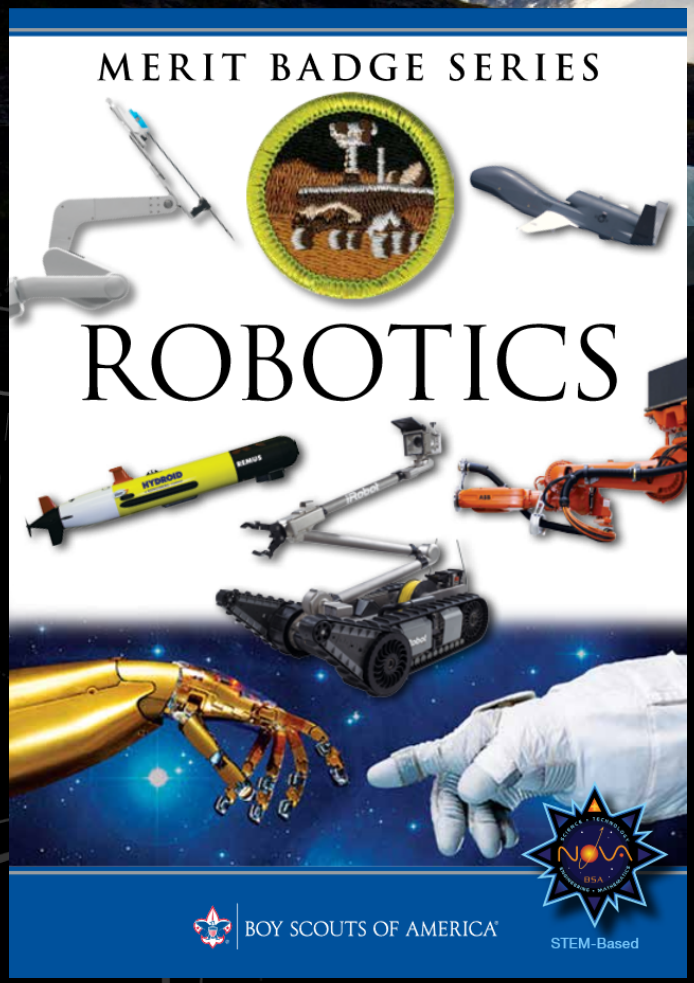
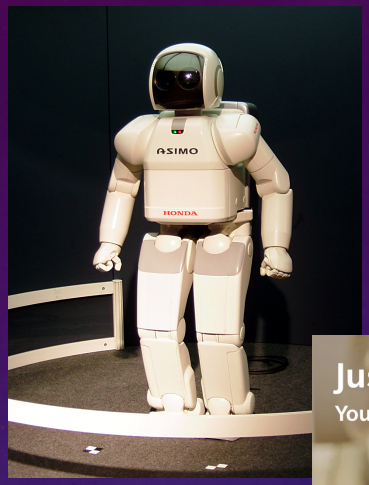
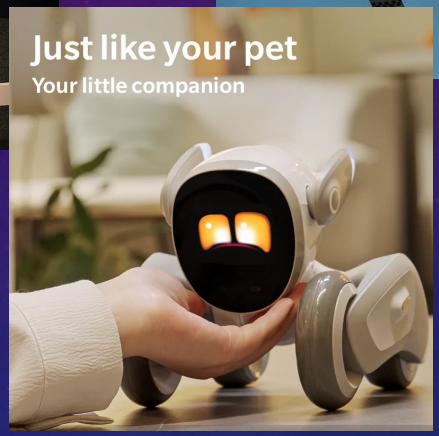


Robots in our lives

Boy Scouts Robotics Merit Badge

WHAT IS A ROBOT?





- A programmable machine
- Capable of carrying out actions automatically
- Can be directly controlled by humans or can operate on their own

Early Automaton

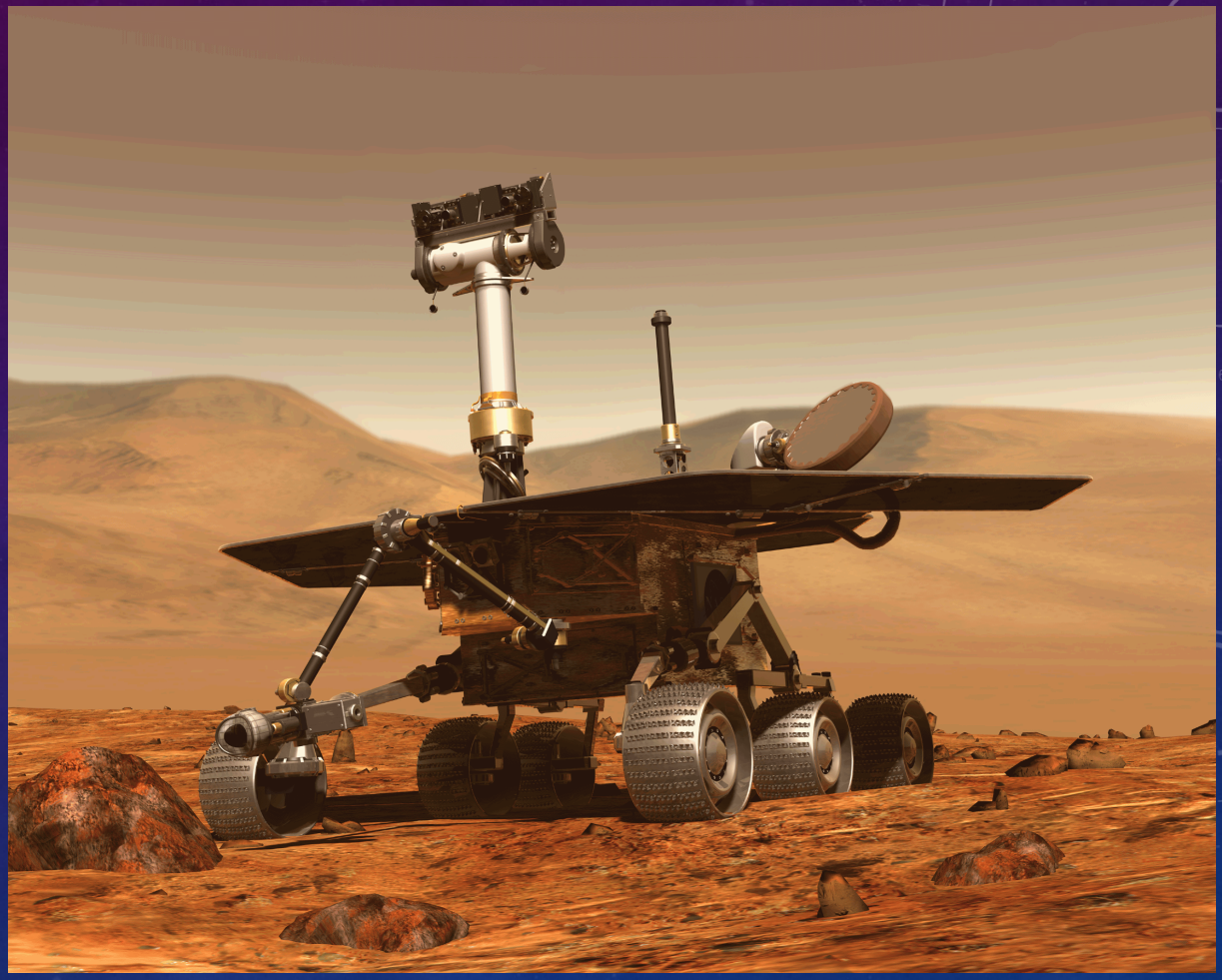
WHAT TASKS CAN ROBOTS HELP US WITH?

