

# EXPLORE ROBOTICS – CISC 1003

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# Topics

- Class syllabus
- Introduction to Robots
- Introducing the virtual environment

# Course Syllabus

- [Course Syllabus](#)

# Course Syllabus

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Office Location: Ingersol 2156A
- Office hours: Tuesdays, Thursdays 3:30 – 4:30 pm

# Course Syllabus

- Online Course Webpage:  
<http://thalevi.github.io/CISC1003>

Course has 6 units. Each unit includes:

- 1-2 Lectures
- 1-2 virtual labs
- 1-2 assignments

# Course Conflicts

- This class does not support conflicts with other classes/activities
- Attendance is mandatory
- ***We will not be accommodating midterm/final exam conflicts due to taking overlapping class***

# Course Syllabus (Cont.)

- Attendance: This is a hands-on course. There is no option of making up missed labs.
- We will be working with the virtual lab online:
  - [VEX CODE VR](#)
- We will be creating programs with:
  - [VEX Virtual Lab](#)

# Course Syllabus (Cont.)

- We will also be working with the EV3 robot
  - [EV3 user guide](#)
  - [EV3 help](#)
  - [EV3-Introduction to Programming](#)
  - [EV3 activities](#)
  - [EV3 Building Instructions](#)



# Books

- Books:
  - **Elements of Robotics**, Mordechai Ben-Ari and Francesco Mondada
    - <https://link.springer.com/book/10.1007/978-3-319-62533-1>
    - Direct Download Link:  
<https://link.springer.com/content/pdf/10.1007%2F978-3-319-62533-1.pdf>

# Books

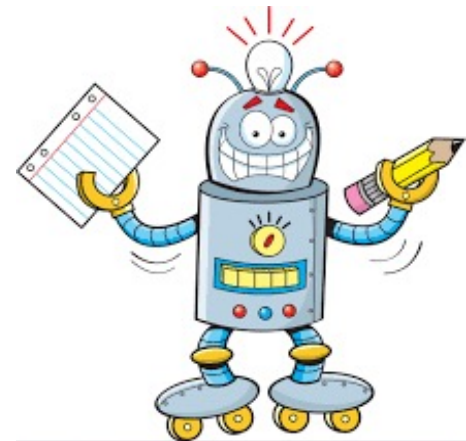
- Books:
  - **Introduction to Autonomous Robots**, Nikolaus Correll
    - v1.9, March 6, 2020, Magellan Scientific ISBN-13: 978-0692700877
    - Direct Download Link:  
<https://github.com/correll/Introduction-to-Autonomous-Robots/releases/download/v1.9.2/book.pdf>

# Books

- Books:
  - **The Robotics Primer**, Mataric, 2007
    - Publisher: The MIT Press (September 30, 2007)
    - ISBN-10: 026263354X
    - ISBN-13: 978-0262633543

# Student Introduction

- Please take a minute to introduce yourself:
- Name
- Year
- Department/Major
- Why are you taking robotics



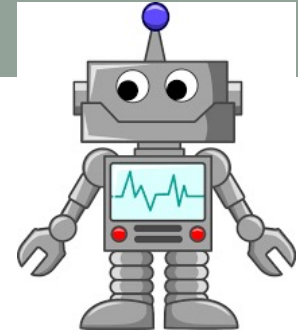
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# Questions?



# Unit A - Introduction to Robots

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

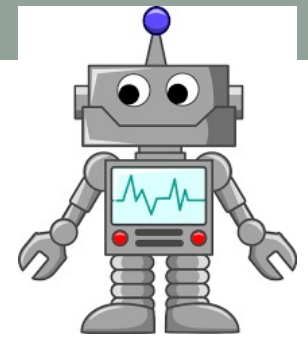


# Why study robotics?

- 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



# What is a Robot?

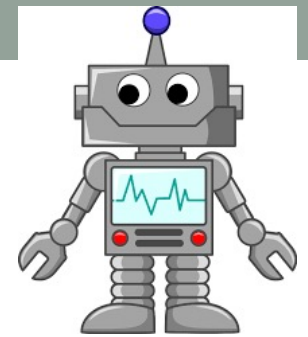
- “Carrying out actions automatically.”
  - This is a key element in robotics
    - but also in many other simpler machines called automata.
  - The difference between a robot and a dishwasher is in the definition of what a “complex series of actions” is.
    - Is washing clothes composed of a complex series of actions or not?
      - Is flying a plane on autopilot a complex action? Is cooking bread complex?
    - For all these tasks there are machines that are at the boundary between automata and robots.

