

EXPLORE ROBOTICS – CISC 1003



Topics

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

Course Syllabus

- Tzipora Halevi, Assistant Professor
email: halevi@sci.brooklyn.cuny.edu
Office Hours: Wednesdays, 6:30pm – 8:00pm
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 EV3).

Books

- Books:
 - **The Robotics Primer**, Mataric, 2007
 - **Robot Programming: A Guide to Controlling Autonomous Robots**
by Hughes, Cameron, Hughes, Tracey
 - **The LEGO MINDSTORMS EV3 Discovery Book: A Beginner's Guide to Building and Programming Robots**,
1st Edition (recommended)

Course Syllabus(cont.)

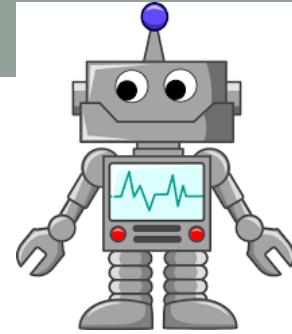
- Assignments include:
 - Written, take home
 - Quizzes, tests
 - In-class presentation
 - Demonstrations, slide-show, etc.
- Grading = 6 unit material (10% each) + Exam (30%) + Attendance+Participation (10%)

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)

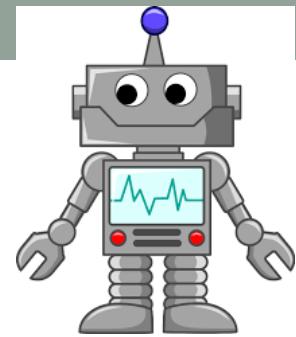


Why study robotics?

- 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...

<https://edspace.american.edu/perf683/2015/10/02/how-easy-would-it-be-for-a-robot-to-takeover-your-job/>

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 (autonomoi)
- 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.

Agents

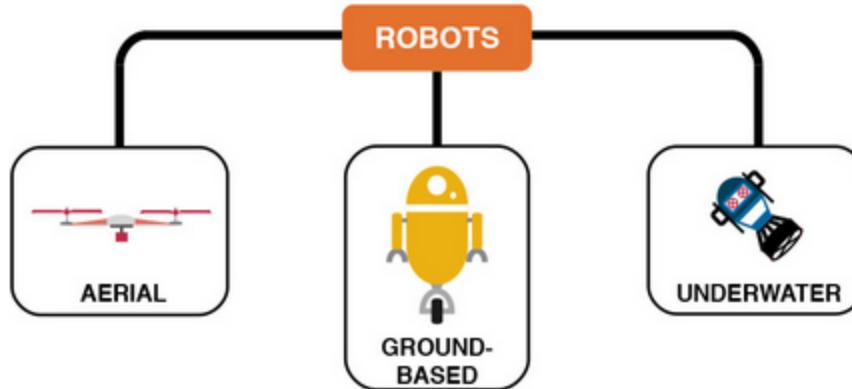


- Autonomous Agent:
 - An agent that works on behalf of someone else
 - but can make decisions on its own
 - guided by feedback (for example, from its sensors).

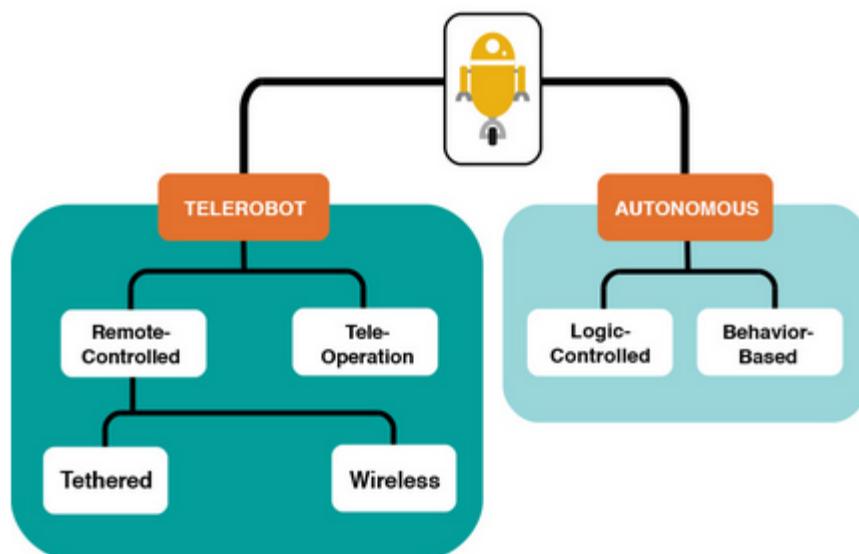
What is a robot? (Cont.)

