

# EXPLORE ROBOTICS – CISC 1003

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# Topics

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

# Course Syllabus

- Tzipora Halevi, Assistant Professor  
email: [halevi@sci.brooklyn.cuny.edu](mailto:halevi@sci.brooklyn.cuny.edu)  
Office Hours: Thursdays, 3:30pm – 5:00pm  
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.)

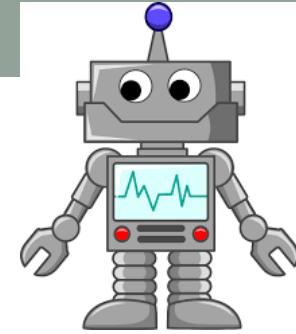
- Assignments include:
  - Written, take home
  - Quizzes, tests
  - In-class presentation
    - Demonstrations, slide-show, etc.
- Grading = 6 unit material (10% each) + Exam (30%) + Attendance+Participation (10%)

# 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)

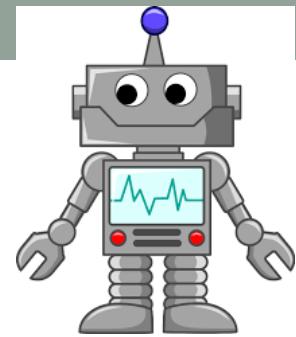


# Why study robotics?

- 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

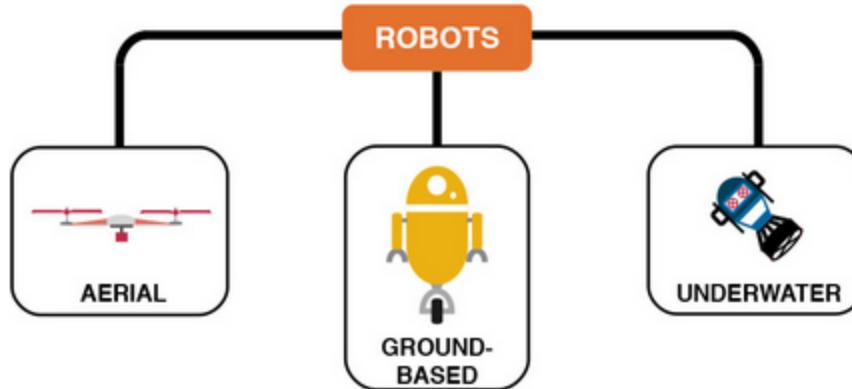


- Autonomous Agent:
  - An agent that works on behalf of someone else
  - but can make decisions on its own
    - guided by feedback (for example, from its sensors).

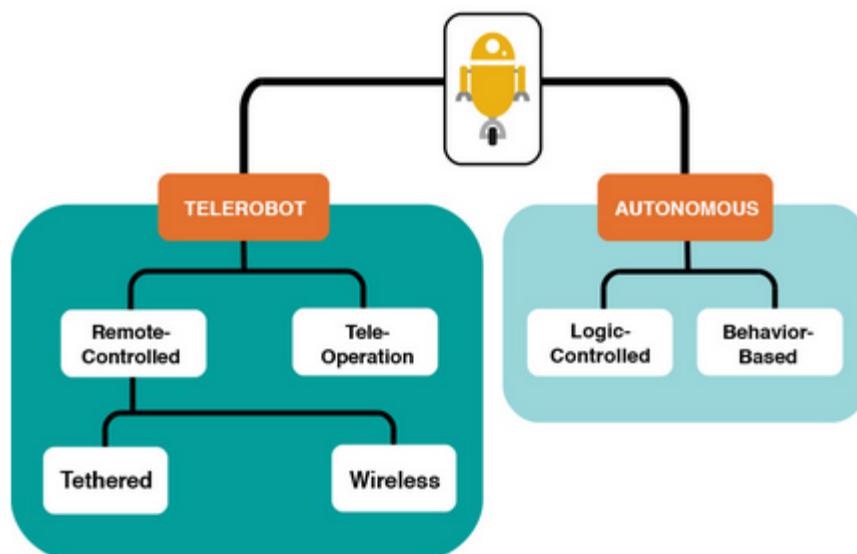
# What is a robot? (Cont.)

