

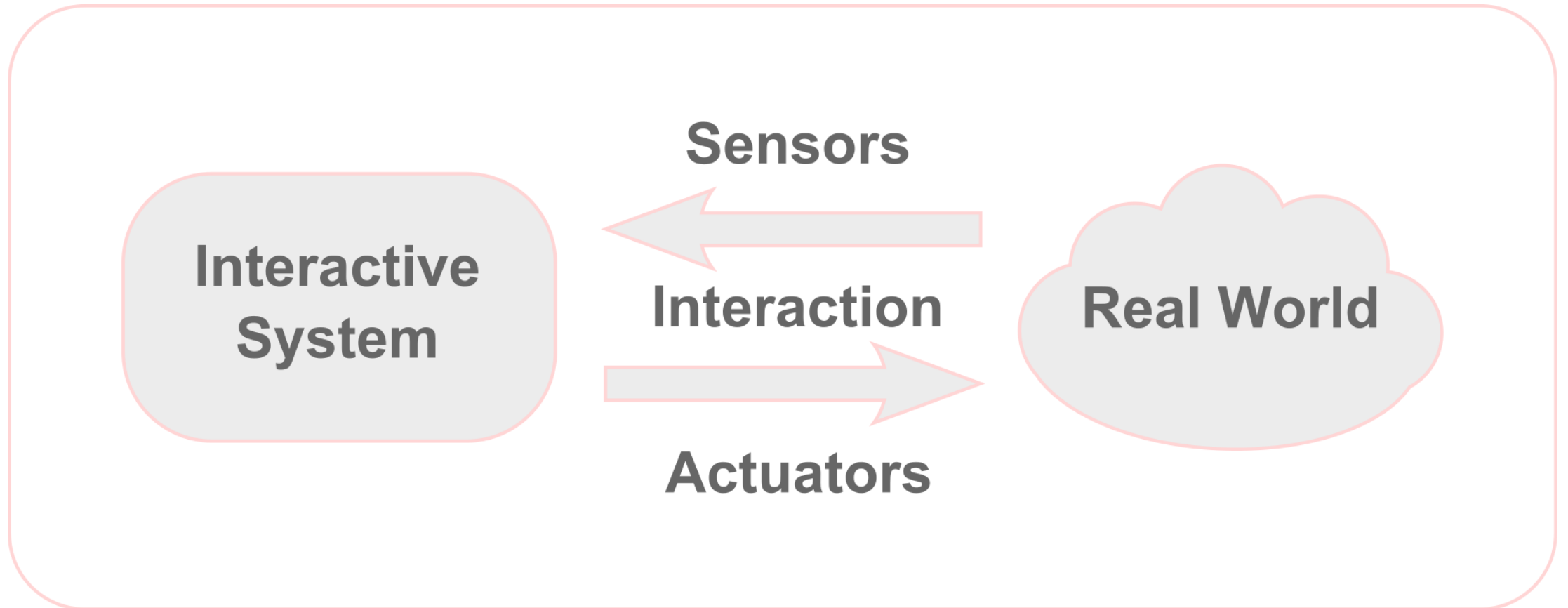
# Physical Computing

# Agenda

- What's Physical Computing
- Electricity
- Circuits
- Components
- Physical Computing with the Arduino

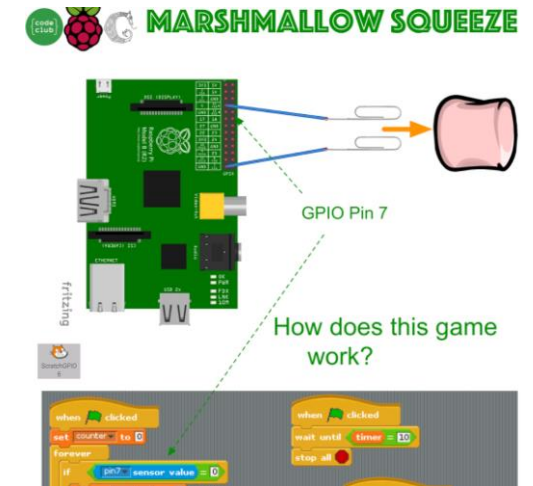
# Physical Computing

*A creative framework for understanding human beings' relationship to the digital world*



# Physical Computing

- Break away from conventional input/output peripherals:
  - Keyboard, mouse, screen
- Think about how human/environment signals can be captured and changed into electronic signals that can be interpreted by a computing device.
- Physical computing applications tend to depend on people for input (and sometimes output), and transform that input into another form, like an animation, a sound, or motion.
- Sometimes powerfully fuses art and technology.



