

Welcome to Robotics



Topics

- Class syllabus
- Introduction to Robots
- Start building the robot

Course Syllabus

- Tzipora Halevi, Assistant Professor
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Office Hours: Mondays, 2:30pm – 4:30pm
Ingersol room 2156A
- Course has 6 units. Each unit includes:
 - 1-2 Lectures
 - 1-2 labs
 - 1-2 assignments
 - Class presentation

Course Syllabus (Cont.)

- Attendance: This is a hands-on course. There is no option of making up missed labs.
- Lab with two partners per group
 - Hands-on session using Lego Robot (Mindstorm NXT).
- Books:
 - Autonomous Robots: From biological inspiration to implementation and control, by George Bekey, MIT Press, 2005 (recommended)
 - The Robotics Primer, Mataric, 2007

Course Syllabus(cont.)

- Assignments include:
 - Written, take home
 - Quizzes, tests
 - In-class presentation
 - Demonstrations, slide-show, etc.
- Grading = 6 unit material (10% each) + Exam (30%) + Attendance+Participation (10%)

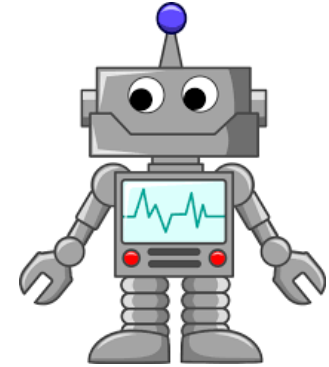
Unit A - Introduction to Robots

- Why study robotics?
- What is a robot?
- Robots in society
- Robot components
- Introduction to the course robots

Unit A - Introduction to Robots

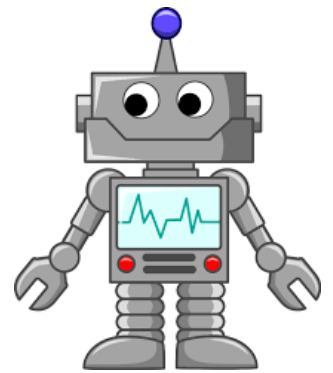
- Reading:
 - Autonomous Robots: From biological inspiration to implementation and control, by George Bekey, MIT Press, 2005; chapter 1.
 - The Robotics Primer, chapters 1–3 (pages 1–28)
 - Big Dog the rough-terrain quadruped robot, Raibert at. Al
 - Legged robots by Raibert

Why study robotics?



- Introduction to computational aspects of robotics
- Interdisciplinary - related to other disciplines
 - Artificial Intelligence, Computer Vision, Control Systems, Neuroscience, Biology
- Instant feedback
 - Robots moves, makes noises, etc.
- Developing field
 - Robots will change the world we live in
 - Potential future career path...

What is a robot?



- “A **robot** (also called a **droid**) is a machine — especially one programmable by a computer— capable of carrying out a complex series of actions automatically.” – Wikipedia
 - Robots can be autonomous or semi-autonomous
 - can refer to both physical robots and virtual software agents
- We focus on “AUTONOMOUS” mobile robots. These robots can be considered “agents” in the physical world...

Autonomy



- What is an autonomy (autonomous)?
- Derived from ancient greek:
 - Auto = self, nomos = “law”
 - "one who gives oneself one's own law"
- Be independent, free of constraints
- Able to act on ones own initiative
- For robots ==?
 - No REMOTE CONTROL!

Agents



- What is an agent?
- Derived from the latin word “AGERE” (todo).
- Acts on behalf of some other entity to achieve goal.
- Depends on the context: Real estate agent, chemical agent, etc.
- Autonomous Agent: An agent that works on behalf of someone else, but can make decisions on its own, guided by feedback (for example, from its sensors).

What is a robot? (Cont.)

- Our definition of robot (for our purposes):
 - An autonomous agent, acting independently. Our environment is the real world.
 - The robot can sense its environment (including its own internal state) and act on it to achieve pre-defined goals.
- Robotics: The study of robots – their design, construction, capabilities and purpose.