- 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.

BASIC CATEGORIES FOR ROBOTS



TWO BASIC CATEGORIES OF ROBOT OPERATION



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

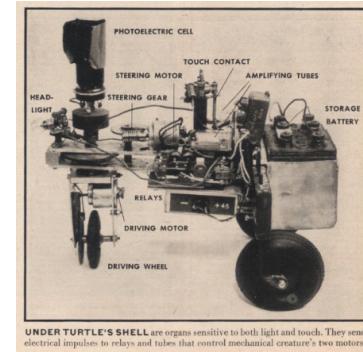


- Who broke these rules?
 - Hollywood broke these rules in “The terminator” [1984], “Transformers”[2007] movies



The First Robots

- Grey Walter's Tortoises (1940):
 - Simulated biological systems (biomimetic).
 - 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

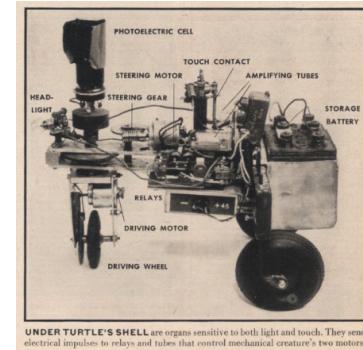


* <http://cyberneticzoo.com/cyberneticanimals/elsie-cyberneticanimals/elsie/>

The First Robots

- Grey Walter's Tortoises (1940):

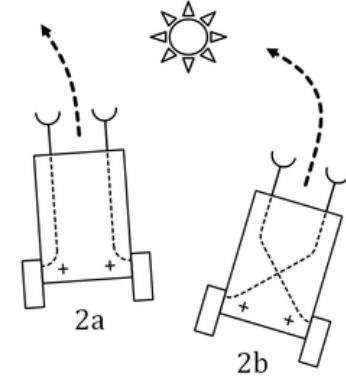
- Simple reasoning:
 - Reactive control using a collection of prioritized “reflexes”.
 - Could still lead to complex behavior (emergent phenomena).



* <http://cyberneticzoo.com/cyberneticanimals/elsie-cyberneticanimals/elsie/>

The First Robots (cont.)

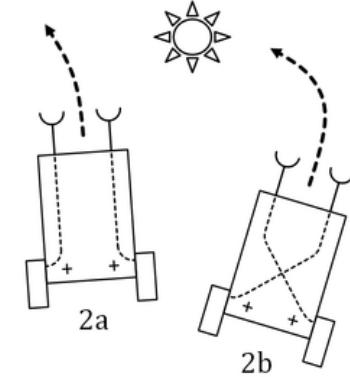
- Braitenberg's vehicles (1984):
 - Not actually built (by him) but proposed.
 - Started out with a single motor and a single light sensor, and gradually progressed to more motors and more sensors, and more interesting connections between them.



*image from https://en.wikipedia.org/wiki/Braitenberg_vehicle

The First Robots (cont.)

- Braitenberg's vehicles (1984):
 - 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.



