

IoT Workshop

A small introduction to the DIY spirit, electronics and programming with the Arduino Framework.

José Eduardo Ferreira da Costa
up201907216@edu.fe.up.pt



Overview

1. Introduction

DIY in a nutshell.

2. Electronics

Basic components, microcontrollers and breadboards.

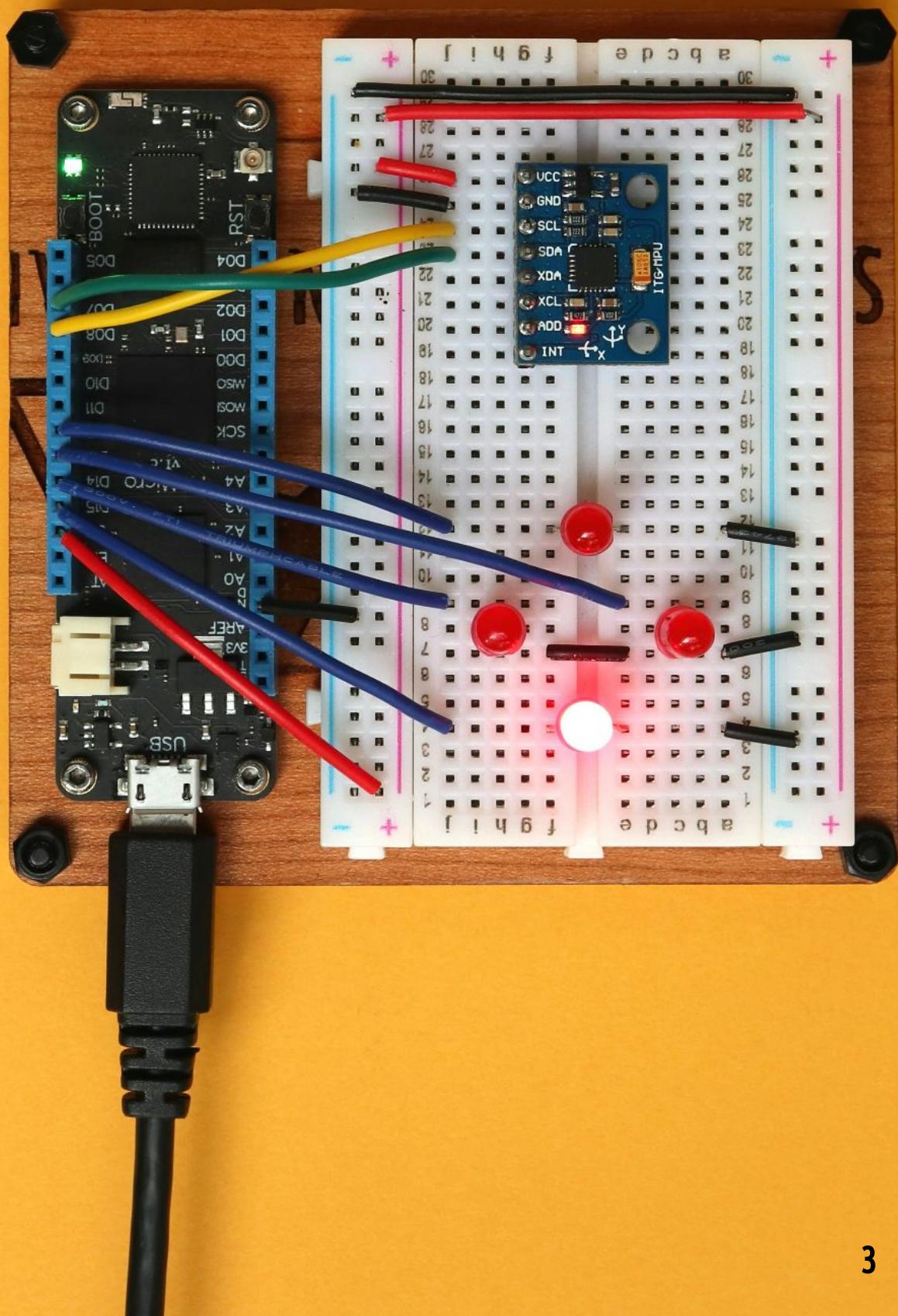
3. Arduino Framework

Basics to get up and running with your own microcontroller.

4. Hands-on

Let's make something useful (sorta).

1. Introduction



What is DIY?