Robots History



- From the Slavic word *robota* (“forced laborer”)
- First applied as a term for artificial automata in a 1920 play
 - *R.U.R.* (Rossum’s Universal Robots) , by the Czech writer, Karel Čapek
- Self-operating machines date back to the ancient China, Greece and Ptolemaic Egypt.
 - Resembling humans and animals

Robots History



- Isaac Asimov, scientist and science fiction author coined the word “Robotics” to describe the field of study.
- Asimov proposed in "Runaround" (1942) the 3 Laws of Robotics:
 - A robot may not injure a human being or, through inaction, allow a human being to come to harm.
 - A robot must obey any 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.

Robots History

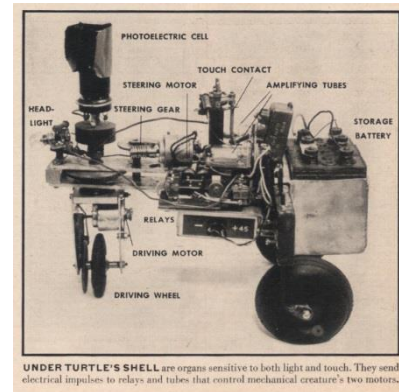


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- Hollywood broke these rules in “The terminator” [1984], “Transformers”[2007] movies

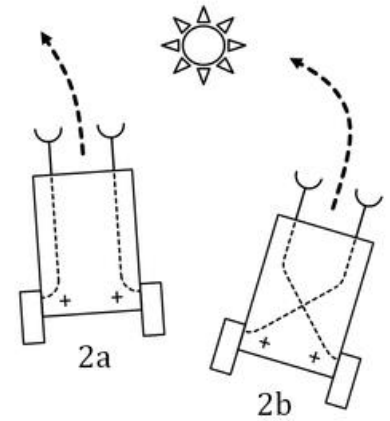


The First Robots

- Grey Walter's Tortoises (1940):
 - Simulated biological systems (biomemetic).
 - Machines with simple sensors that could:
 - React to light - detect/follow/avoid light.
 - Track/Move/Avoid obstacles.
 - Feed (recharge batteries) – robots could find their way to a recharging station when they ran low on battery power
 - Simple reasoning:
 - Reactive control using a collection of prioritized “reflexes”.
 - Could still lead to complex behavior (emergent phenomena).



The First Robots (cont.)



- Braitenberg's vehicles (1984):
 - Not actually built (by him) but proposed.
 - Started out with a single motor and a single light sensor, and gradually progressed to more motors and more sensors, and more interesting connections between them.
- Excitatory and Inhibitory Connections
 - Stronger signals could induce stronger response.
 - For example, a light sensor could be connected directly to the wheels, so the stronger the light, the faster the robot moved, or even the inverse of the strength.

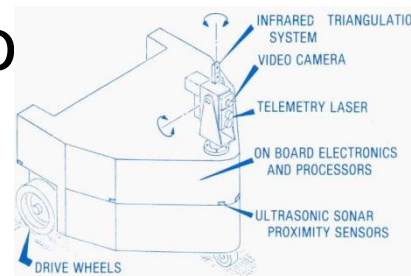
Artificial Intelligence (AI)



- The study of "intelligent agents"
 - “devices that perceive their environment, take actions to maximize their chance of success at some goal” *Wikipedia
- Field created in 1956
 - Minsky, McCarthy, Newell, Simon
 - Produced “Ground breaking” programs that could:
 - Play and win checkers, solve word problems, prove logical theorems, speak English.

Early AI Inspired Robots

- Shakey the robot (66 – 72)
 - First general-purpose mobile [robot](#) to use “reason”
 - Could analyze commands, break them down into basic chunks by itself.
 - Used a camera & bumper sensors to create a "model" of it's environment to help it create and execute plans.
- HILAIRE(1970's)
 - Camera, ultrasound sensor, laser rangefinder.



AI Inspired Robots (cont.)