*image from https://en.wikipedia.org/wiki/Braitenberg_vehicle

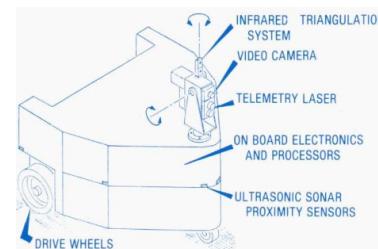
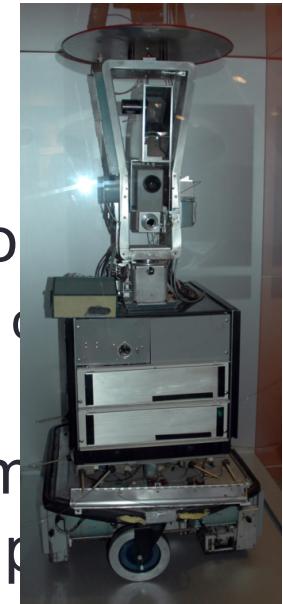
Artificial Intelligence (AI)



- 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.

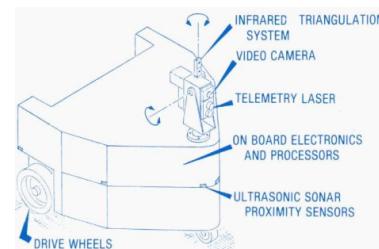
Early AI Inspired Robots

- Shakey the robot (66 – 72)
 - First general-purpose mobile robot to use “reasoning”
 - Could analyze commands, break them down into basic actions, and execute them by itself.
 - Used a camera & bumper sensors to create a “model” of its environment to help it create and execute plans



Early AI Inspired Robots

- HILAIRE(1970's)
 - Camera, ultrasound sensors, 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 History

- History of Robots

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

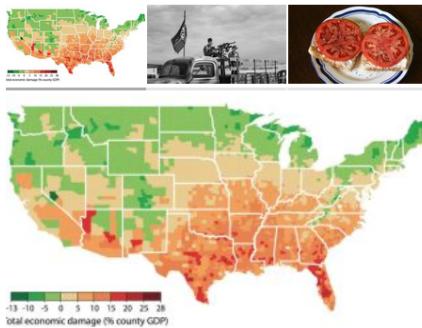
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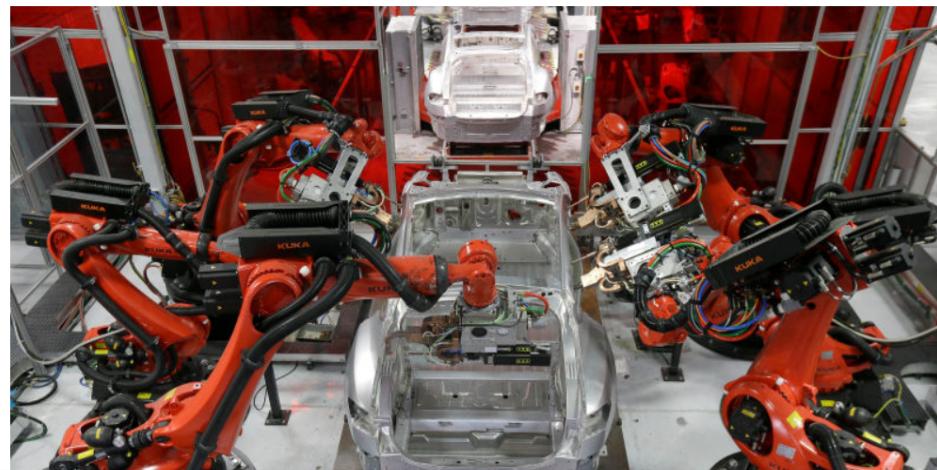
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Future of Robotics (cont.)