# What is a Robot?

- “Programmable by a computer” is another key element of a robot
  - Some automata are programmed mechanically and are not very flexible.
  - On the other hand, computers are found everywhere
    - so it is hard to use this criterion to distinguish a robot from another machine.

# What is a Robot?

- A crucial element of robots that is not mentioned explicitly in the definition is the use of *sensors*.
- Most automata do not have *sensors* and cannot adapt their actions to their environment
- *Sensors* are what enable a robot to carry out complex tasks.



# What is a robot?

- 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.

# Agents



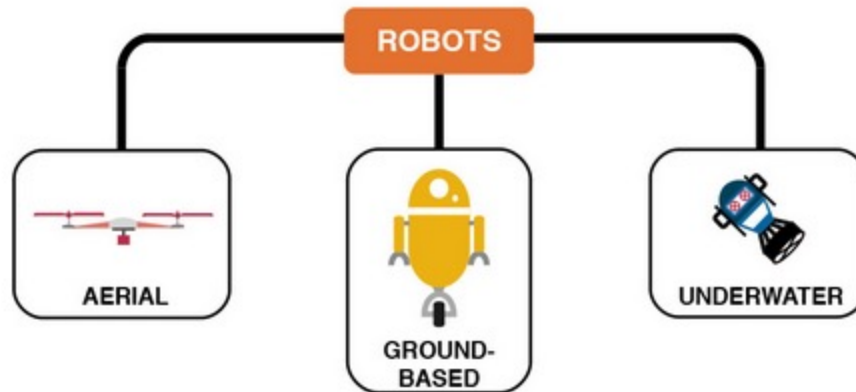
- Autonomous Agent:
  - An agent that works on behalf of someone else
  - but can make decisions on its own
    - guided by feedback (for example, from its sensors).

# What is a robot? (Cont.)

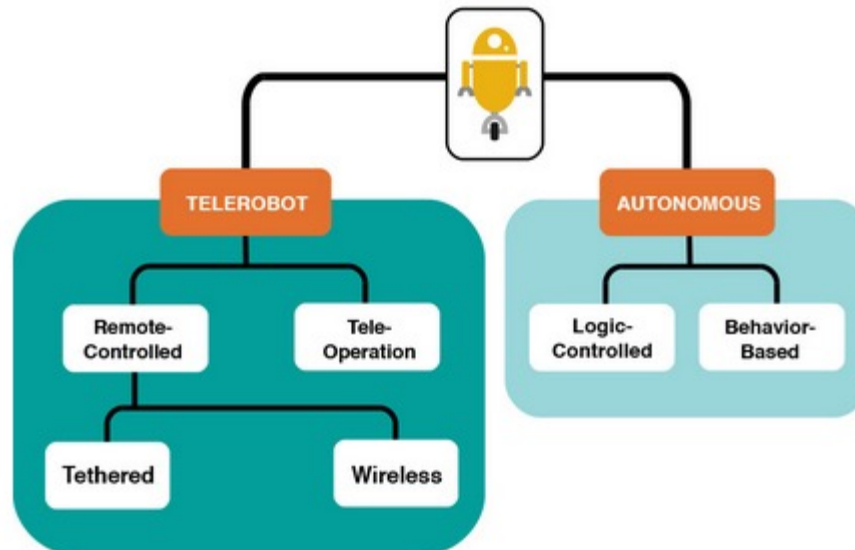
- Our definition of robot (for our purposes):
  - An autonomous agent, acting independently. Our environment is the real world.
  - The robot can sense its environment (including its own internal state)
    - and act on it to achieve pre-defined goals.
- Robotics: The study of robots
  - their design, 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 Sci-Fi author coined the word “Robotics” to describe the field of study.
- Asimov proposed in "Runaround" (1942) the 3 Laws of Robotics

# Asimov's 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

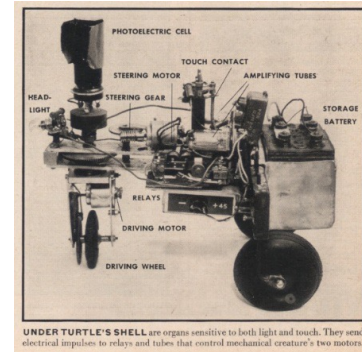


- What was the goal of these rules?
  - Ensure that robots always serve and obey humans
- Who broke these rules?
  - Hollywood broke these rules in “The terminator” [1984], “Transformers”[2007] movies