ROBOTS CAN HELP US

Robots can help humans perform dangerous, dirty, dull, and difficult tasks

EXPLORATION

Mars Rover Spirit



SAFETY

Bomb Disposal using remote controlled (RC) robots

Why do some robots have tracks instead of wheels?

PRODUCTION

Automobile assembly

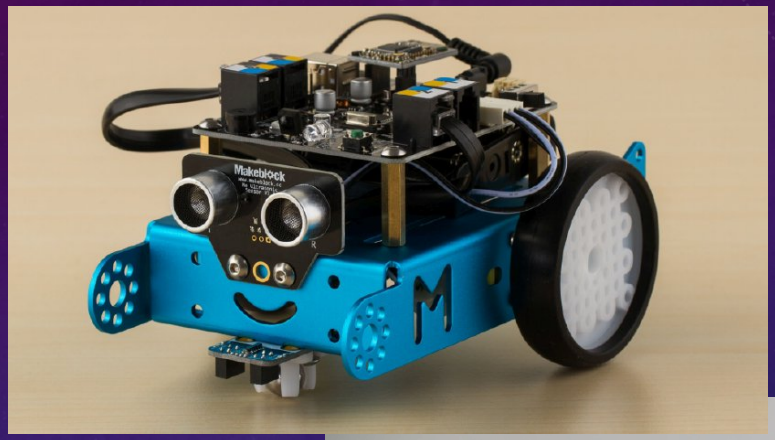
What about safety?

HOME ROBOTICS

Autonomous servants

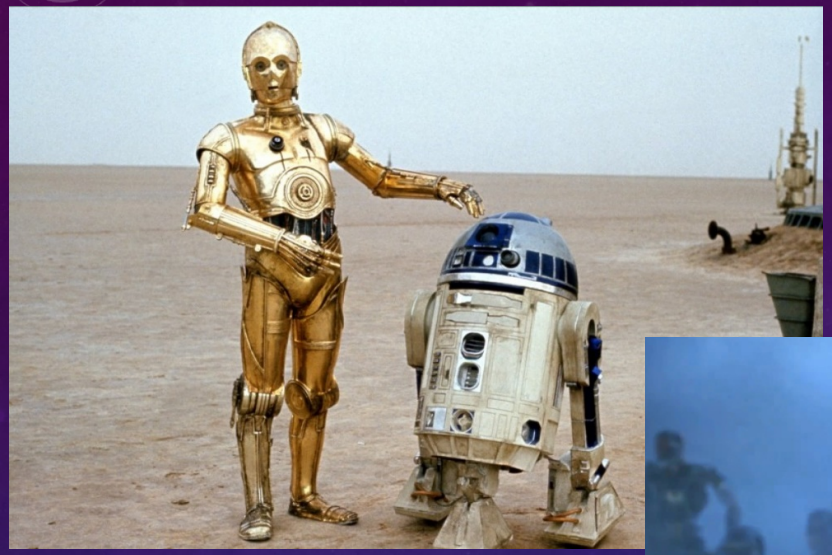
What does Autonomous mean?

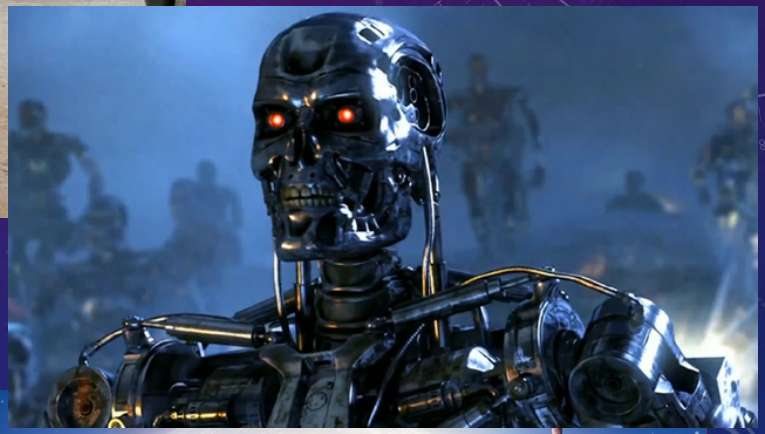
TOYS AND HOBBIES



What is bipedal locomotion?