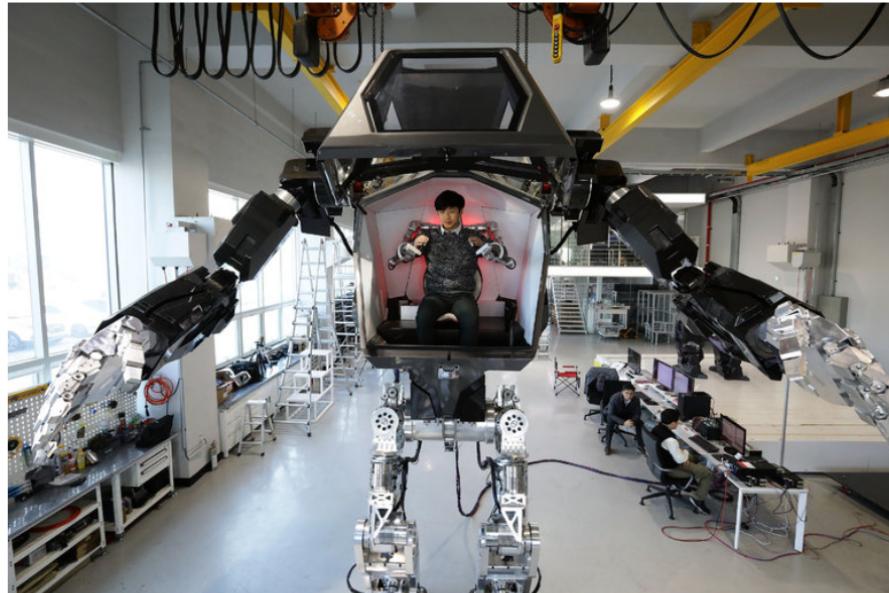
ME SEARCH

The New York Times

TECHNOLOGY

Robots Will Take Jobs, but Not as Fast as Some Fear, New Report Says

By STEVE LOHR JAN. 12, 2017



Future of Robotics (cont.)

the guardian

union sports soccer tech arts lifestyle fashion business travel environment [≡ browse all sections](#)

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



Most popular in US

-  Netflix develops marijuana strains based on its original shows
-  Hurricane Harvey: Texas battered by 'marathon' storm amid flooding fears - latest updates
-  Party poopers: rightwing rally cancelled in San Francisco amid dog poo protest

