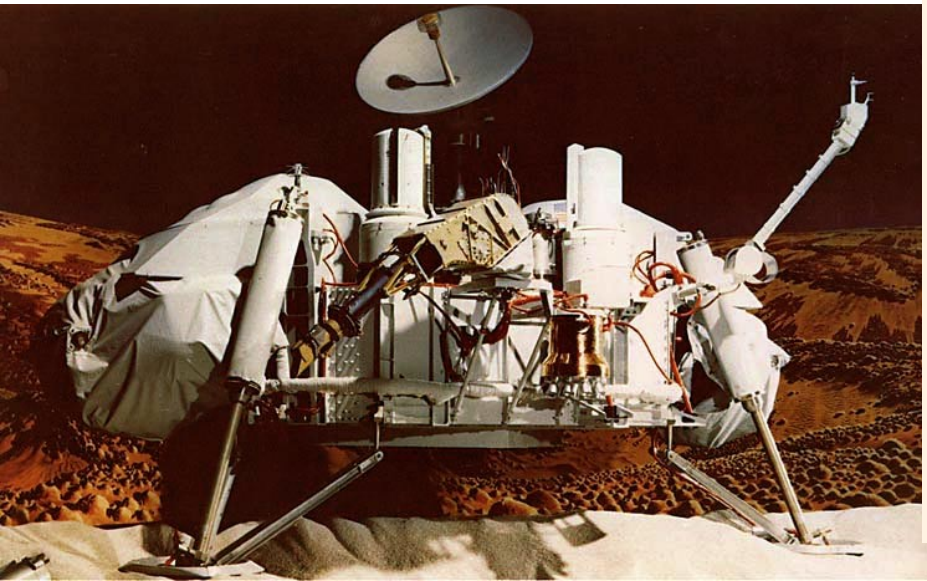
Can sense environment

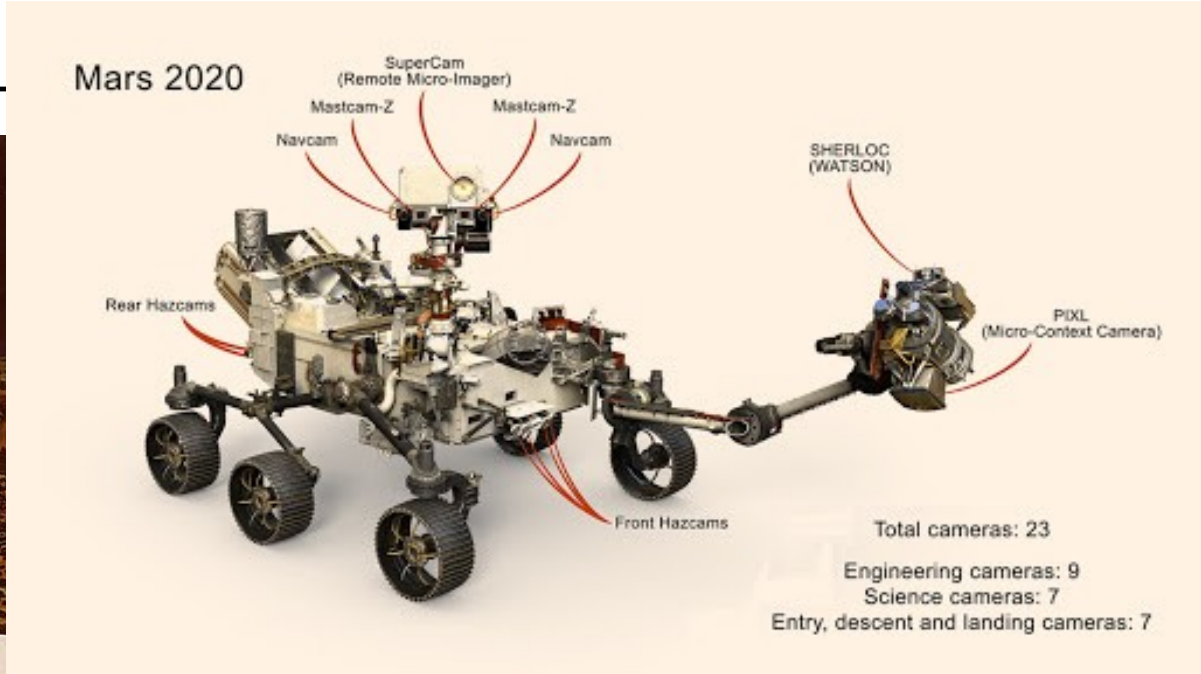
- If the robot can't sense, can't make decisions
  - must instead follow some predetermined plan.
  - not acting autonomously
  - not working effectively in the world.