# Electricity

- **Electricity** is the flow of electrical energy through some conductive material.
- **Sensors** are components that convert other forms of energy into electrical energy so we can read the changes in those other forms.
  - Transduction (e.g. microphone)
- **Voltage** is a measure of the difference in electrical potential energy between two points in a circuit. It is measured in **Volts**.
- **Current** is a measure of the magnitude of the flow of electrons through a particular point in a circuit. It is measured in **Amperes**, or **Amps**.
- **Resistance** is a measure of a material's ability to oppose the flow of electricity. It is measured in **Ohms**.

# Electricity: Relationship

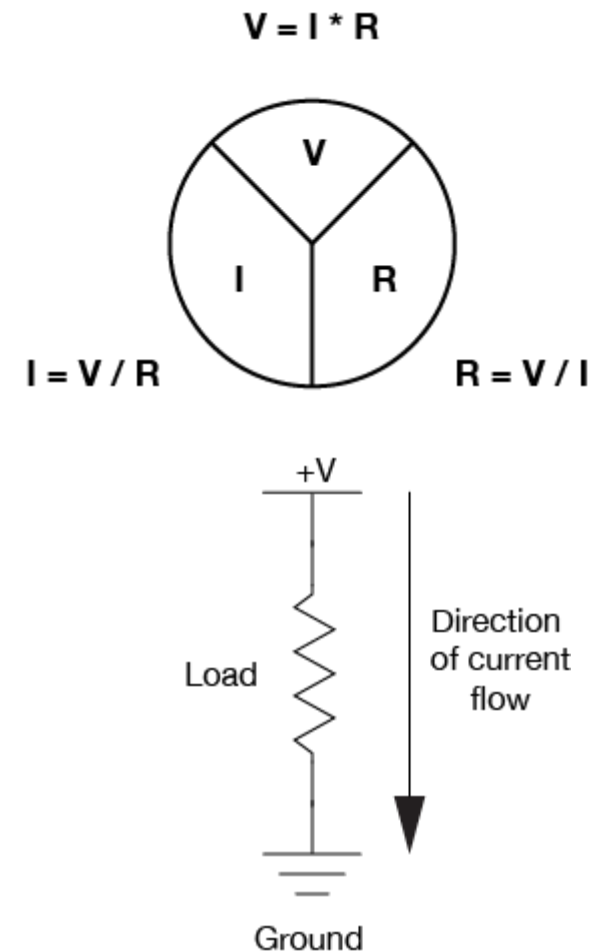
- **Voltage (V)**, **Current (I)**, and **Resistance (R)** are all related, by the following formula:

$$V = I \times R$$

- **electrical power (P)** (measured in watts), as follows:

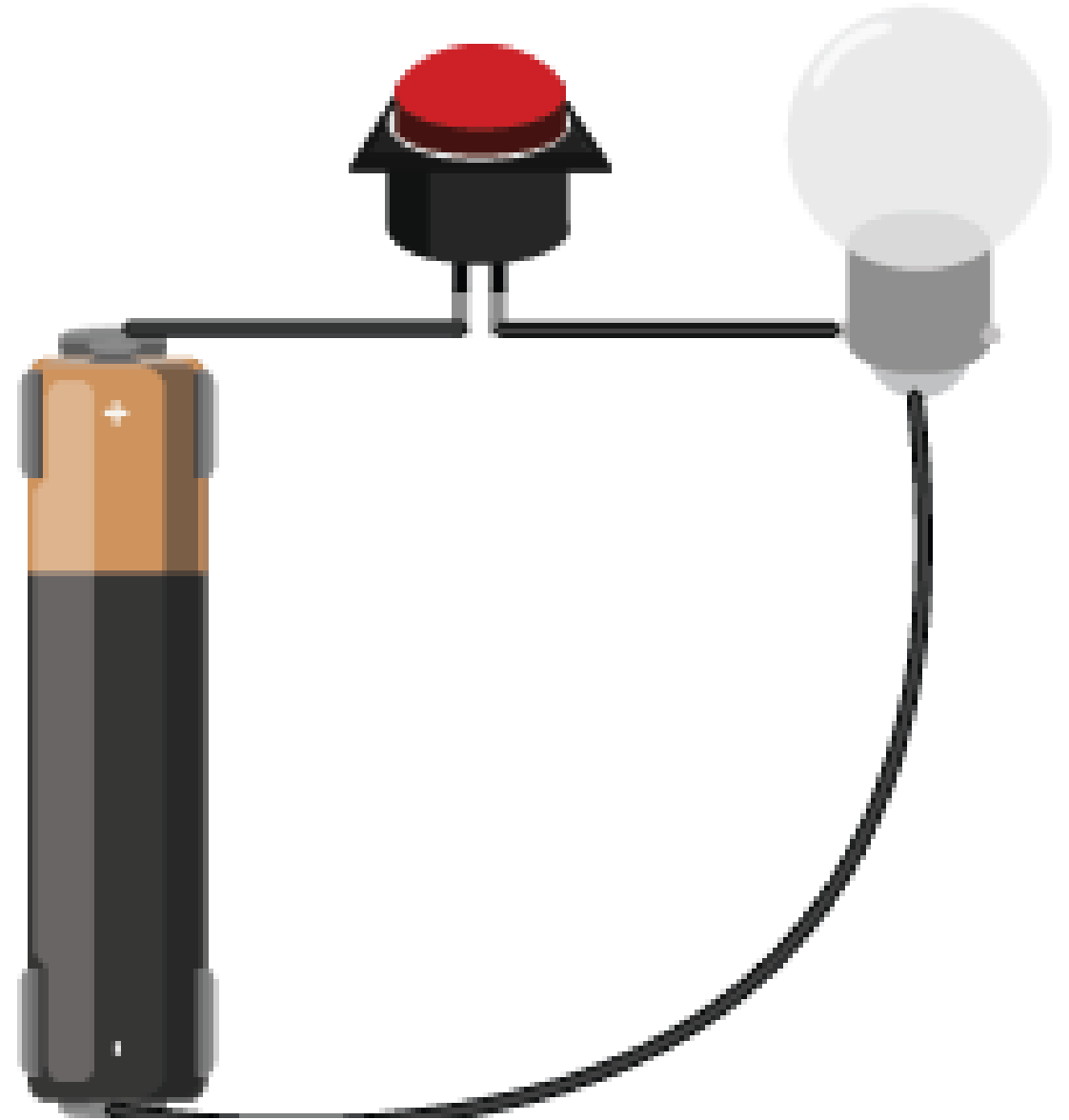
$$\text{Watts} = \text{Volts} * \text{Amps}$$

$$P = V * I$$



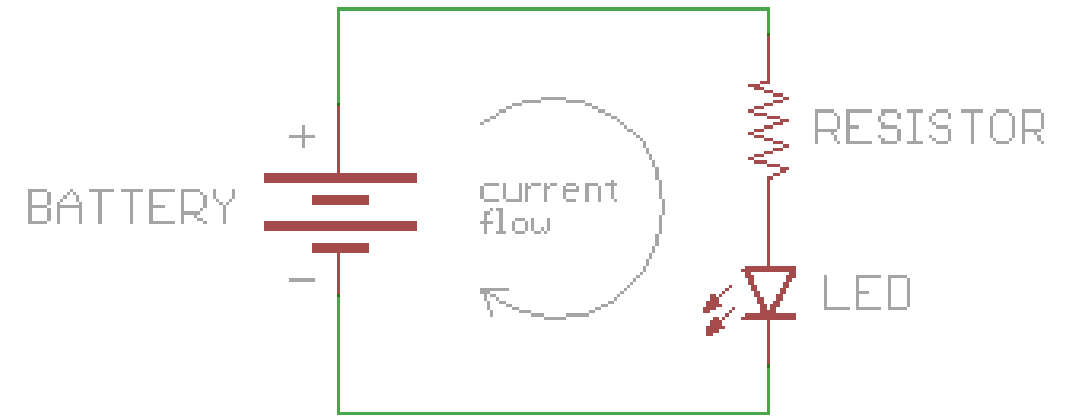
# Circuit

- Physical Computing usually involves interfacing a computing device with electrical circuit(s).
- A circuit needs a:
  - Electrical Energy Source (e.g. battery)
  - Load (Converts elec energy to something else)



# Circuit 2

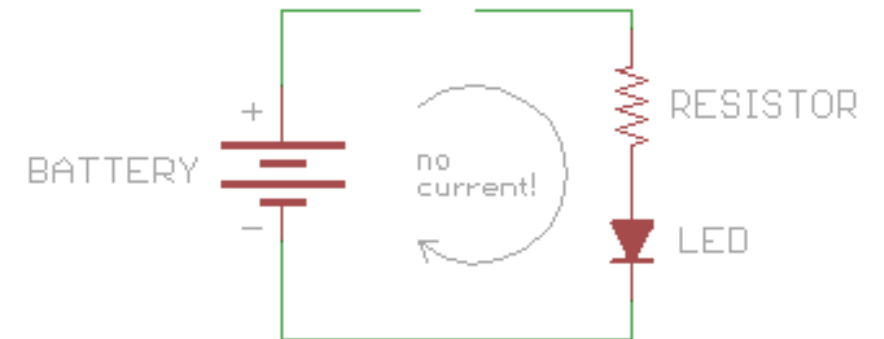
- Electricity needs to flow to do anything useful.
  - Needs a path to flow through, which must be an electrical conductor (like copper)
- Electricity will flow from a higher voltage(+) to a lower voltage(-) or ground.