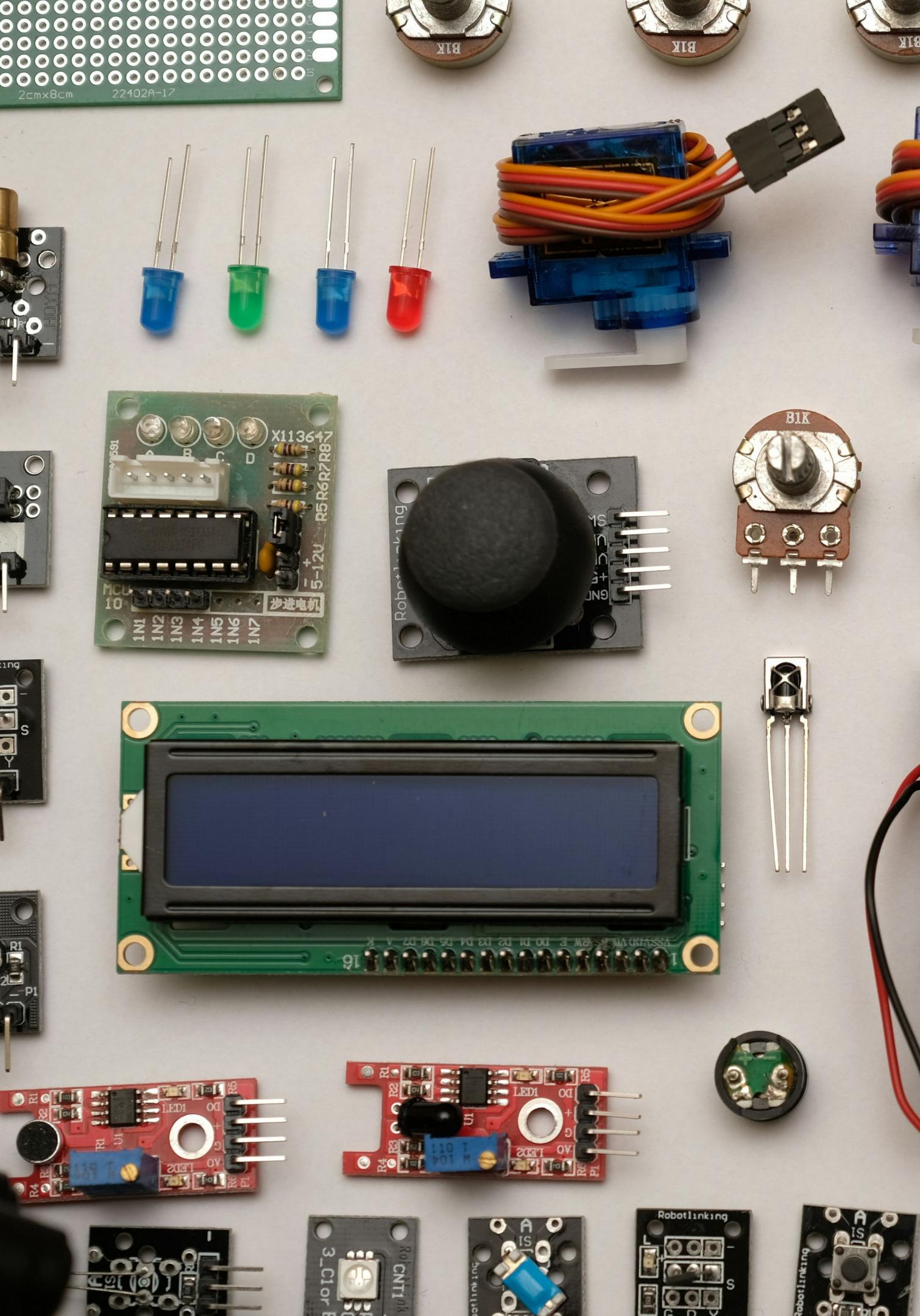
- Building, modifying or repairing things without certified or professional help
- Motivated by lack of funds, availability or quality, by the need for customization, etc.
- Wikipedia classifies it as a means of anti-consumerism, self determination and as a cultural reaction to the pressure of academic and professional ultra specialization.



What is DIY? - For me

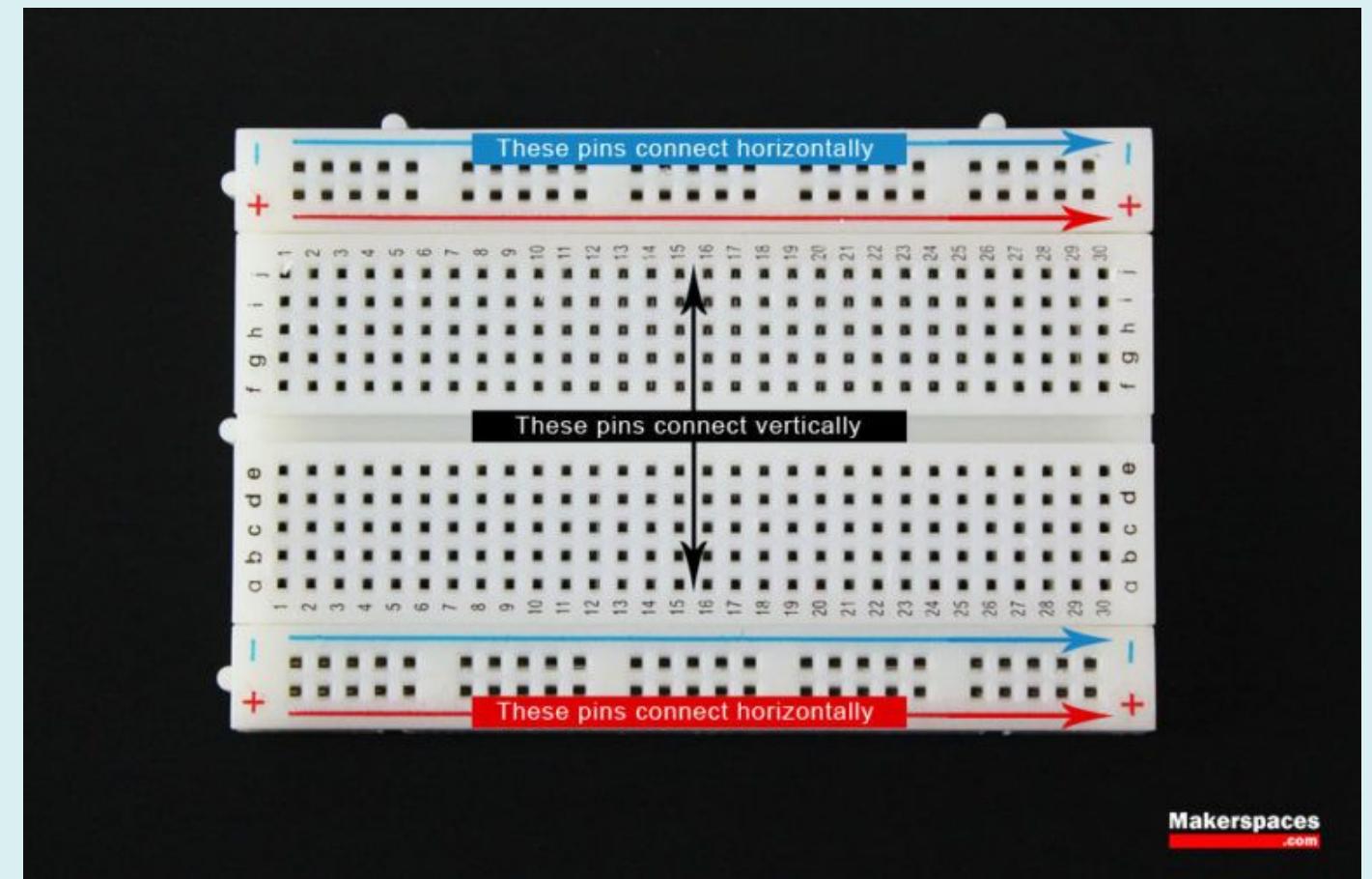
- Finding a solution for problems your on your own, using the tools you have at hand
- Learning about something you never had intended to learn before
- Applying this philosophy not only to electronics and software