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

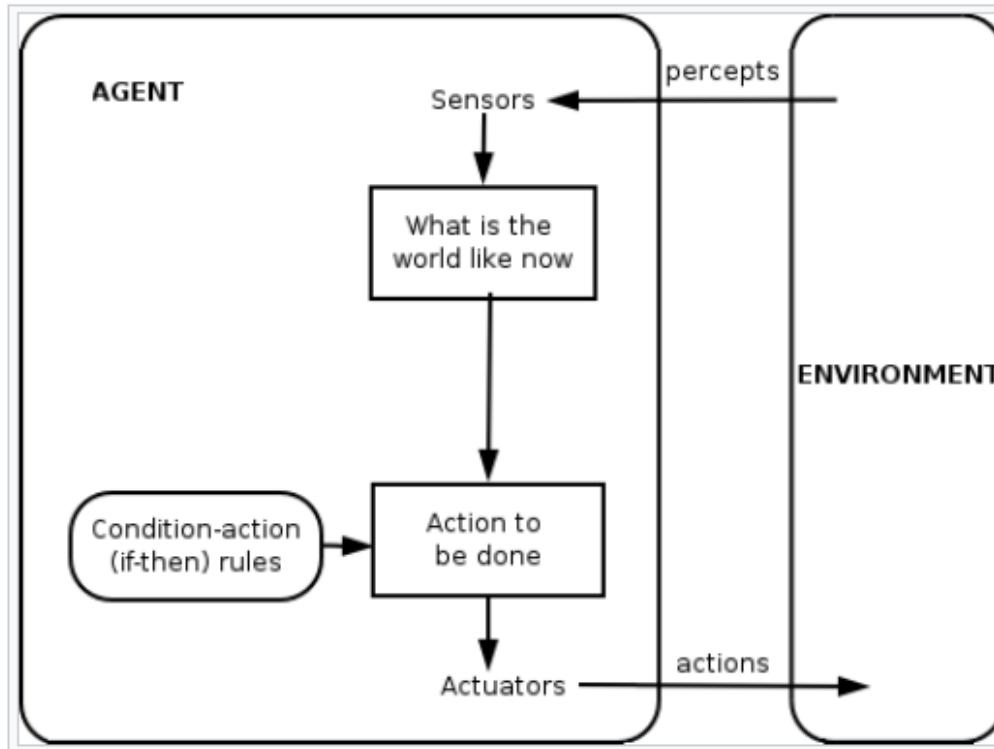


Robot Components

- 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



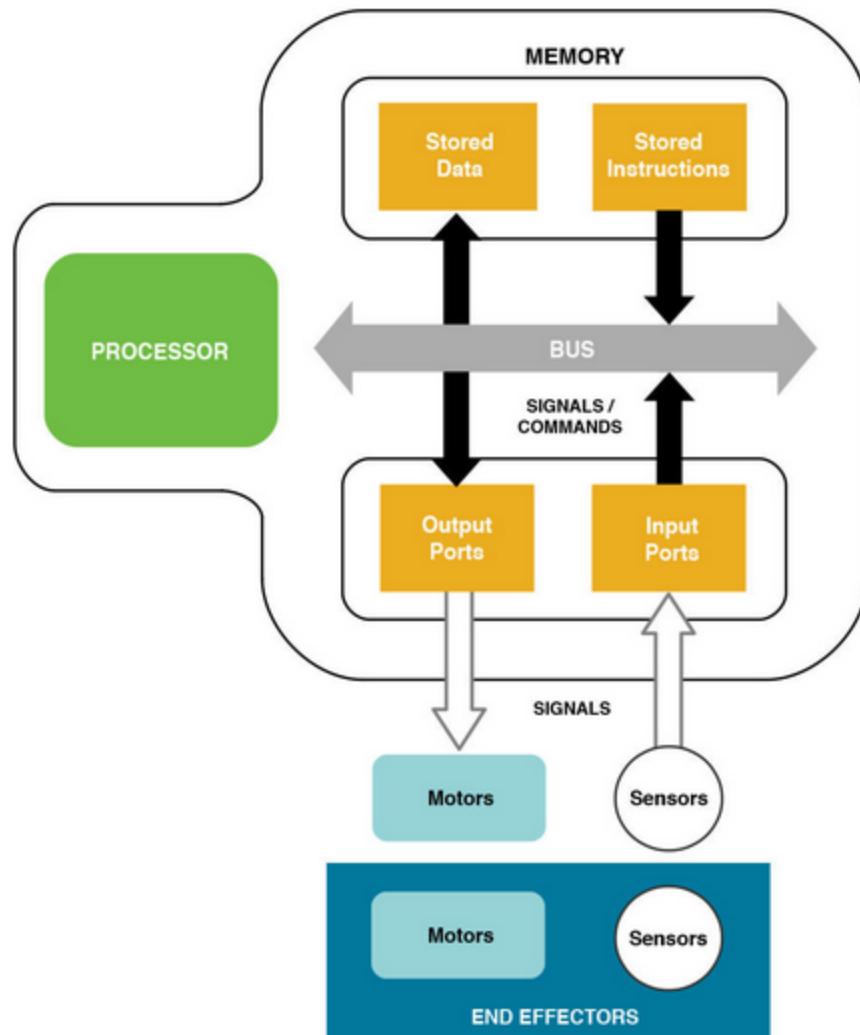
Robot Components (cont.)