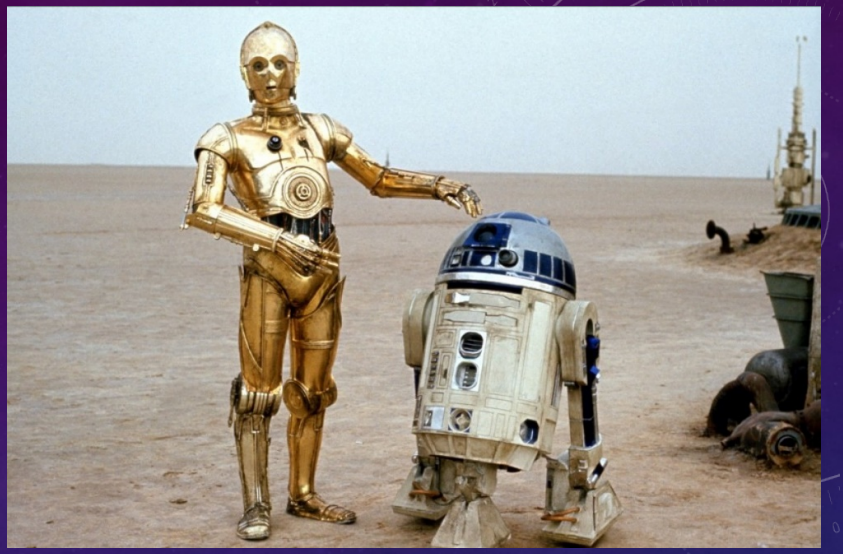
FICTION

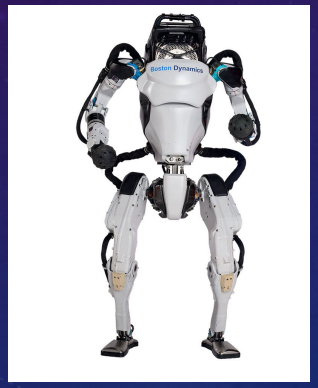




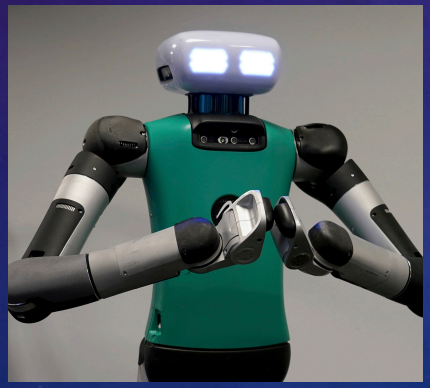
Are we close to developing robots like these?
What is Artificial Intelligence?

OR MAYBE WE ARE ALREADY HERE...





Atlas - Boston Dynamics



Digit – Agility Robotics

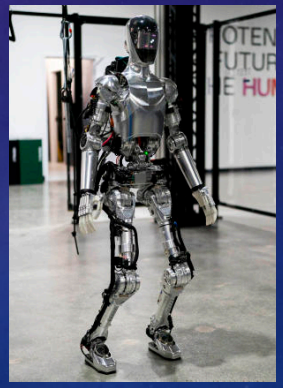
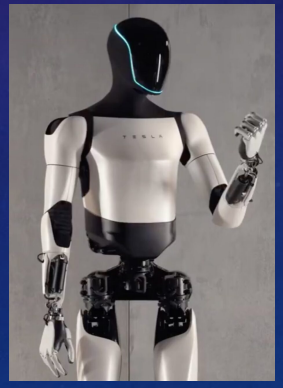


Figure 01 - Figure AI

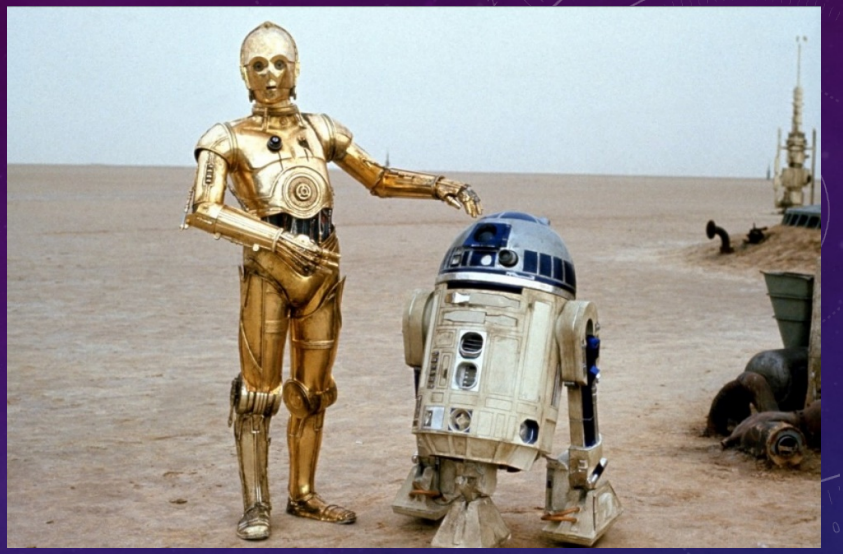


Optimus – Tesla

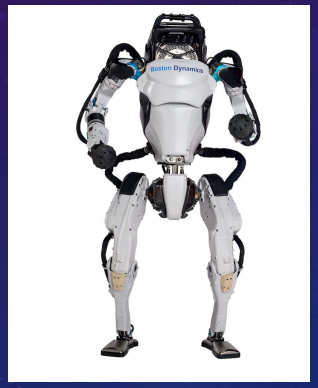
Apollo - Apptronik

OR MAYBE WE ARE ALREADY HERE…

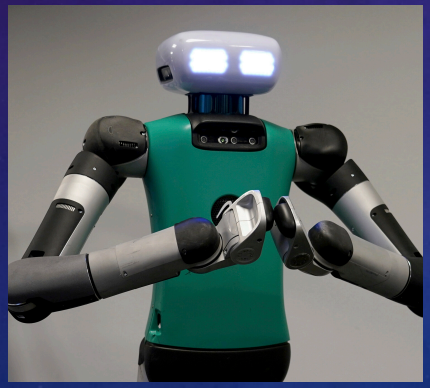
OR MAYBE WE ARE ALREADY HERE…



But why build robots that look like and mimic humans?



Atlas - Boston Dynamics



Digit – Agility Robotics

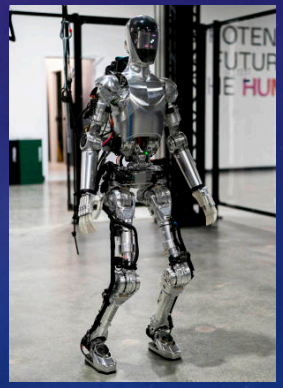
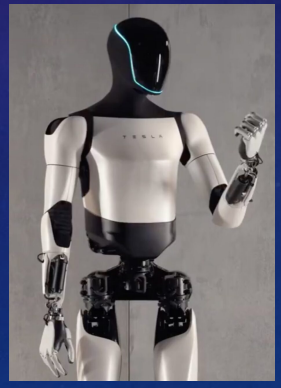