2. Electronics



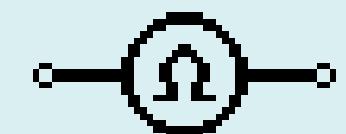
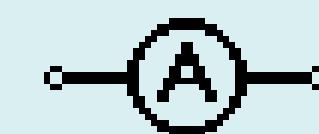
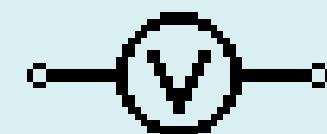
Breadboard

- Useful for prototyping circuits without the need to solder components
- Power rails are connected horizontally
- Other rails are connected vertically, separated by the plastic groove



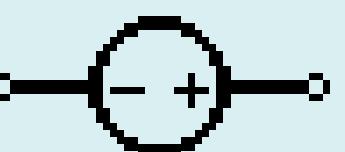
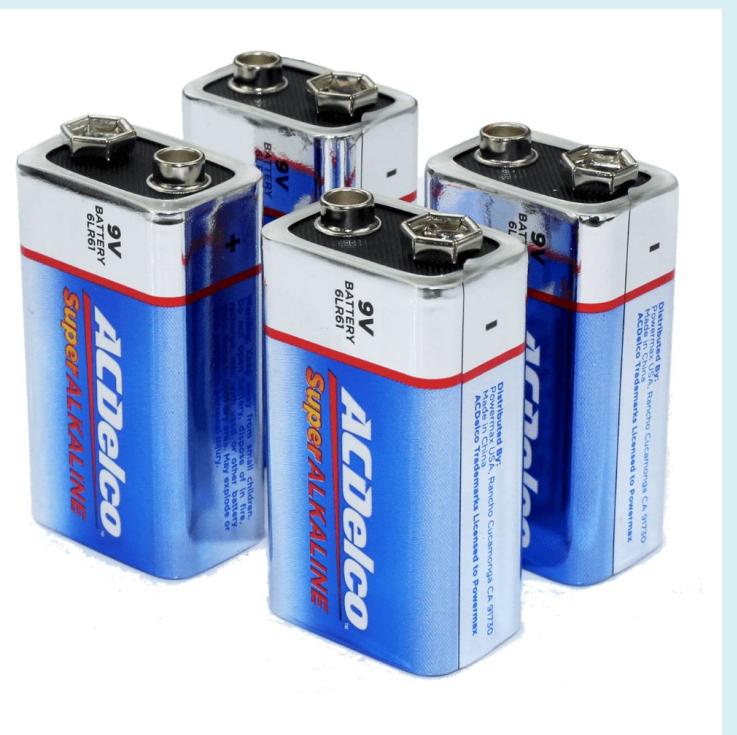
Multimeter

- Measure voltages, current, resistance and checks for continuity
- Useful for troubleshooting circuits



Power supply / Batteries

- Provide power to your electronics
- Power supplies are characterized by their voltage (V) and current (A)
- Batteries are characterized only by voltage as currents are expected to be low (250mA for a 9V, for a 2h duration)



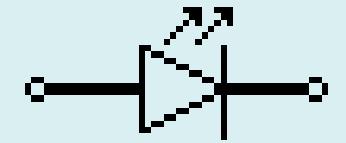
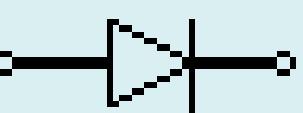
Resistor

- Used to limit currents and voltages in your circuit
- Are characterized by their Impedance/Resistance (Ω , Ohm)
- Also used to establish stable baselines for measurements
- Carbon resistors are colour coded to represent their resistance value: Use this website to do the conversion:
<http://www.dannyg.com/examples/res2/resistor.htm>