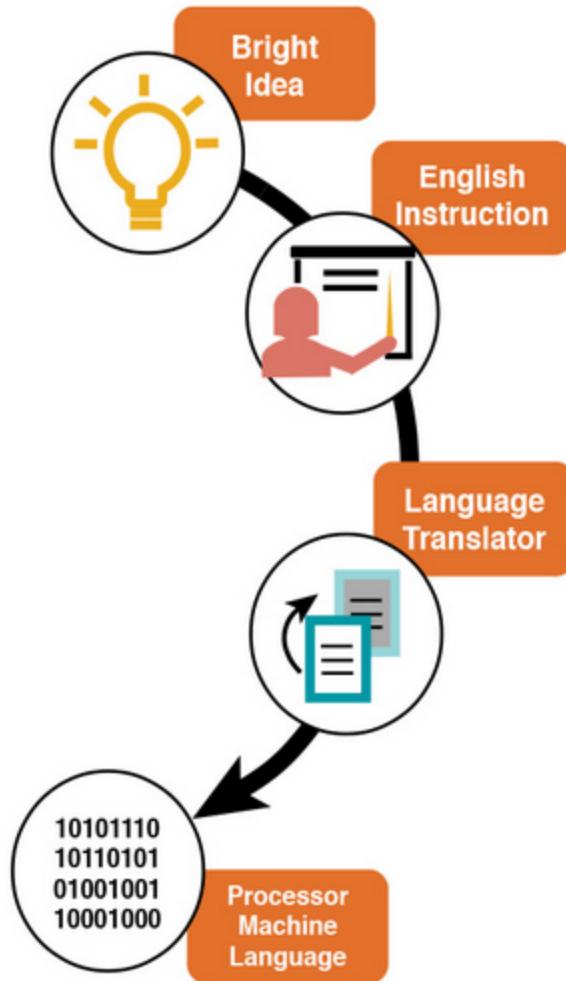
*https://en.wikipedia.org/wiki/Intelligent_agent