Act to Achieve Goals.

Robot has to be able to act

- or just big sensor platform.
- difference between
- Perseverance landed 2021





Where did the field of Robotics come from

- Now that we have a decent definition of what a robot is
  - where did the field come from?
  - Modern field grew out of
    - control theory
    - cybernetics
    - AI
    - with a healthy dose of engineering thrown in.

Control Theory

- Mathematical study of properties of automated systems
  - old disciple
    - ancient Greek origins
  - in more modern times often studied as part of mechanical engineering
  - positive and negative feedback loops
  - Basics are easy to implement, so we will cover them
    - Even if they are more of the domain of Mechanical eng these days

Cybernetics

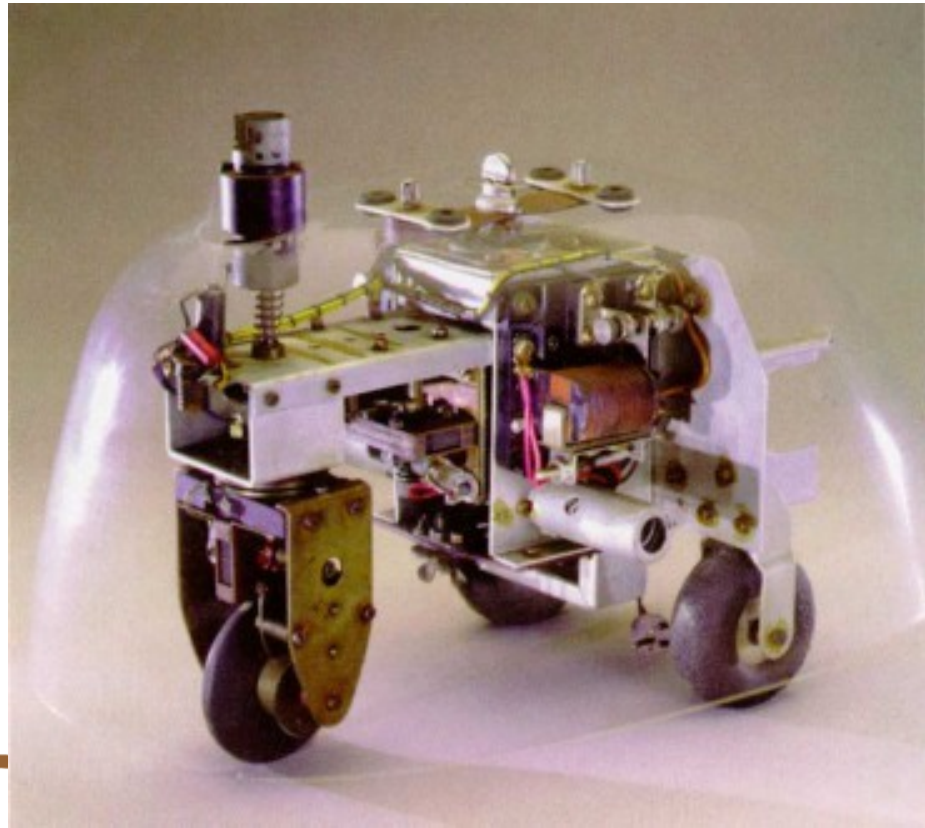
- field pioneered in 1940's
- study of control theory applied to biological entities
  - searching for common principles in animals and machines
- no longer exists as a discipline
- idea of biomemetic machines still very important
  - machines that work the same way (some) living things work

Artificial Intelligence

- Study of how to get machines to “think”
  - study of how machines can do things only humans are good at
    - self defeating but often accurate definition.
  - Important part of the autonomous part of robotics.
  - how can the robot decide how to achieve its goal
  - early AI robots took side track – too much thinking for too many aspects of robot
  - still important for robots that do anything really useful.
  - Not the LLM style AI currently so popular