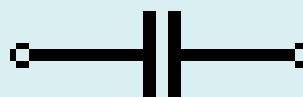
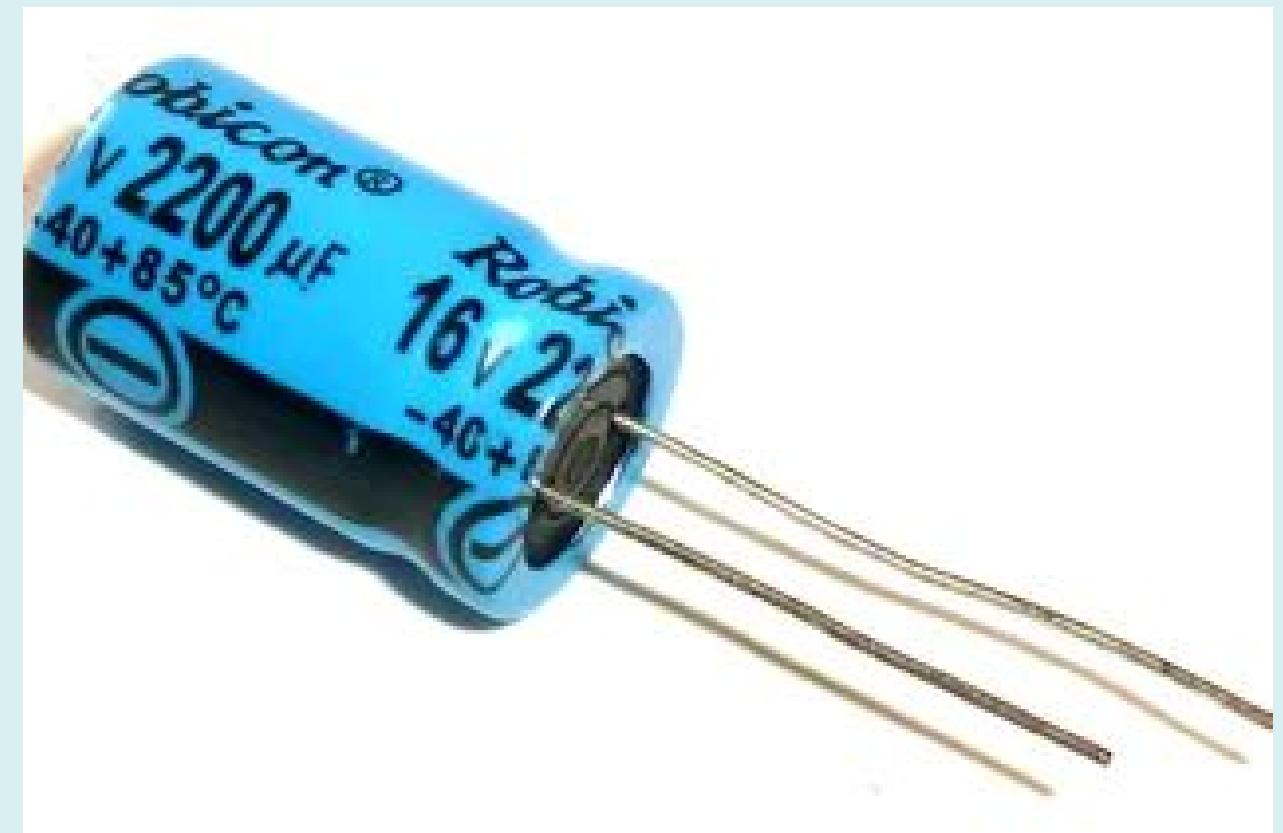
Diode

- Semiconductor device used that allows current to flow in one direction but not in the opposite direction
- It has a positive (+) terminal, called cathode, and a negative (-) terminal, called anode
- Several types of diodes, being the most common the light emitting diode, abbreviated to LED



Capacitors

- Temporarily store electric charges in an electric field
- Used to smooth out varying voltage DC power supplies
- Unit of measurement is the Farad (F)