Figure 01 - Figure AI

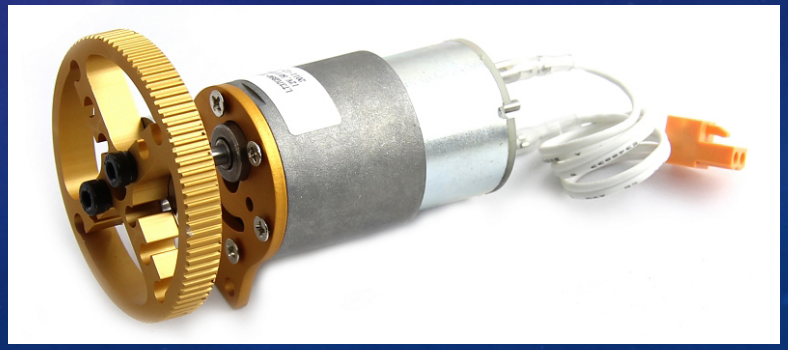


Optimus – Tesla

Apollo - Apptronik

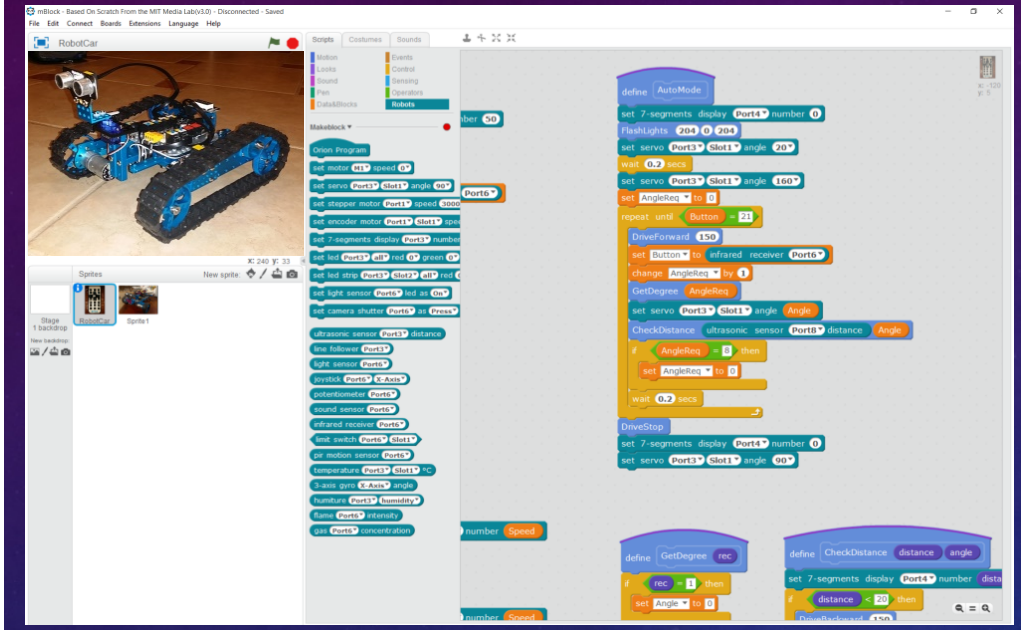
PARTS OF A ROBOT:

SENSORS, CONTROLLERS, ACTUATORS, AND POWER



PROGRAMMING A ROBOT

Visual code language - Scratch

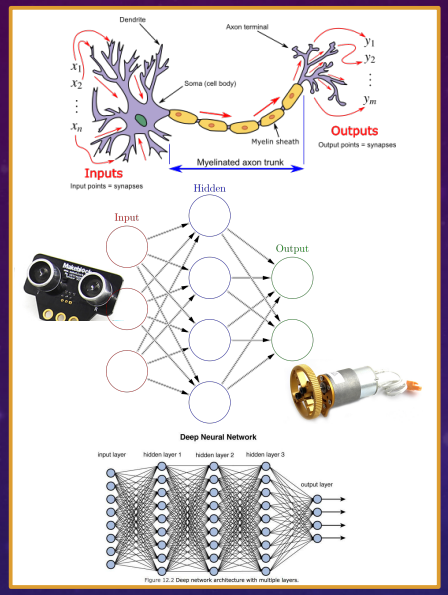


Traditional code language – C++ / Python

```
/* Obstacle avoidance robot source code designed
* for the Robotics merit badge for the Boy Scouts
* This is for the DC motor / motor controller shield version
* ESP8266 NodeMCU
*
* By Bill Caterino - ZigZone Automation
*
*
*
*/
#include <Wire.h>
#define DIRA 0
#define PWMA 5
#define DIRB 2
#define PWMB 4
int DCgo = 1023; // 0 (stop) - 1023 (max)
int DCstop = 0;
int trigPin = 14; // Trigger
int echoPin = 12; // Echo
void setup() {
Serial.begin (9600);
//Define pins for DC motor dirction and speed control
pinMode(DIRA, OUTPUT);
pinMode(PWMA, OUTPUT);
pinMode(DIRB, OUTPUT);
pinMode(PWMB, OUTPUT);
//Define HC-SR04 Ultrasonic sensor inputs and outputs
pinMode(trigPin, OUTPUT);
pinMode(echoPin, INPUT);
//Make sure motors are stopped
brake();
delay (3000); // Pause for a bit after powering on so you have time to put the
robot down
}
void loop() {
Serial.print("Forward / distance: ");
forward();
long dist = getDistance();
Serial.println(dist);
if (dist < 4){ //There is an object less than 4 inches from front of robot
Serial.println("object detected!");
long leftDistance, rightDistance;
brake();
delay(500);
```