- Rover (60's – current):
 - A space exploration vehicle
 - Some were fully autonomous
 - Camera and Ultrasound



* <http://cyberneticzoo.com/cyberneticanimals/1977-hilare-autonomous-mobile-robot-french/>

** [https://en.wikipedia.org/wiki/Rover_\(space_exploration\)](https://en.wikipedia.org/wiki/Rover_(space_exploration))

Robots Today and in the Future

- If a job is repetitive, and only requires basic direction following and decision making skills, a robot can AND will wind up doing it.
 - Corporations are profit driven.
 - Machines will replace humans

Future of Robotics

GIZMODO

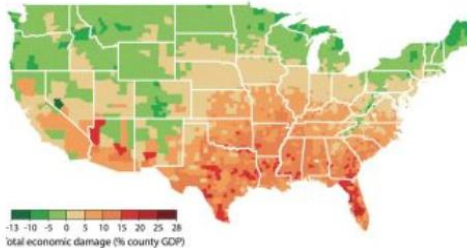
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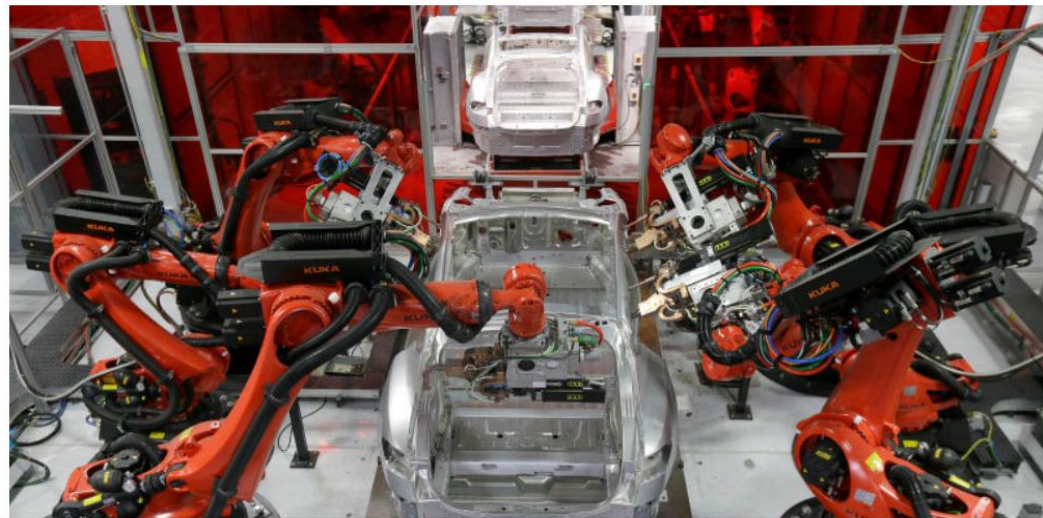
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Future of Robotics (cont.)

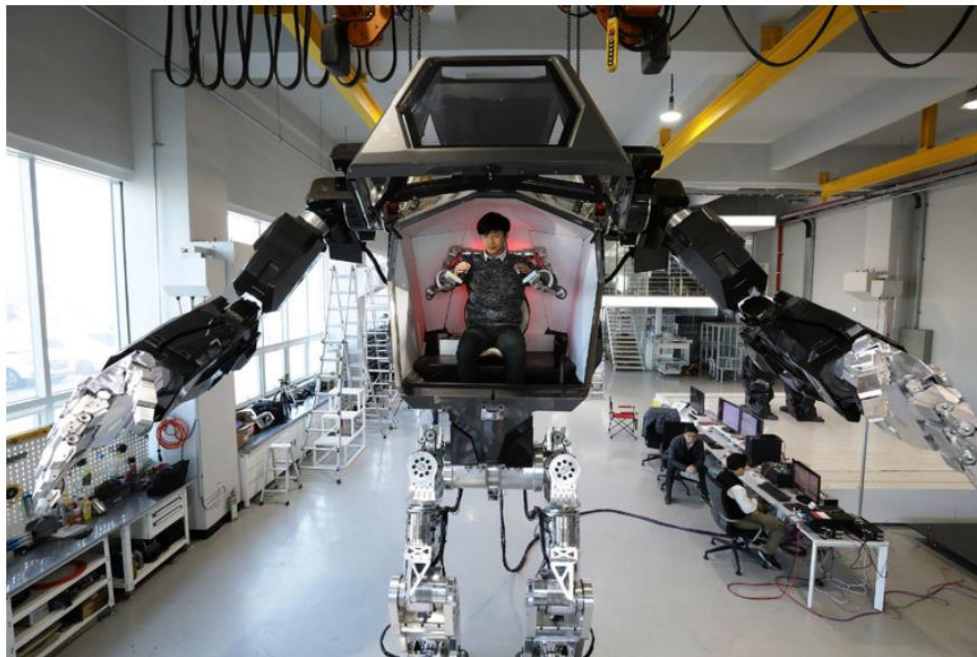
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By STEVE LOHR JAN. 12, 2017