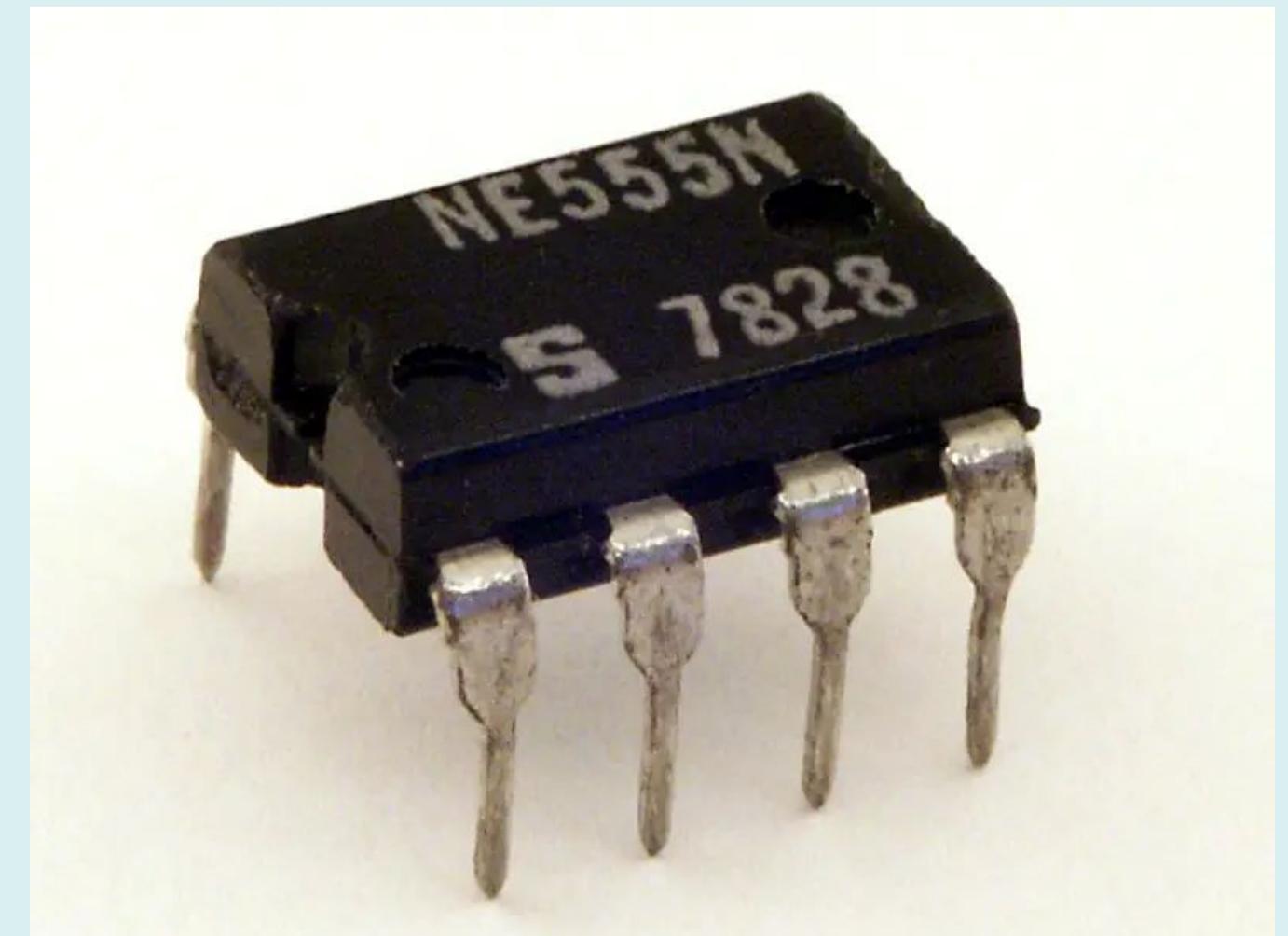
Transistor

- Semiconductor device used to switch or amplify signals and power
- Voltages and currents applied in one side can control voltages and currents on the other side
- Have very different types and working principles
- It is considered by many one of the greatest inventions of the 20th century, allowing for the development of modern electronics, as it replaced vacuum tubes and allowed circuit miniaturization



Integrated Circuit (IC)

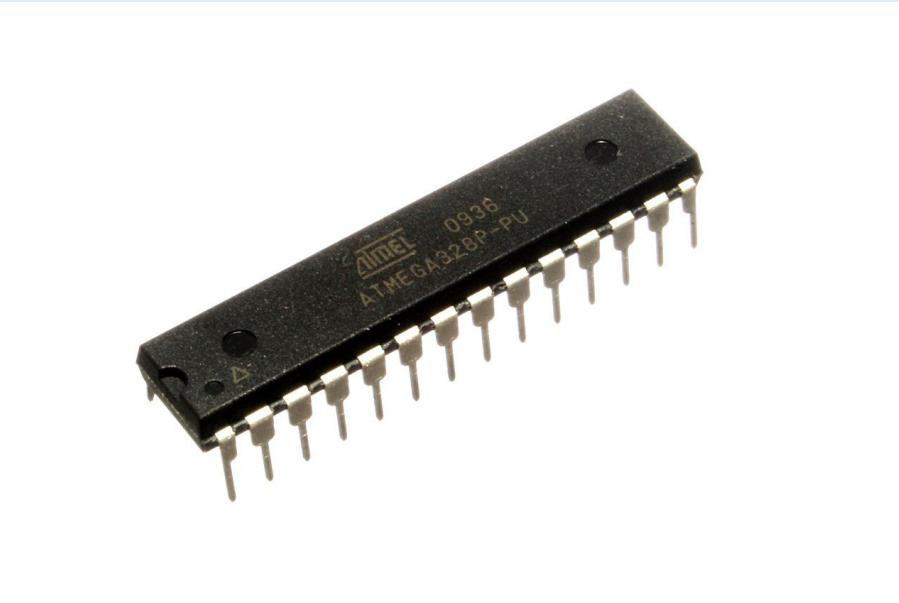
- This is a electronic circuit using miniaturized components to implement some functionality
- Each pin has a specialized function
- May implement timers, voltage regulators, microcontrollers and many other components