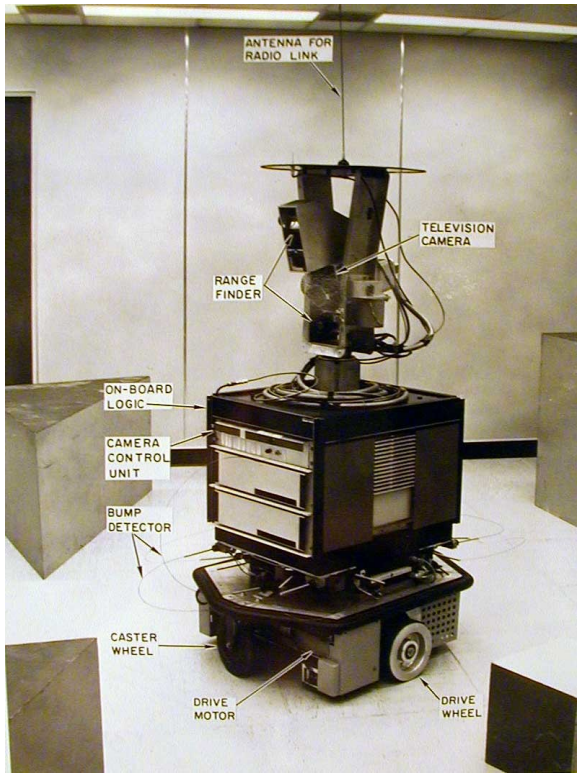
The first real robot

- The first real robot by our definition(1949)
  - W. Grey Walter's tortoise
  - light sensors only
  - tricycle steering
  - vacuum tube computation

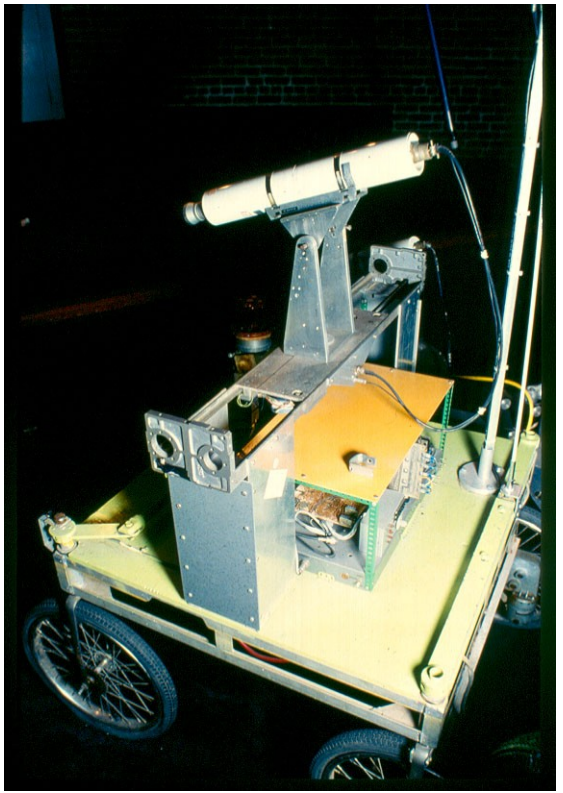


Other important robots in history

- Shakey



Stanford Cart

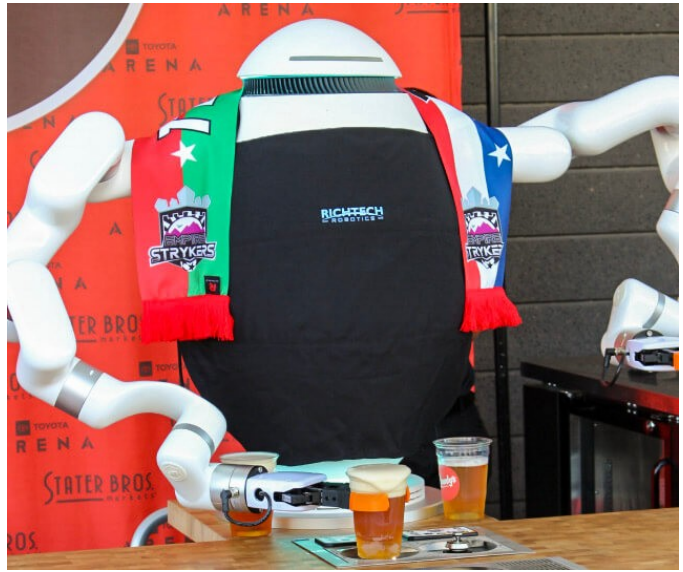


Braitenburg's vehicles

Robots today I

- Left: Aria by Realbotix at CES 2025 (retail $175,000)
- Right: Unitree Go2 Robot Dog, On amazon for $2400

Robots today II



Robotics vs. Computer Science

- In computer science we create models
  - Abstract
  - Generally repeatable discrete conditions.
- In robotics, must deal with actual world all the time.
  - Small or large part depending on mobility.
  - The real world is messy.

Assignment

- Check your lab access
- Sign up for your group.
- Read Chapter 1 in the book (pages 19-26)