- 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

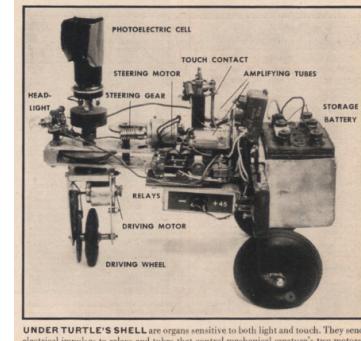


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  - A robot must protect its own existence as long as such protection does not conflict with the First or Second Law.
- Hollywood broke these rules in “The terminator” [1984], “Transformers”[2007] movies



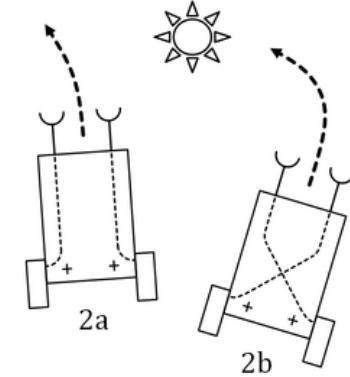
# The First Robots

- 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
  - 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.
- 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](https://en.wikipedia.org/wiki/Braitenberg_vehicle)

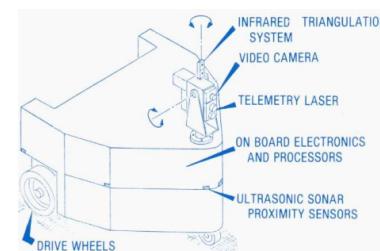
# Artificial Intelligence (AI)



- 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 “reason”
    - Could analyze commands, break them down into basic chunks by itself.
    - Used a camera & bumper sensors to create a "model" of its environment to help it create and execute plans.
- 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

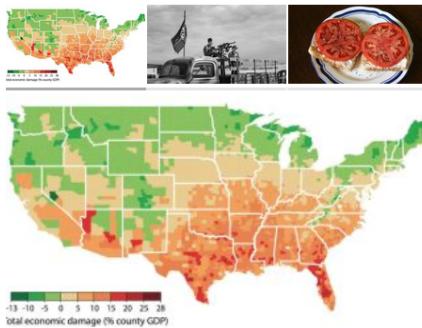
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Today 5:00pm

## Robots Are Already Replacing Human Workers at an Alarming Rate



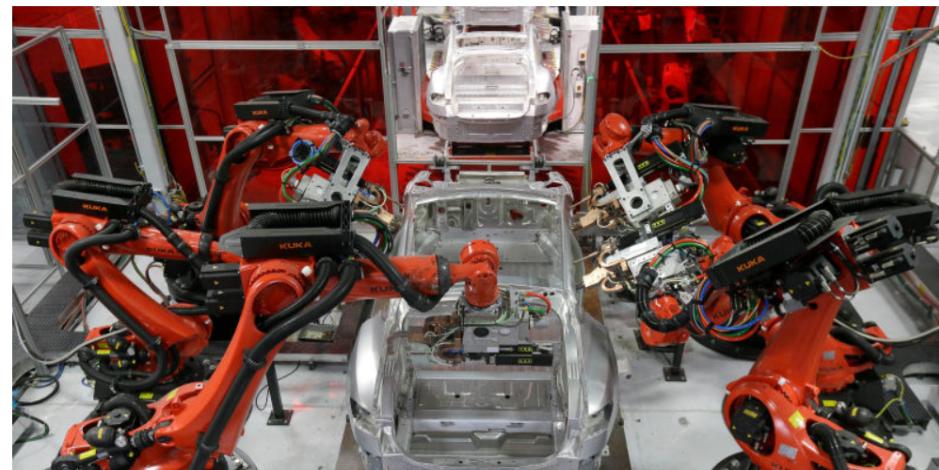
George Dvorsky

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# Future of Robotics (cont.)