The 555 timer

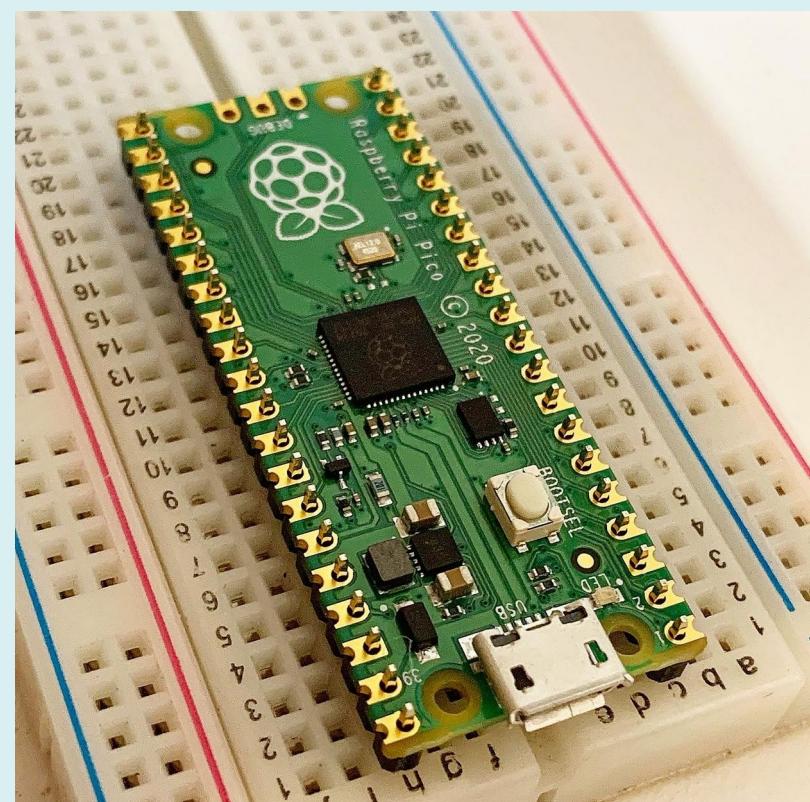
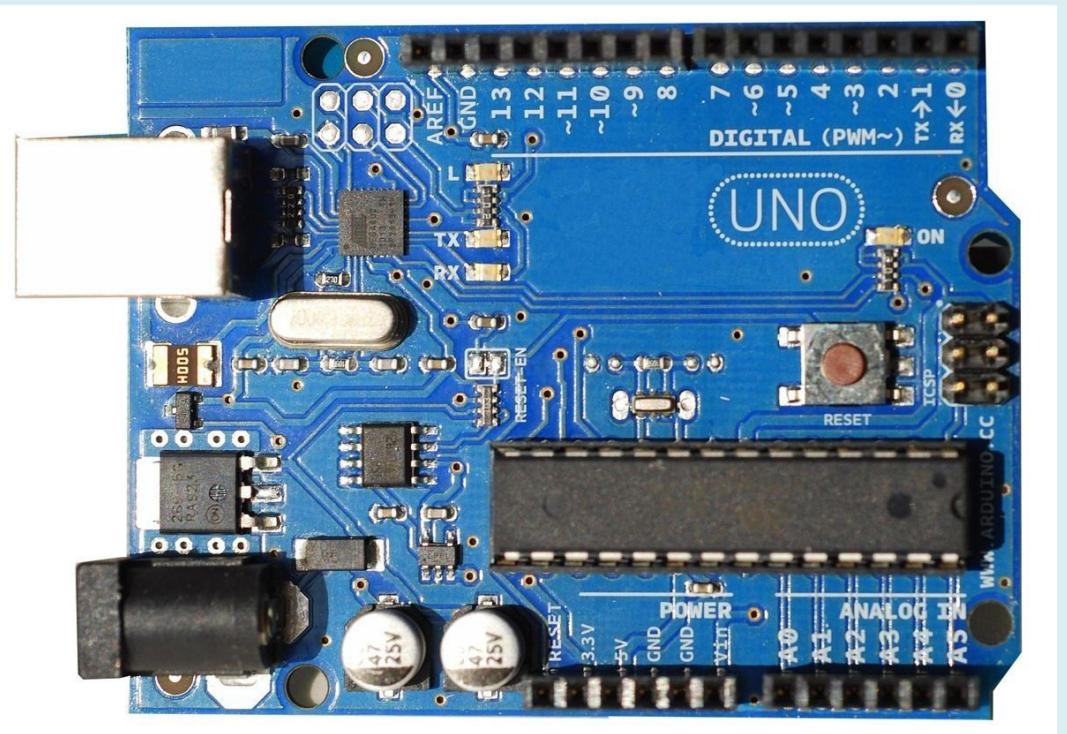
Microcontroller

- Small computer inside a single IC
- May contain one or more CPUs, memory and programmable input and output controllers
- Examples are the ATmega328P used in the R1 through R3 Arduino development boards and the RP2040 in the Raspberry Pi Pico



Development board

- Extend the interfaces available to communicate with microcontrollers
- One of those interfaces are the GPIO pins that are used to implement various communication protocols and work using either analogue or digital signals
- An analogue signal is a continuous signal that uses a time varying feature of that signal to represent some other time varying feature. It is quite error prone, uses a lot of energy and it has poor precision
- A digital signal uses discrete values to represent information. It's more precise, more resilient and consumes less energy



3. Arduino Framework



Arduino Framework

- Has a programming language based on C++
- The execution uses 2 functions, the *setup()* function, used to setup variables, hardware, libraries and pin modes, and the *loop()* function that loops over the code of that function
- Extensive set of libraries implementing support for various peripherals, communication protocols and software libraries