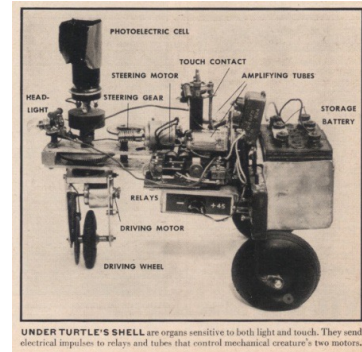
# The First Robots

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



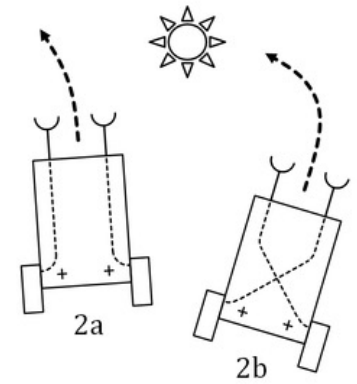
# The First Robots

- Grey Walter's Tortoises (1940):
  - Simple reasoning:
    - Reactive control using a collection of prioritized “reflexes”.
    - Could still lead to complex behavior (emergent phenomena).



# 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
  - gradually progressed to more motors and more sensors
    - and more interesting connections between them.

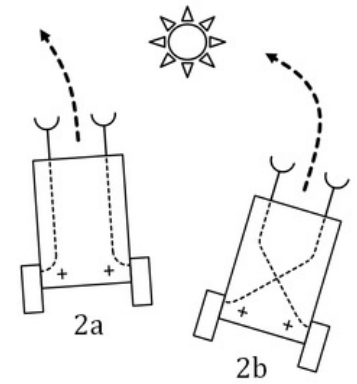


\*image from [https://en.wikipedia.org/wiki/Braitenberg\\_vehicle](https://en.wikipedia.org/wiki/Braitenberg_vehicle)



# 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](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.

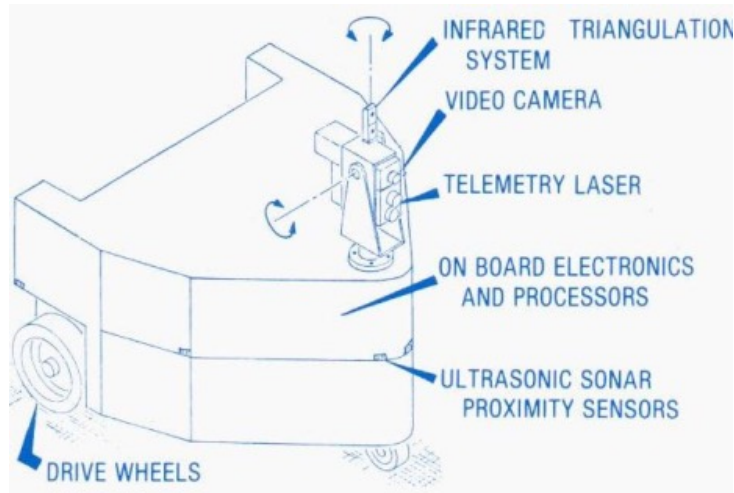
# Early AI Inspired Robots

- 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 it's 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

- [Sophia the Robot](#)

# Robots Today and in the Future

- If a job is repetitive
  - 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

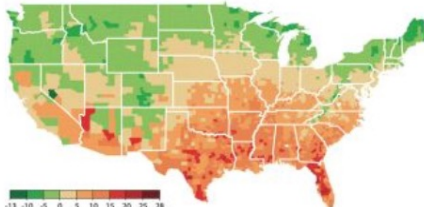
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Today 5:00pm