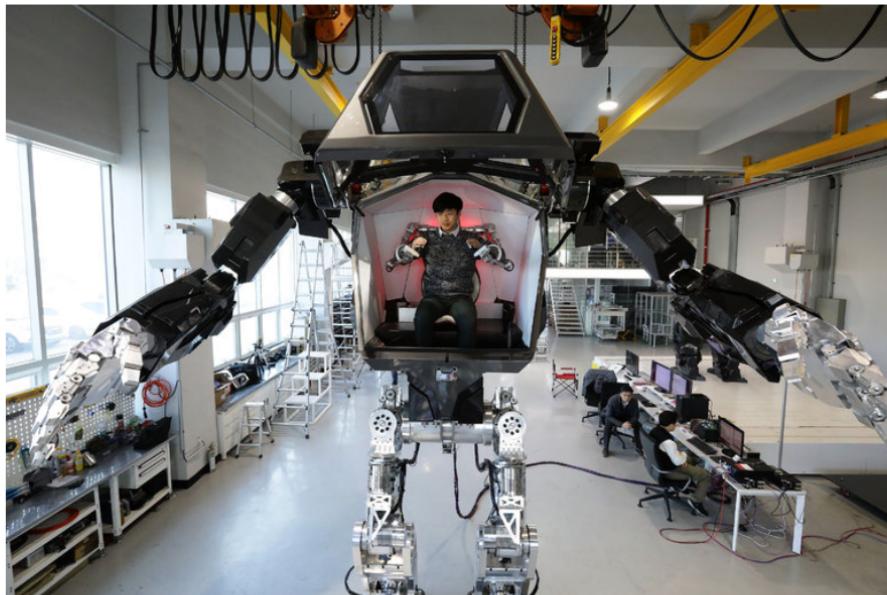
ME SEARCH

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

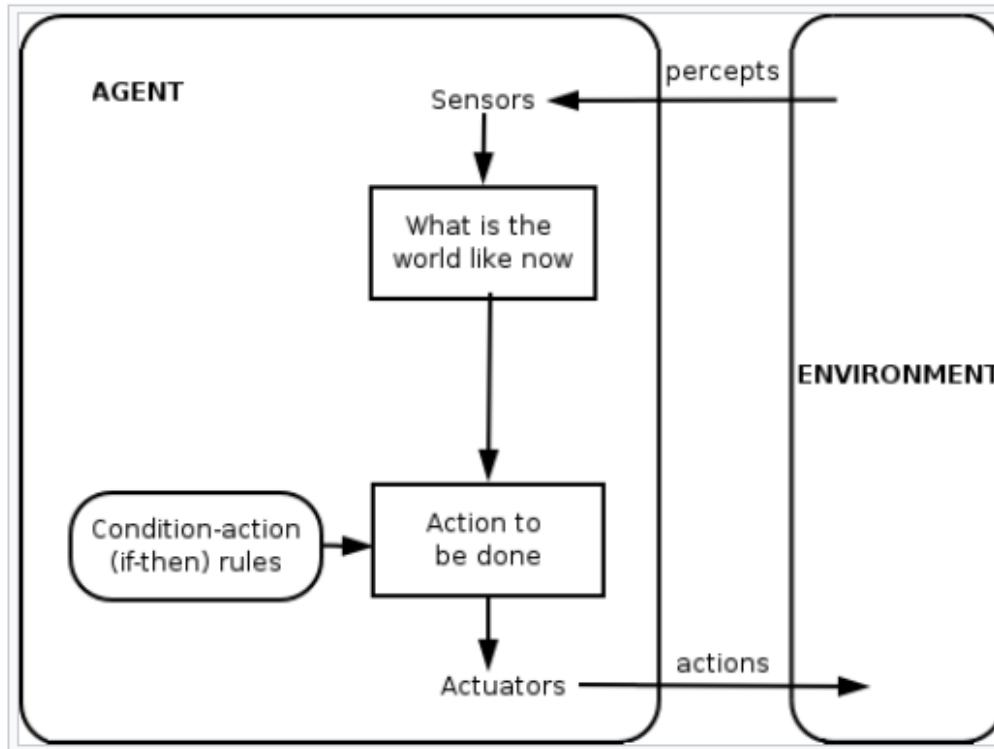


# Robot Components

- 