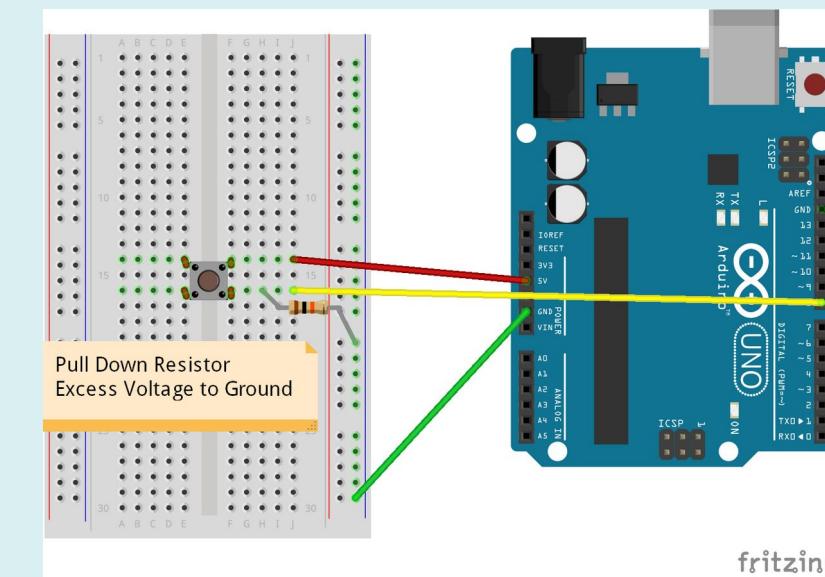


The screenshot shows the Arduino IDE interface with the title bar "Blink | Arduino 1.8.5". The main area displays the "Blink" sketch code. The code includes a comment about public domain, a link to the tutorial, and two functions: *setup()* and *loop()*. The *setup()* function initializes the LED_BUILTIN pin as an output. The *loop()* function alternates the LED state between HIGH and LOW every second, with comments explaining the purpose of each line.

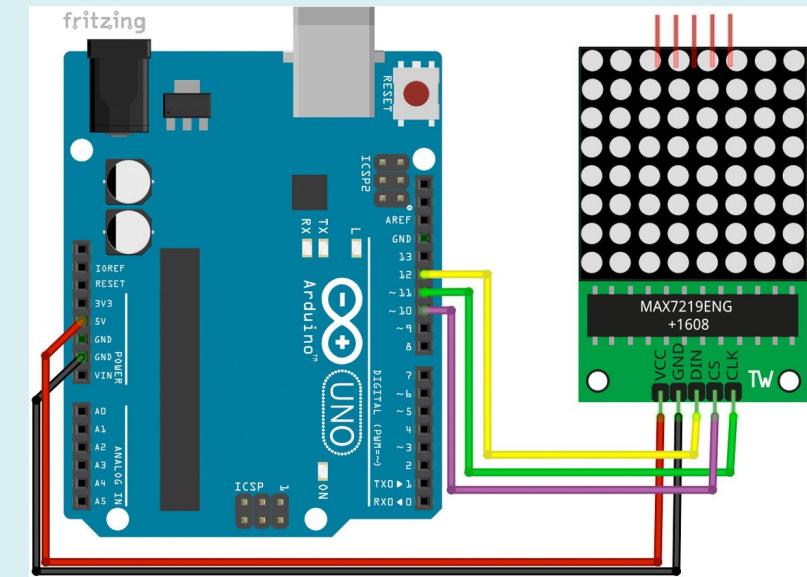
```
This example code is in the public domain.  
http://www.arduino.cc/en/Tutorial/Blink  
*/  
  
// the setup function runs once when you press reset or power the board  
void setup() {  
  // initialize digital pin LED_BUILTIN as an output.  
  pinMode(LED_BUILTIN, OUTPUT);  
}  
  
// the loop function runs over and over again forever  
void loop() {$  
  digitalWrite(LED_BUILTIN, HIGH); // turn the LED on (HIGH is the voltage level)  
  delay(1000); // wait for a second  
  digitalWrite(LED_BUILTIN, LOW); // turn the LED off by making the voltage LOW  
  delay(1000); // wait for a second  
}
```

Arduino Framework - GPIO

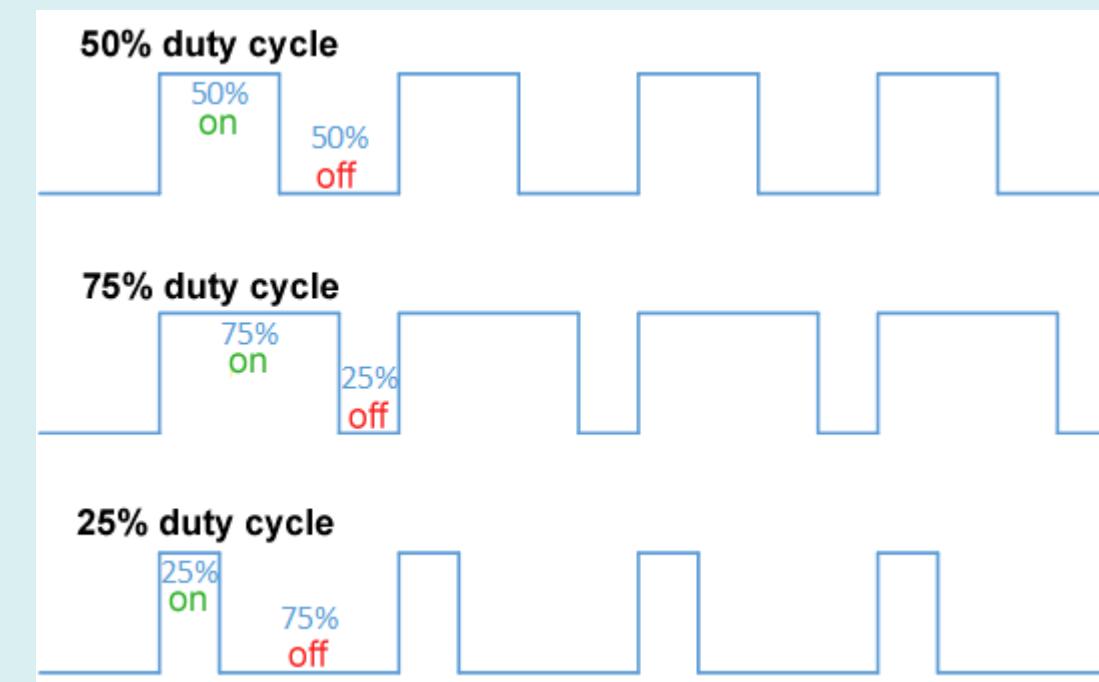
- GPIO pins available at the board can be configured to behave as inputs or outputs
- By default in the Arduino Framework pins behave as input pins
- Usually all input pins can read digital signals but only some can read analog signals
- Pins configured as output can only produce square waves (common in digital signals, the pins are either high or low), but similar effects to analog signals can be achieved by turning the signal on and off at the right frequencies (learn about the [duty cycle](#) and [Pulse Width Modulation - PWM](#))