Future of Robotics (cont.)

the guardian

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Robots will eliminate 6% of all US jobs by 2021, report says

Employees in fields such as customer service and transportation face a 'disruptive tidal wave' of automation in the not-too-distant future



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By 2021, robots will have eliminated 6% of all jobs in the US, starting with customer service representatives and eventually truck and taxi drivers. That's just

Robot Components



- Reminder:
 - For our purposes, a robot is an autonomous agent, acting independently. Our environment is the real world.
 - The robot can sense its environment (including its own internal state) and act on it to achieve pre-defined goals.

Robot Components



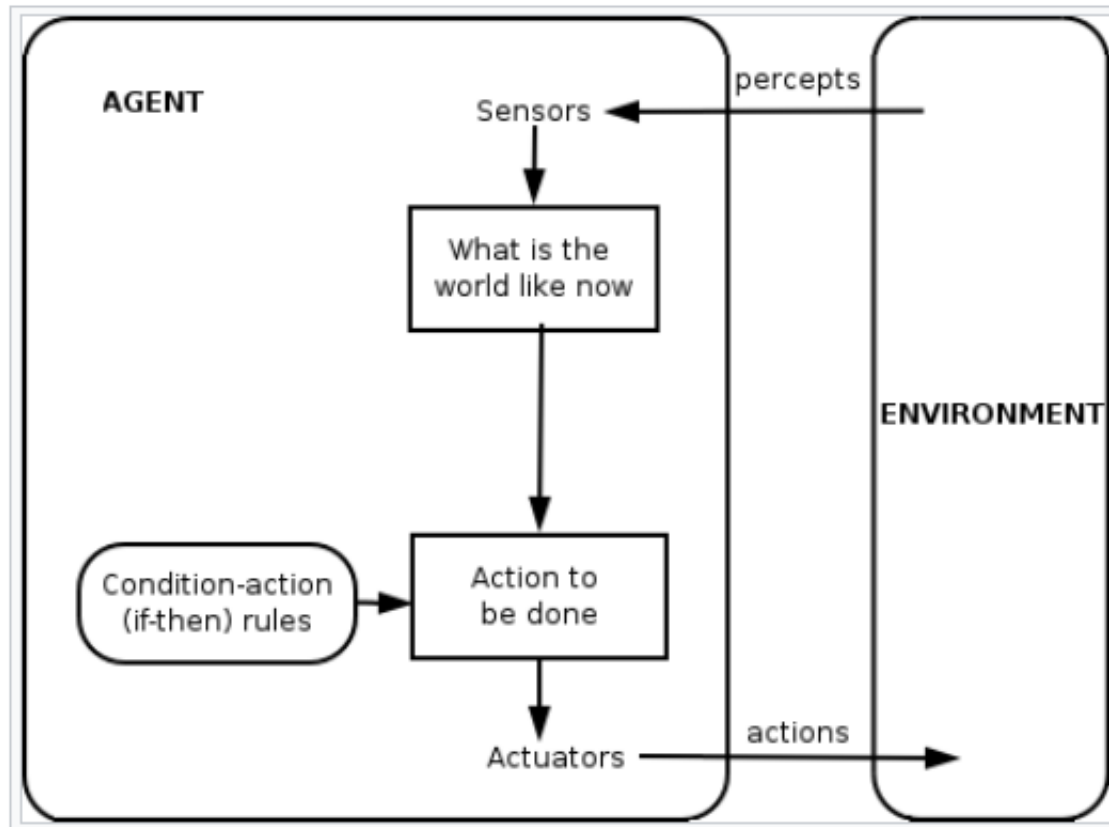
- The robot needs to have:
 - A physical body – robots act in the physical world
 - Sensors
 - receive information from the outside world
 - A controller
 - Includes a computer for the needed computations

Robot Components



- The robot needs to have (cont.):
 - Actuators and effectors – devices that enable the robot to affect the environment
 - By exerting forces upon it or moving through it
 - Include artificial muscles and electric motors
 - Power Source – batteries, solar cells, etc. Multiple power sources can be used together

Robot Components (cont.)



*https://en.wikipedia.org/wiki/Intelligent_agent

LAB

- Let's start working with robots!