MICROCONTROLLER

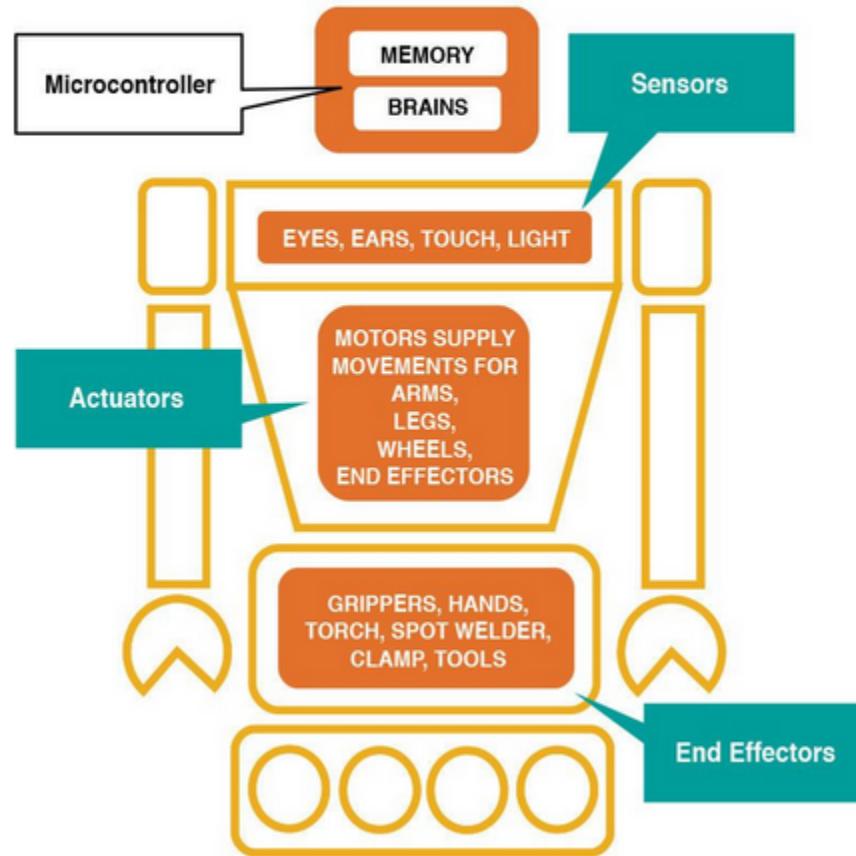
BASIC MICROCONTROLLER COMPONENTS



BRIGHT IDEA TO MACHINE LANGUAGE TRANSLATION



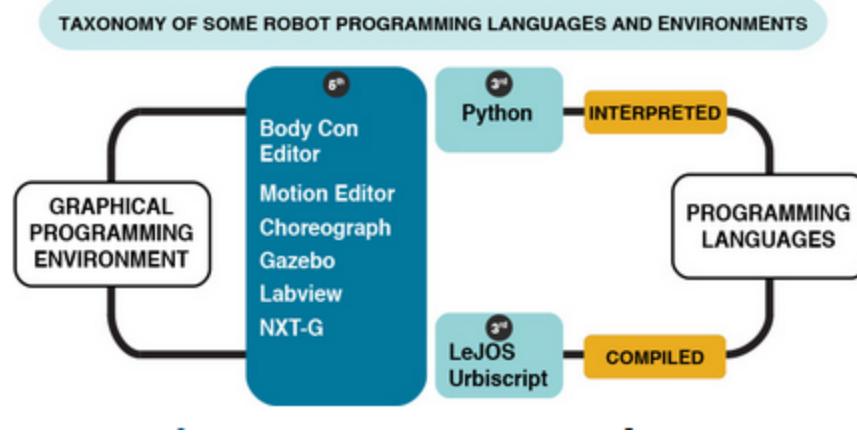
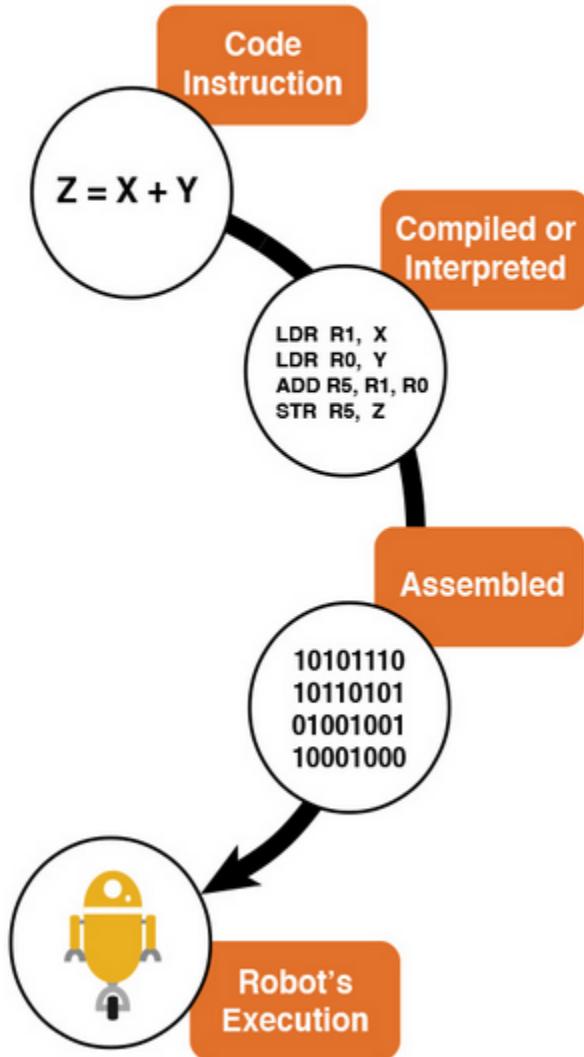
TRANSLATED ROBOT SKELETON



Robot Languages

COMPILER AND INTERPRETER TRANSLATION

- Machine (Binary)
- Assembly
- Puppet Mode
- Graphical Programming



LAB

- Let's start working with robots!