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



George Dvorsky

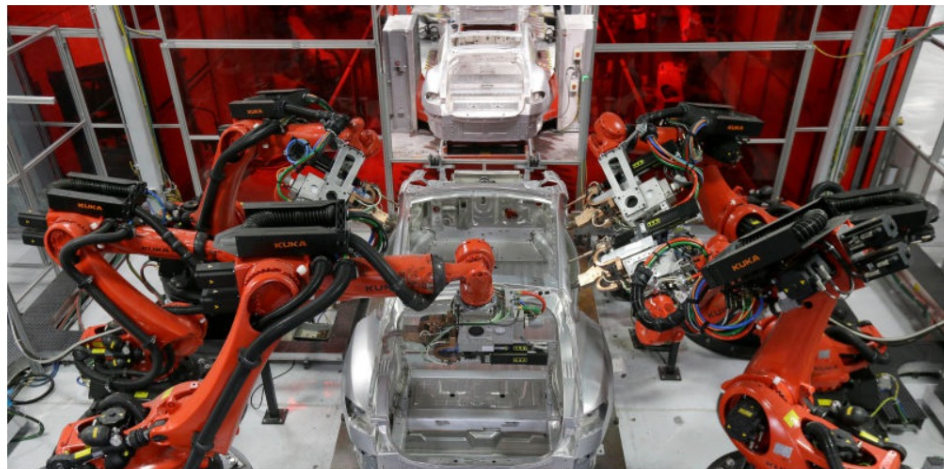
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# Future of Robotics (cont.)

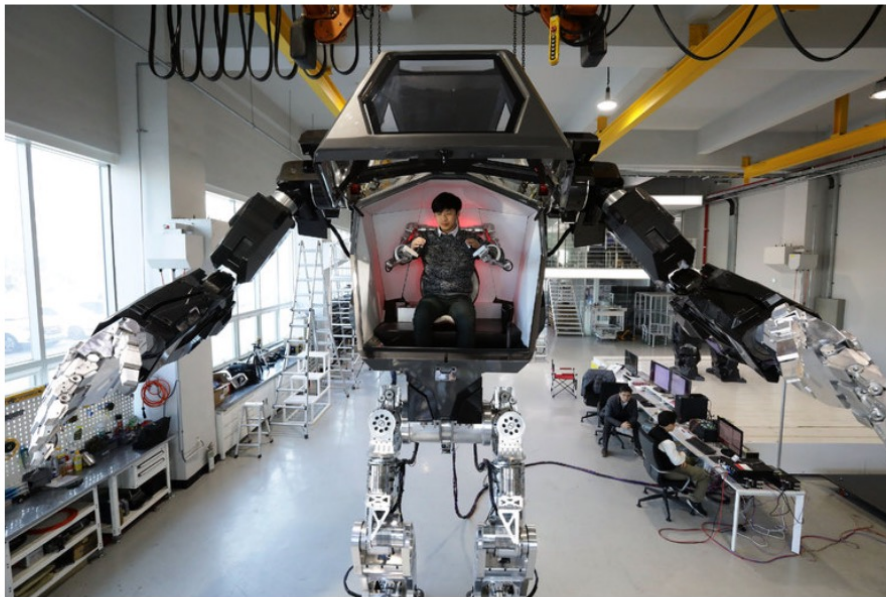
AE Q SEARCH

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 screenshot shows the Guardian website's navigation bar with categories like 'sport', 'soccer', 'tech', 'arts', 'lifestyle', 'fashion', 'business', 'travel', and 'environment'. The main article title is 'Robots will eliminate 6% of all US jobs by 2021, report says'. The sub-headline reads: 'Employees in fields such as customer service and transportation face a 'disruptive tidal wave' of automation in the not-too-distant future'. The main image is a dark grey self-driving car with a sensor dome on its roof. To the right, a 'Most popular in US' section lists three articles: 'Netflix develops marijuana strains based on its original shows', 'Hurricane Harvey: Texas battered by 'marathon' storm amid flooding fears - latest updates', and '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

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# 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