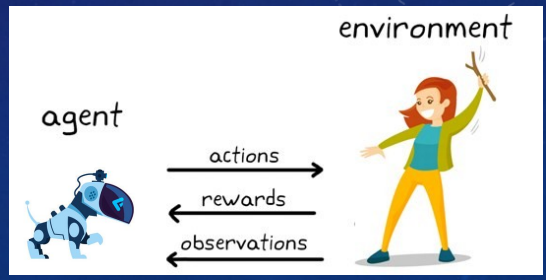
PROGRAMMING A ROBOT ANOTHER WAY

Artificial Intelligence, Neural Networks and Deep Reinforcement Learning



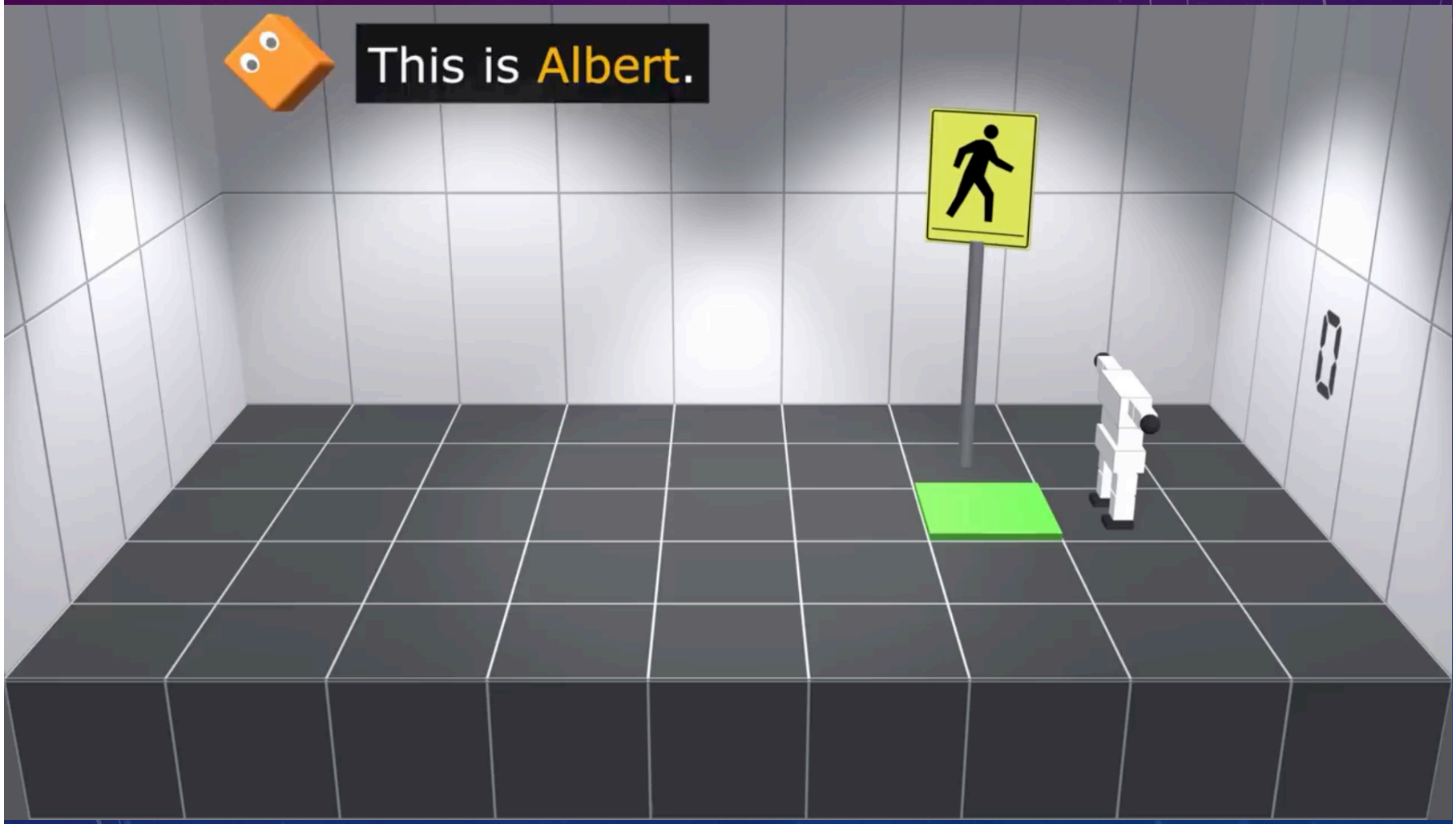
A neural network is a method in artificial intelligence that teaches computers to process data in a way that is inspired by the human brain. It is a type of machine learning process, called deep learning, that uses interconnected nodes or neurons in a layered structure that resembles the human brain.

Deep reinforcement learning enables machines to tackle complex decision-making tasks by learning from experience over time, just like how we learn from trial and error! It's how humans negotiate the world from the very moment they're born. Babies, who smile at their parents and are rewarded with approval, learn that smiling prompts affection.



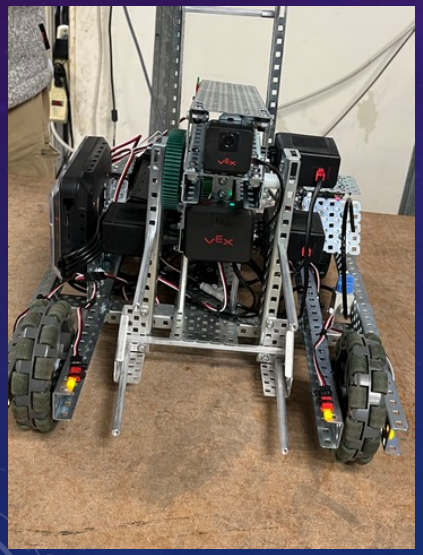
PROGRAMMING A ROBOT ANOTHER WAY

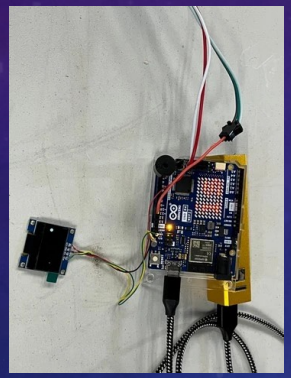
Artificial Intelligence, Neural Networks and Deep Reinforcement Learning



CONNECTICUT ROBOTICS SOCIETY

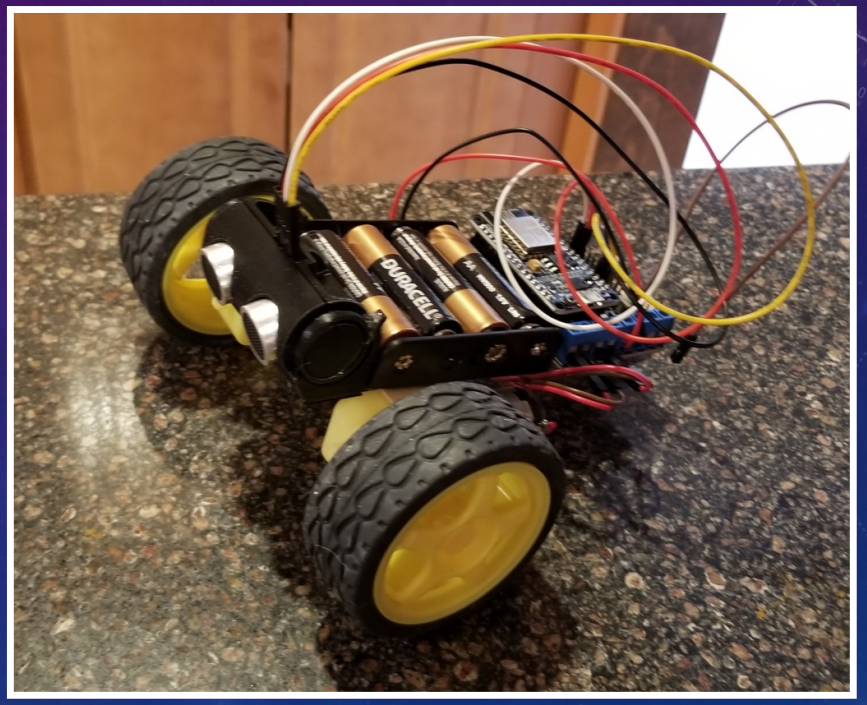
- Local robotics club
- Meets monthly in Windsor, CT at the Vintage Radio & Communications Museum