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.)

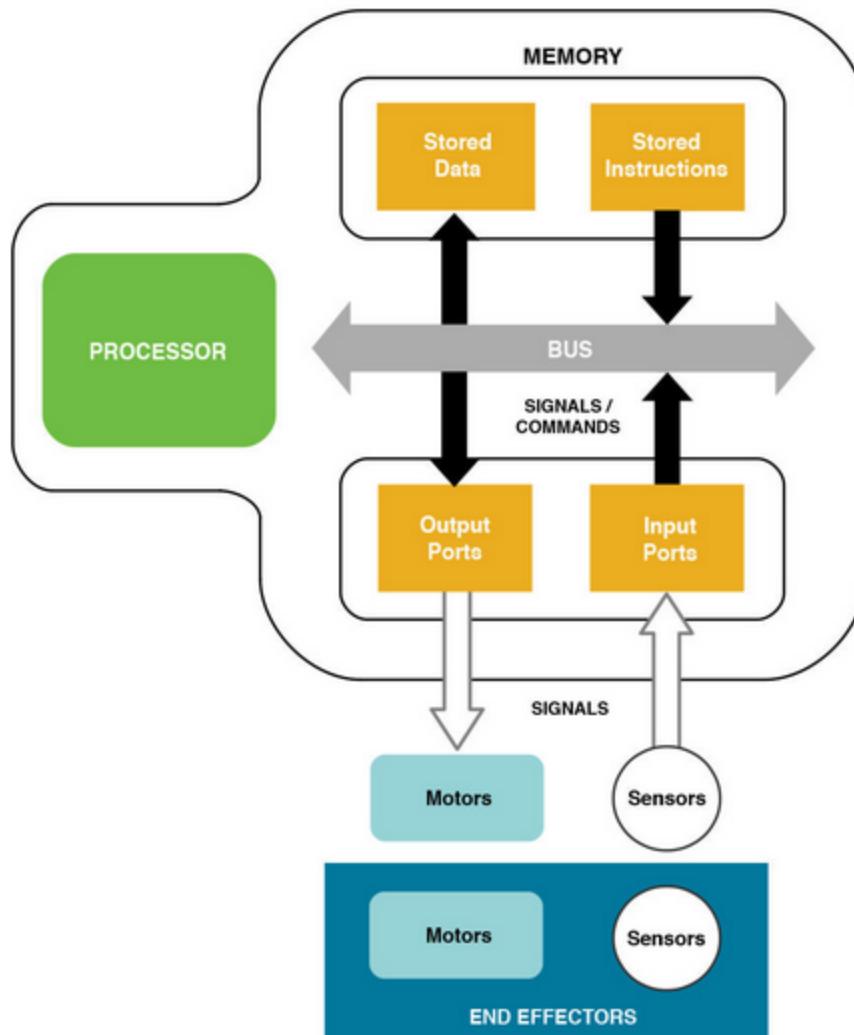


\*[https://en.wikipedia.org/wiki/Intelligent\\_agent](https://en.wikipedia.org/wiki/Intelligent_agent)