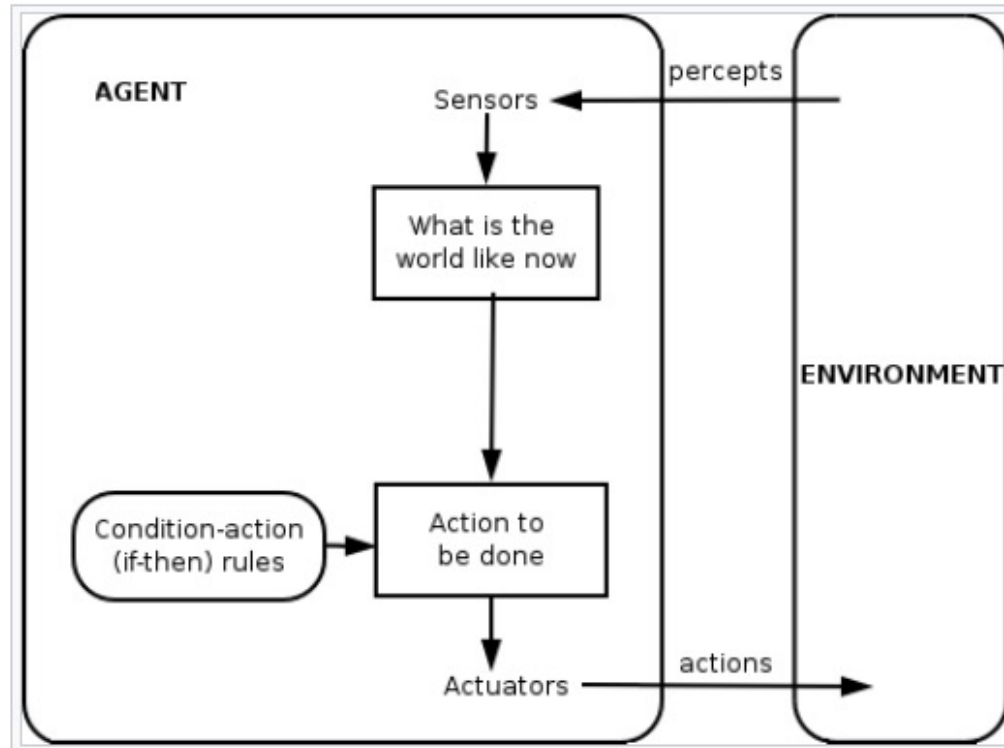


# Robot Components

- 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.)



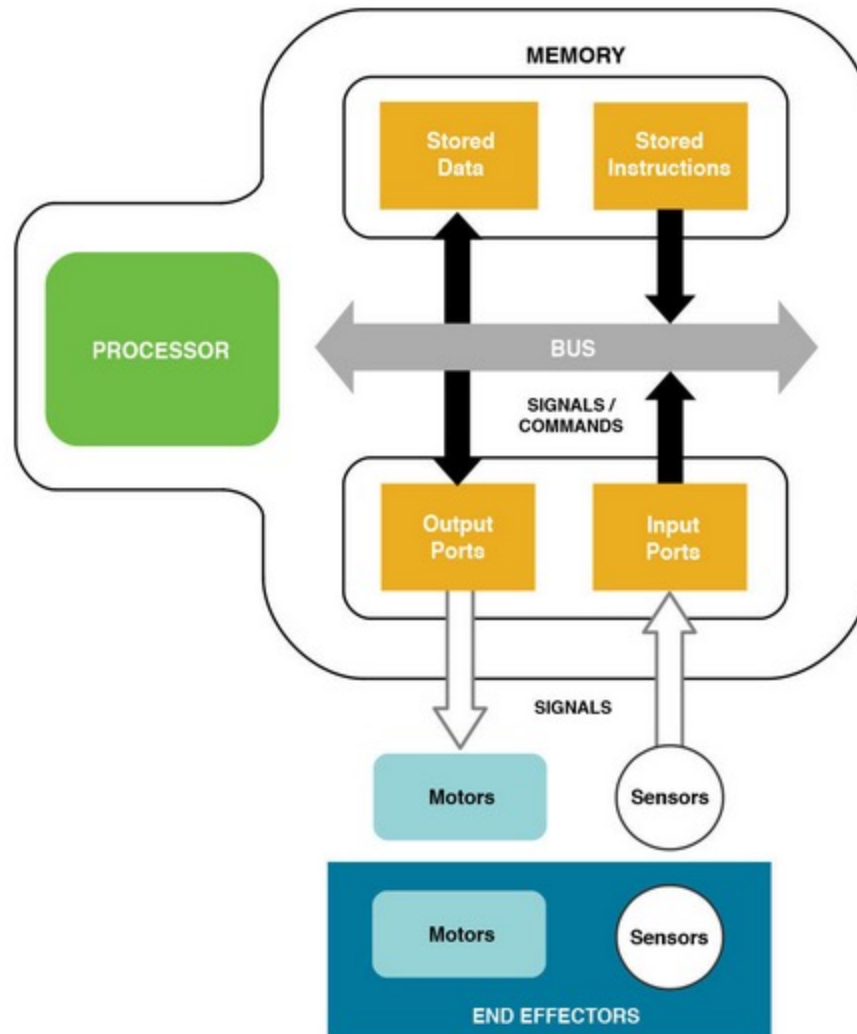
\*[https://en.wikipedia.org/wiki/Intelligent\\_agent](https://en.wikipedia.org/wiki/Intelligent_agent)