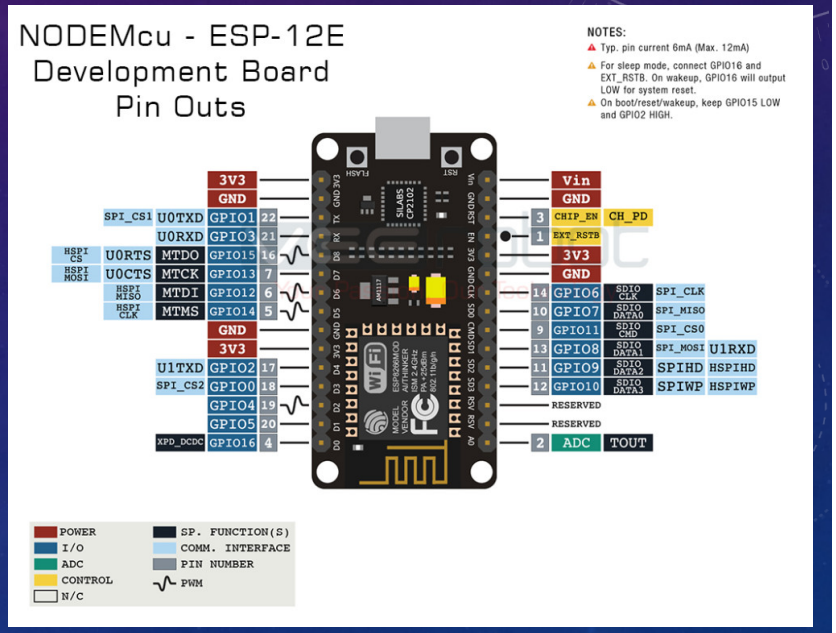
LET'S BUILD A ROBOT!

- **Goals:**
  - Programmable
  - Easy locomotion
  - Autonomous
  - Avoids Obstacles
  - Expandable



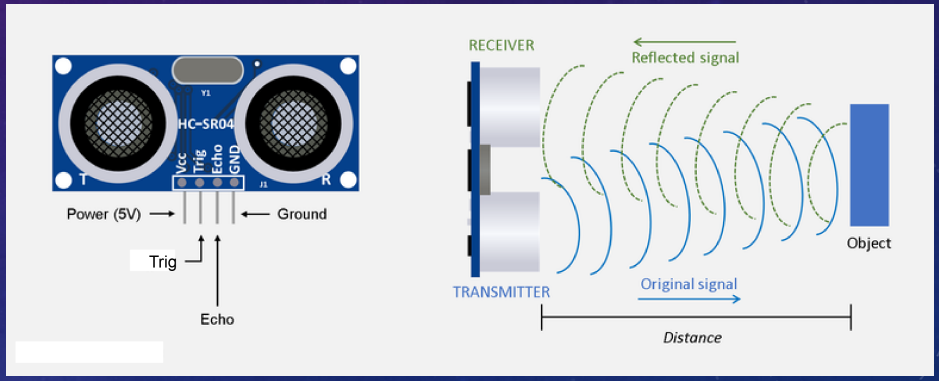
MICROCONTROLLER – ESP8266 NODEMCU

- Program in C++ or MicroPython
- Code C++ using the Arduino IDE:
  - Download IDE: https://www.arduino.cc/en/Main/Software
  - Install CP210x USB Driver: https://www.silabs.com/products/development-tools/software/usb-to-uart-bridge-vcp-drivers
  - Plug in ESP8266. Go to Device Manager and check the COM port
  - Run and configure Arduino IDE:
    - Go to File->Preferences and copy the URL below to get the ESP board manager extensions: http://arduino.esp8266.com/stable/package_esp8266com_index.json
      Placing the "http://" before the URL and let the Arduino IDE use it...otherwise it gives you a protocol error.
    - Go to Tools > Board > Board Manager> Type "esp8266" and download the Community esp8266 and install.
    - Set up your chip:
      Tools -> Board -> NodeMCU 1.0 (ESP-12E Module)
      Tools -> Flash Size -> 4M (3M SPIFFS)
      Tools -> CPU Frequency -> 80 Mhz
      Tools -> Upload Speed -> 921600
      Tools-->Port--> (whatever it is)



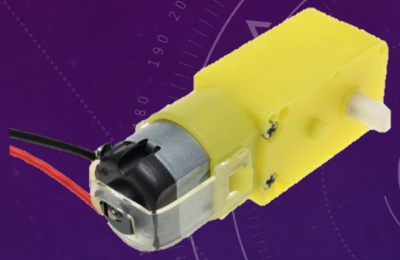
HOW DOES THE ULTRASONIC SENSOR WORK?

- Trigger pin tells the sensor to generate sound pulse from transmitter that reflects off of object
- Echo pin reads the receiver listening for return sound.
- Measure the time it takes for sound to leave the sensor and come back, divide in half, and multiply by speed of sound.

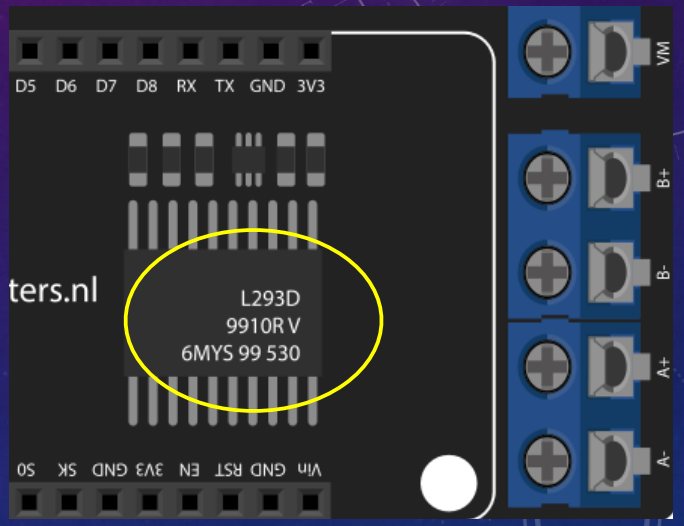


Distance in inches = (TravelTime / 2) x speed of sound or 1/74in/second

HOW DOES THE DC MOTOR WORK?