**Short Circuit - Bad**



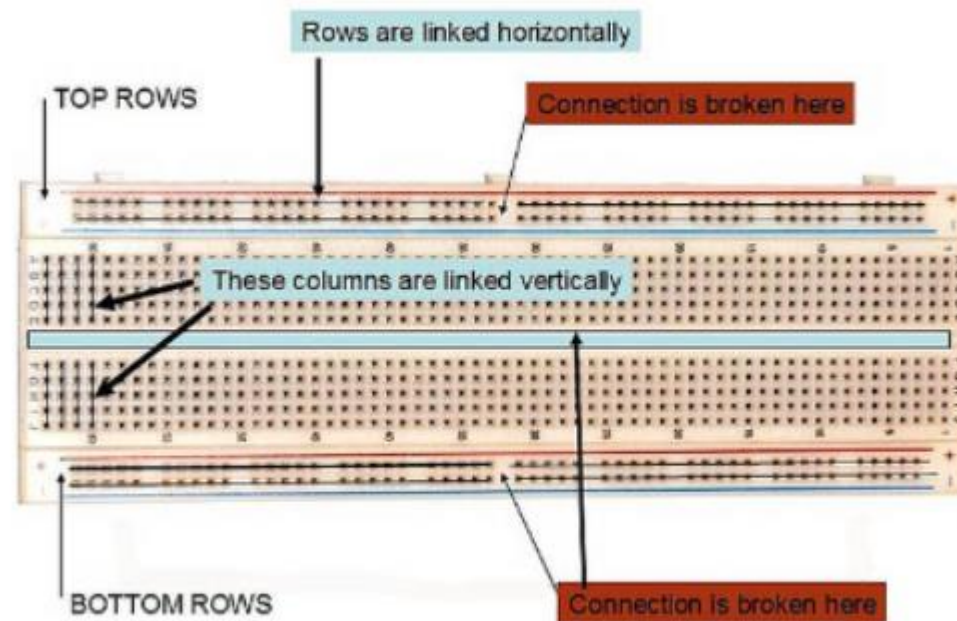
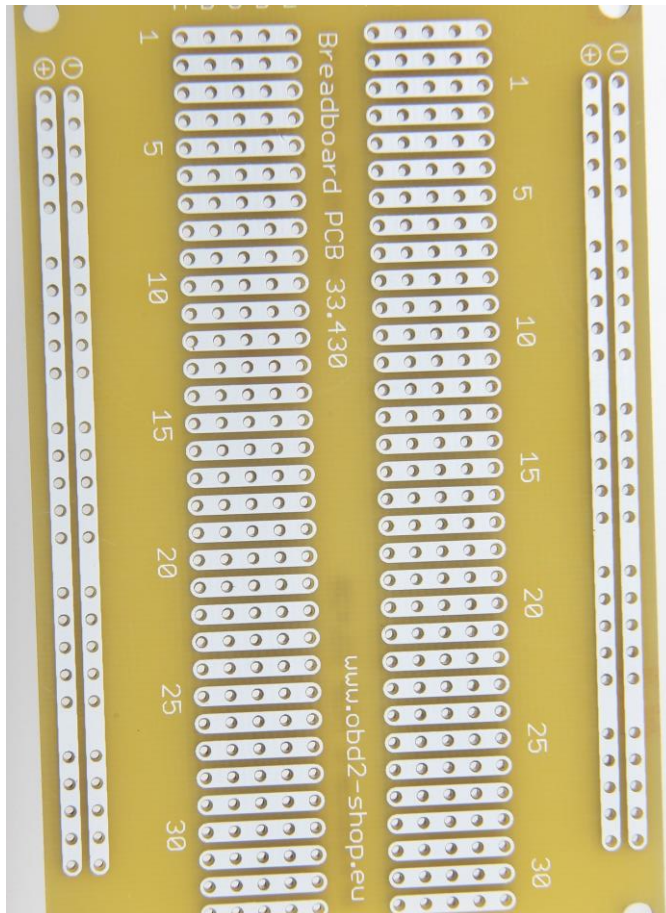
oops!