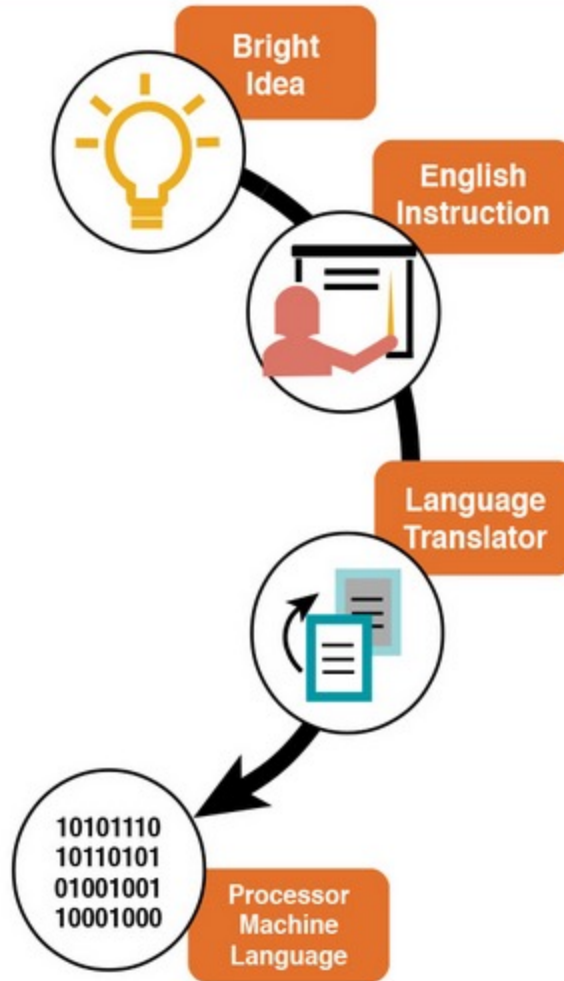
# MICROCONTROLLER

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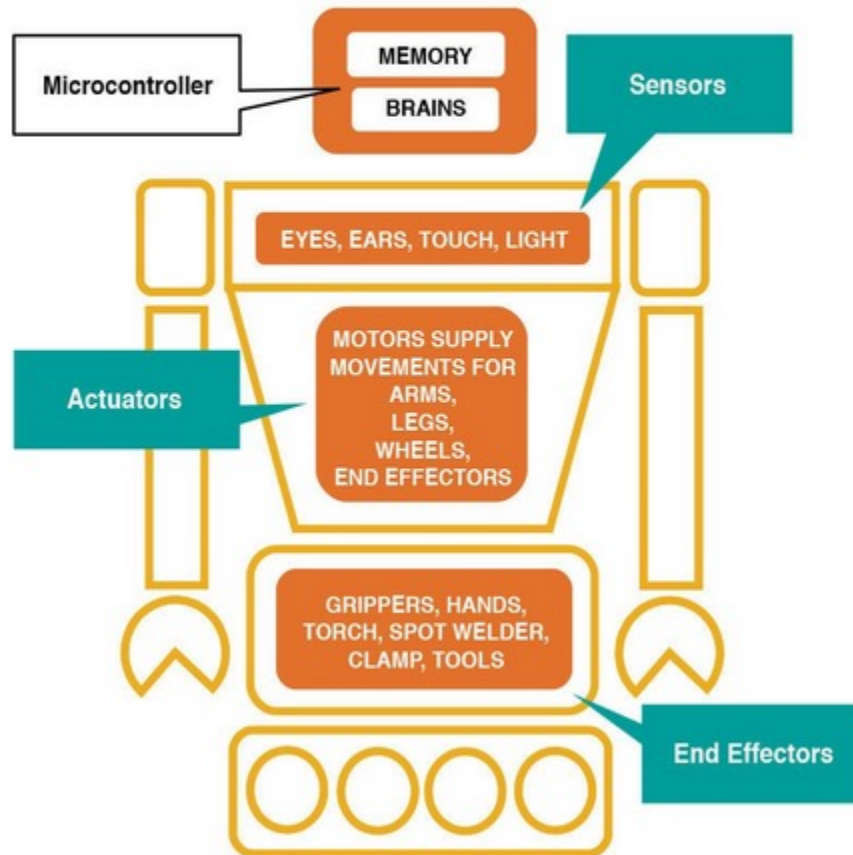
## BASIC MICROCONTROLLER COMPONENTS