- The **motor shield** contains a L293D chip: an Integrated Circuit (IC) that controls the voltage level and polarity going to the DC Motor.
- By varying the voltage you adjust the speed of the motor.
- By switching the polarity, you change the direction of the motor (H-bridge circuit)
- The L293D chip is controlled by four pins on the NodeMCU. Two control the direction for each motor and two control how much voltage is sent to each motor (speed)

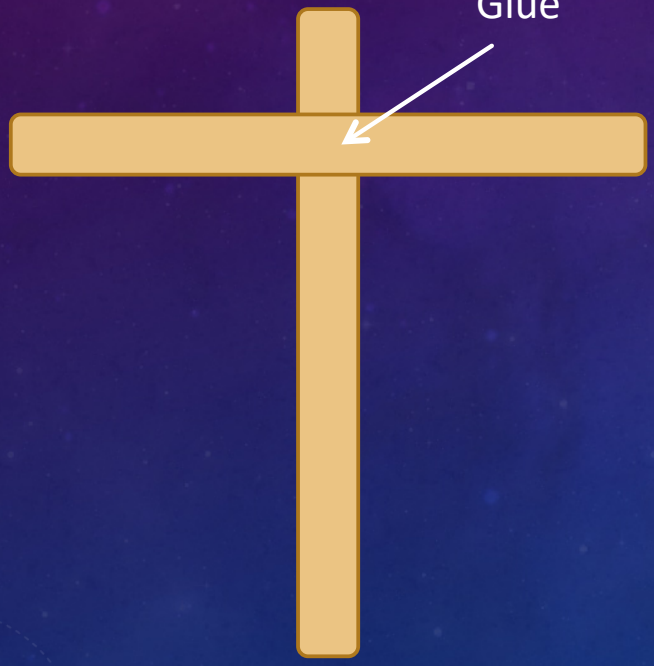


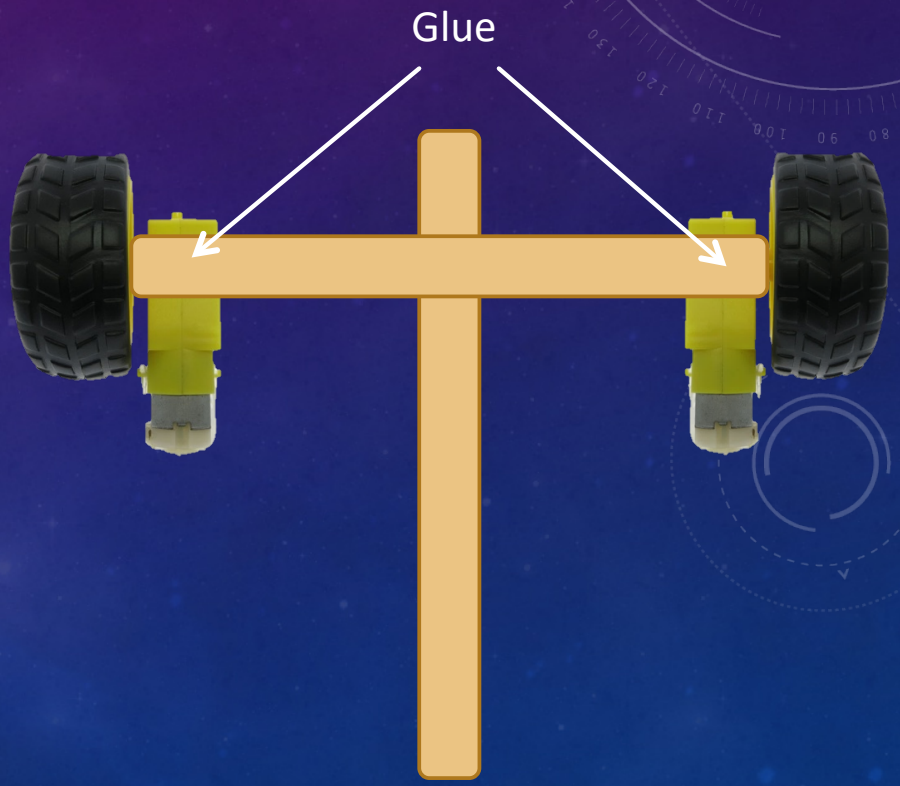
H-Bridge:

CODE REVIEW

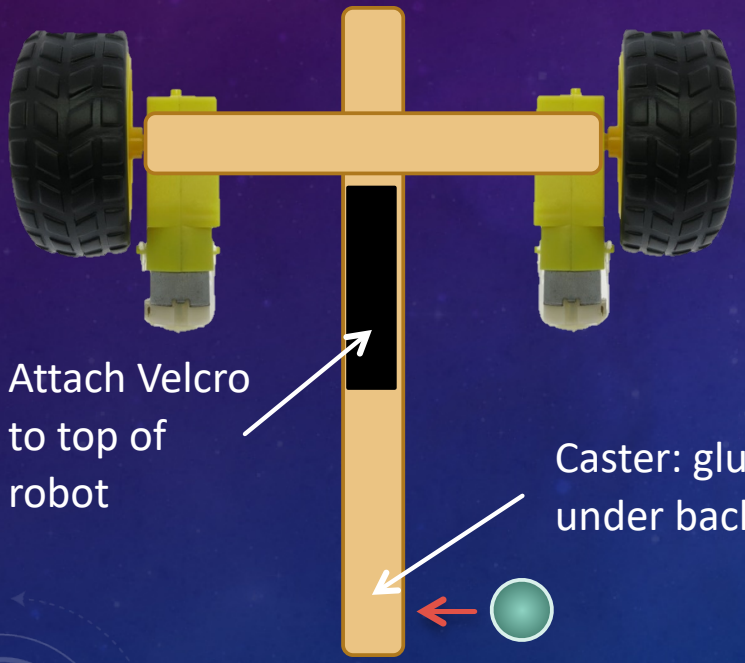
- Language: C++ (Arduino language)
- Contains:
  - Variables: `int trigPin = 14;`
  - Setup code that runs once: `void setup()`
  - Loop code that repeats continually: `void loop()`
  - Functions – bit of code that runs on demand: `long getDistance()`