Being used as input



Being used as output

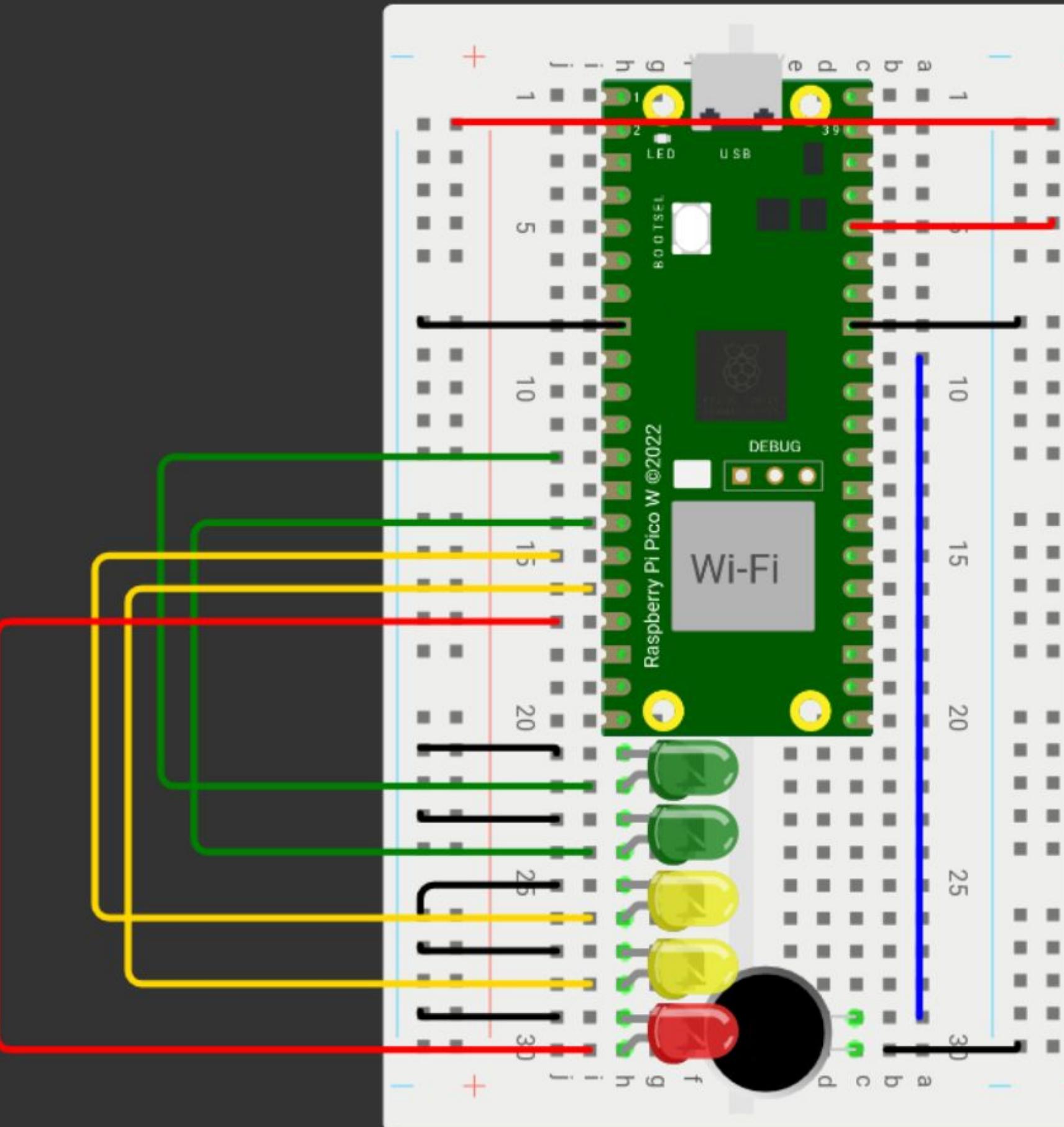


Arduino Framework - Libraries

- Libraries are managed using the Arduino library manager
- Implement communication protocols, support for 3rd party components, software components



2. Hands-on



Noise detector

- Warn us of excessive noise in the vicinity
- Maybe we can stream the noise to our browser
- And get an Wireless Microphone!!