## BRIGHT IDEA TO MACHINE LANGUAGE TRANSLATION



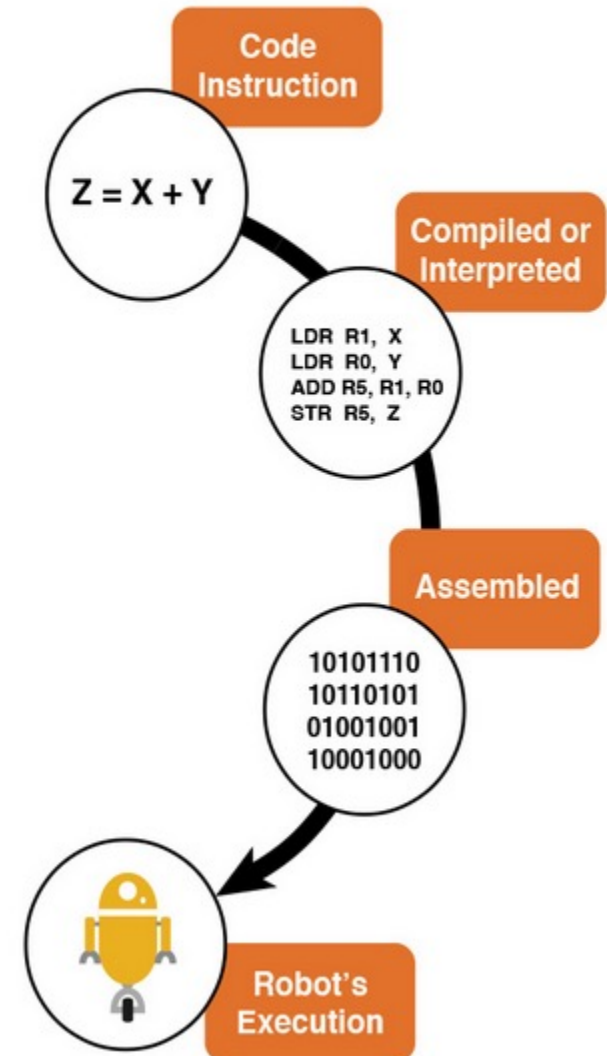
## TRANSLATED ROBOT SKELETON



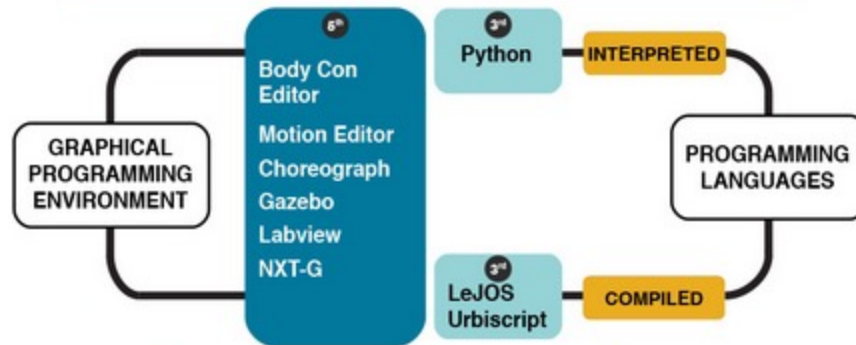
# Robot Languages

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

## COMPILER AND INTERPRETER TRANSLATION



## TAXONOMY OF SOME ROBOT PROGRAMMING LANGUAGES AND ENVIRONMENTS



# LAB

- Let's start working with robots!



# Vexcode VR

- We will be working with the virtual lab online:
  - [VEX CODE VR](#)
  - [Getting-started-with VEXcode VR](#)
- We will be creating programs with:
  - [VEX Virtual Lab](#)

# Course Syllabus (Cont.)

- We will also be working with the EV3 robot
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# Virtual LAB

- Let's start working with robots!