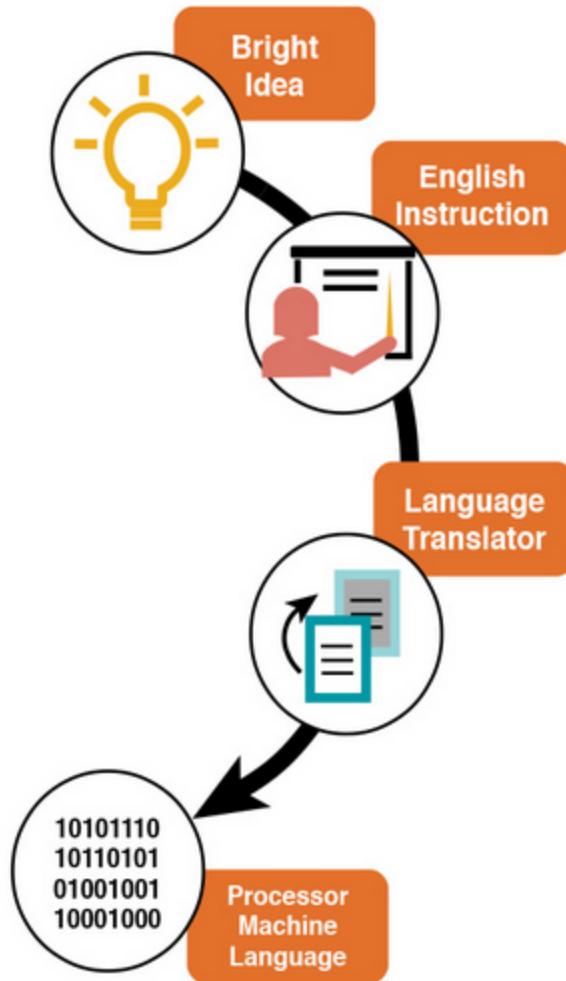
# MICROCONTROLLER

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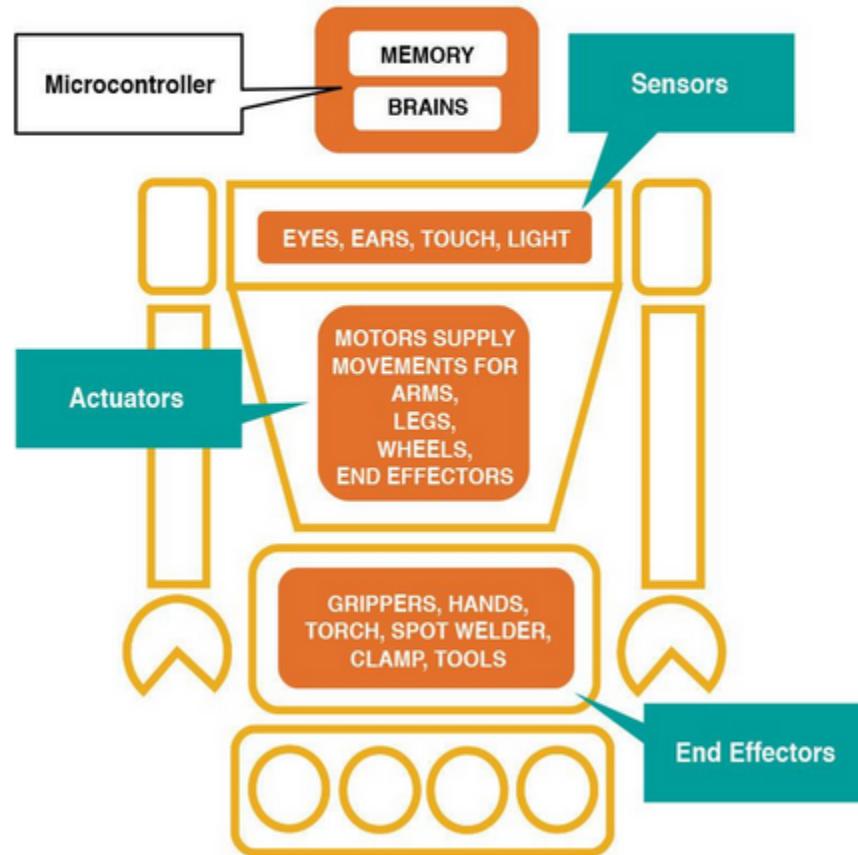
## BASIC MICROCONTROLLER COMPONENTS