ROBOT ASSEMBLY





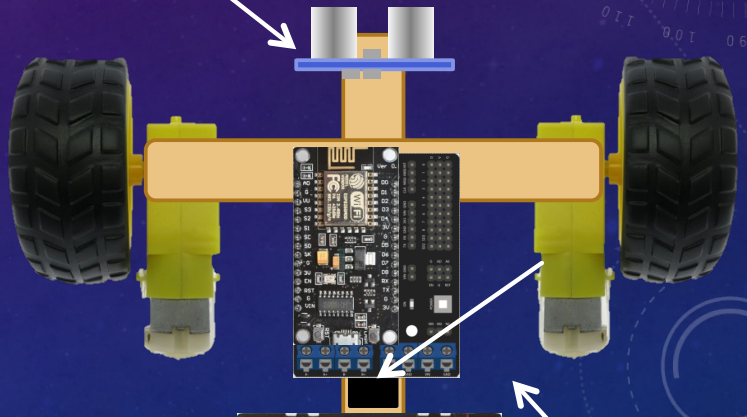
ROBOT ASSEMBLY



Attach Velcro to top of robot

Caster: glue marble under back of robot

Glue sensor to front of robot

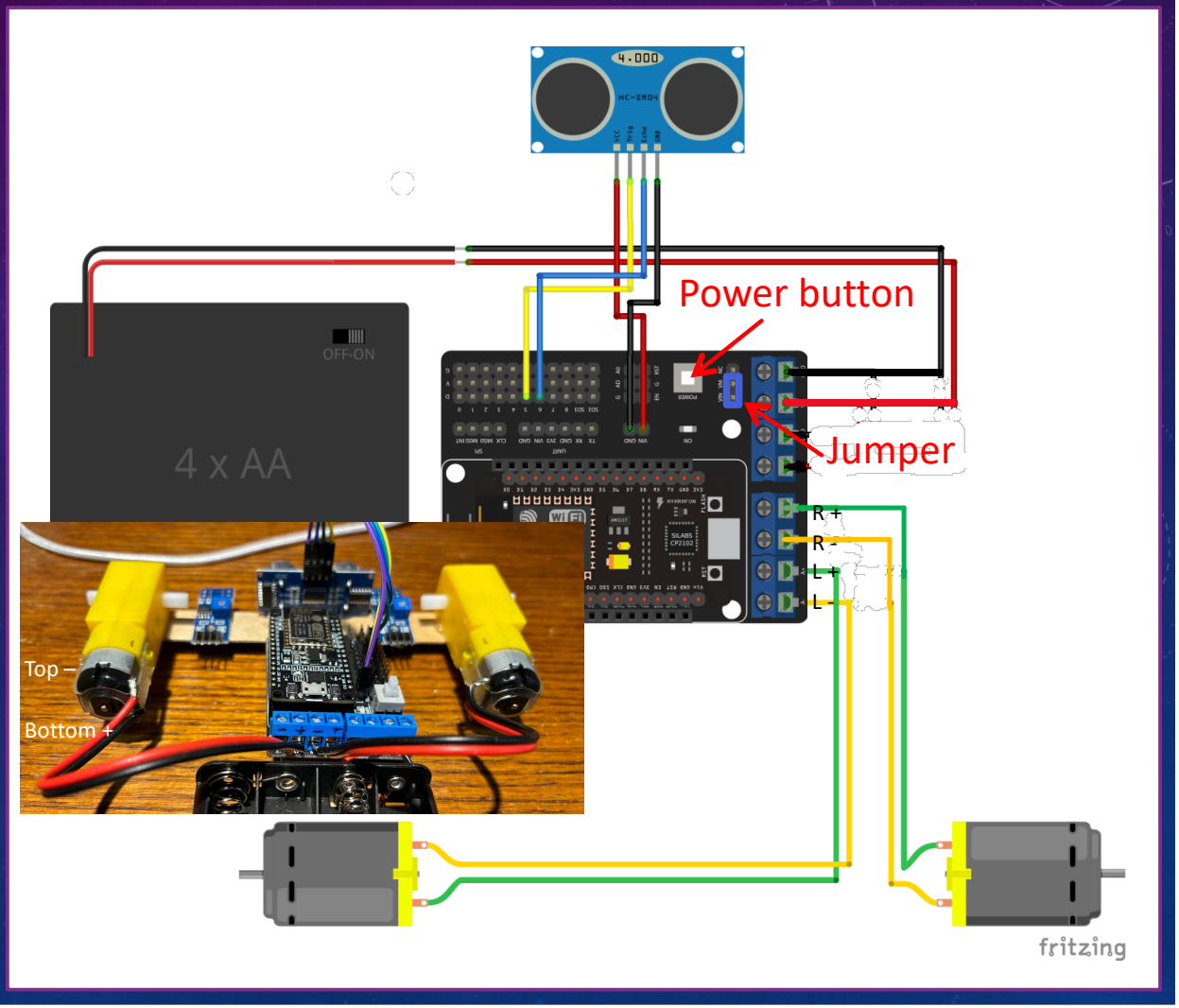


Glue battery holder to back of robot.

Attach Velcro to bottom of the **motor shield** and connect to robot body

ROBOT ASSEMBLY - WIRING

- Ultrasonic sensor wiring:
  - Power: VCC to Vin
  - Ground: gnd to gnd
  - Trigger: trig to D5 (GPIO12)
  - Echo: Echo to D6 (GPIO14)
- DC Motors:
  - Bottom wire to +
  - Top wire to -
  - Add blue jumper as shown



Requirements for the Robotics merit badge:

- Safety. Do each of the following:
  - Explain to your counselor the most likely hazards you may encounter while working with robots and what you should do to anticipate, mitigate and prevent, and respond to these hazards. Describe the appropriate safety gear and clothing that should be used when working with robotics.
  - Discuss first aid and prevention for the types of injuries that could occur while participating in robotics activities and competitions, including cuts, eye injuries, and burns (chemical or heat).
- Robotics industry. Discuss the following with your counselor:
  - The kinds of things robots can do and how robots are best used today.
  - The similarities and differences between remote-control vehicles, telerobots, and autonomous robots.
  - Three different methods robots can use to move themselves other than wheels or tracks. Describe when it would be appropriate to use each method.
- General knowledge. Discuss with your counselor three of the five major fields of robotics (human-robot interface, mobility, manipulation, programming, sensors) and their importance to robotics development. Discuss either the three fields as they relate to a single robot system OR talk about each field in general. Find pictures or at least one video to aid in your discussion.

Requirements for the Robotics merit badge:

- Design, build, program, test. Do each of the following:
  - With your counselor's approval, choose a task for the robot or robotic subsystem that you plan to build. Include sensor feedback and programming in the task. Document this information in your robot engineering notebook.
  - Design your robot. The robot design should use sensors and programming and have at least 2 degrees of freedom. Document the design in your robot engineering notebook using drawings and a written description.
  - Build a robot or robotic subsystem of your original design to accomplish the task you chose for requirement 4a.
  - Discuss with your counselor the programming options available for your robot. Then do either option 1 OR option 2.
    1. Option 1. Program your robot to perform the task you chose for your robot in 4a. Include a sample of your program's source code in your robot engineering notebook.
    2. Option 2. Prepare a flowchart of the desired steps to program your robot for accomplishing the task in 4a. Include procedures that show activities based on sensor inputs. Place this in your robot engineering notebook.
  - Test your robot and record the results in your robot engineering notebook. Include suggestions on how you could improve your robot, as well as pictures or sketches of your finished robot.

Requirements for the Robotics merit badge:

- Demonstrate. Do the following:
  - Demonstrate for your counselor the robot you built in requirement 4.
  - Share your robot engineering notebook with your counselor. Talk about how well your robot accomplished the task, the improvements you would make in your next design, and what you learned about the design process.
- Competitions. Do ONE of the following.
  - Attend a robotics competition and report to your counselor what you saw and learned about the competition and how teams are organized and managed.
  - Learn about three youth robotics competitions. Tell your counselor about these, including the type of competition, time commitment, age of the participants, and how many teams are involved.
- Careers. Name three career opportunities in robotics. Pick one and find out the education, training, and experience required for this profession. Discuss this with your counselor, and explain why this profession might interest you.