## BRIGHT IDEA TO MACHINE LANGUAGE TRANSLATION



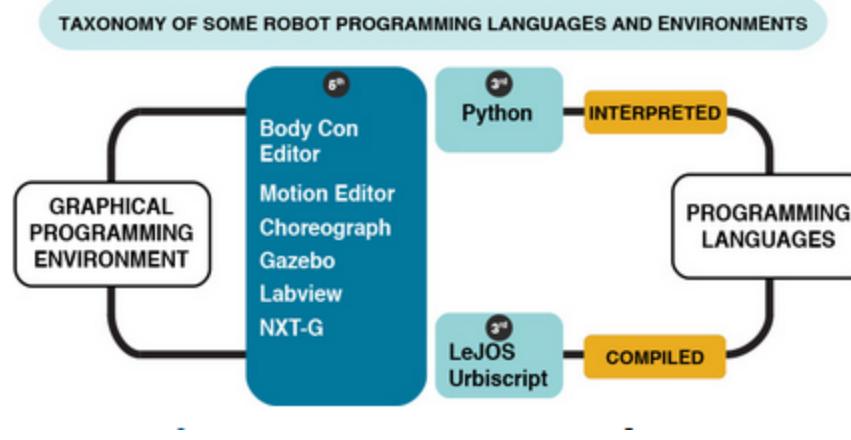
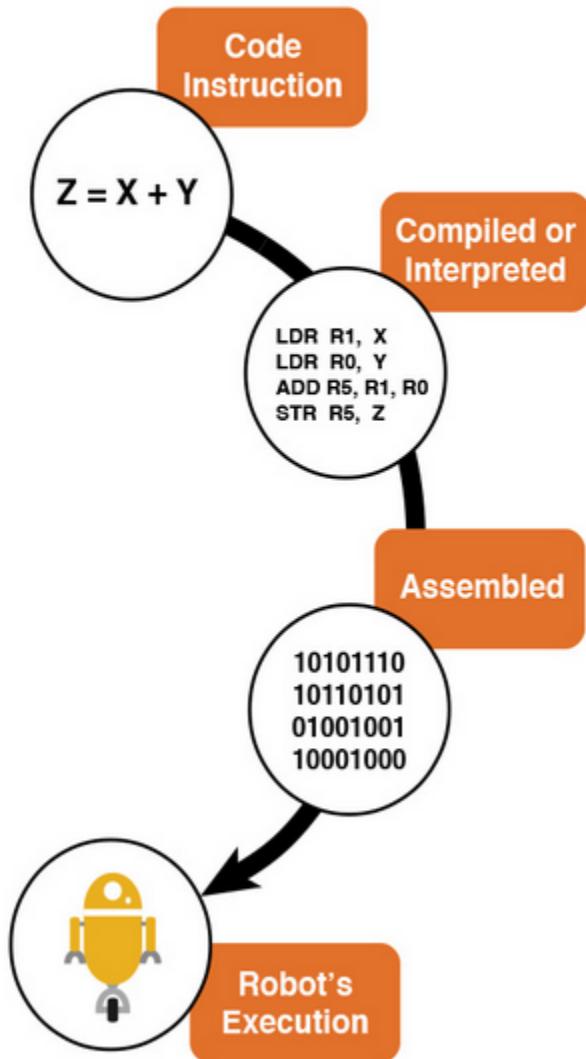
## TRANSLATED ROBOT SKELETON



# Robot Languages

## COMPILER AND INTERPRETER TRANSLATION

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



# LAB

- Let's start working with robots!