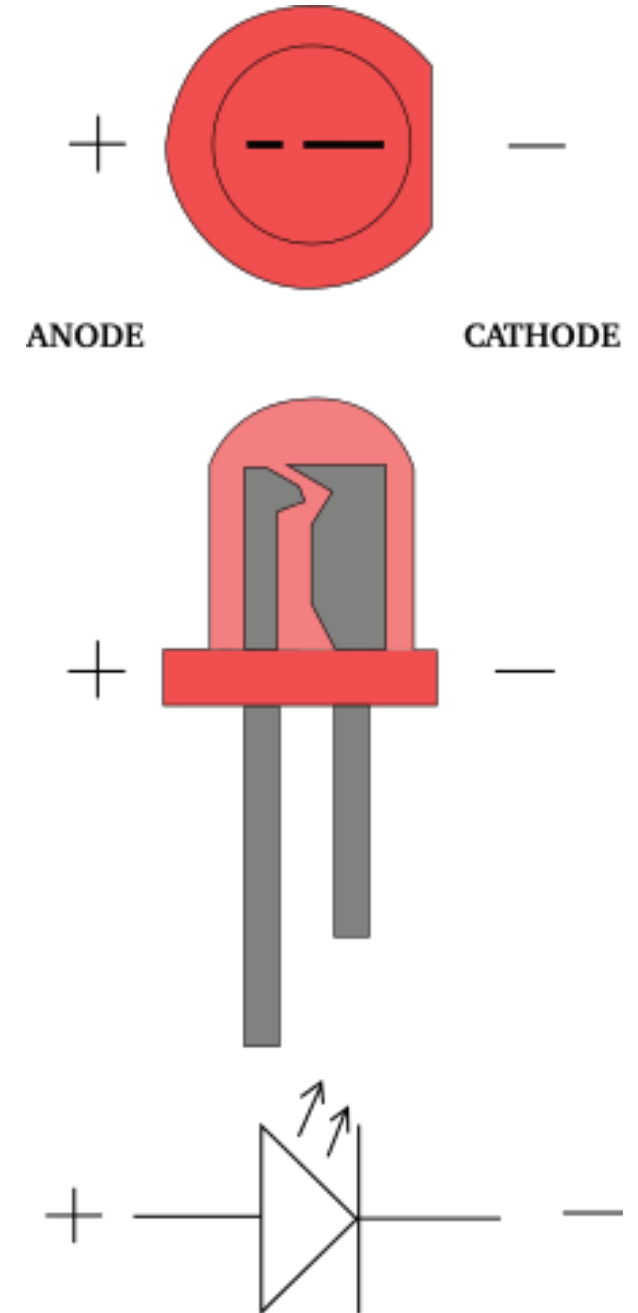
# Electronics: Breadboard

Used for prototyping electronic solutions



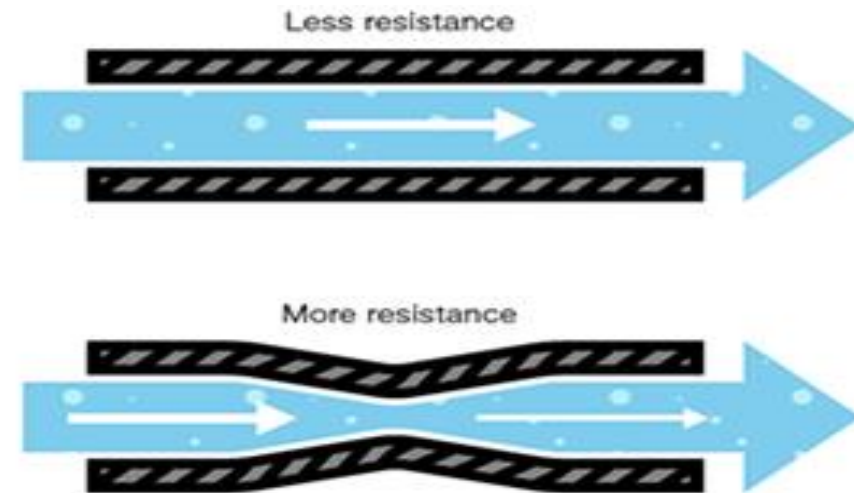
# LEDs

- Emits light when current passes through
- Typical LED requires 2V at 20mA
- RGB LEDs, LED strips, IR LEDs, Ultrabright



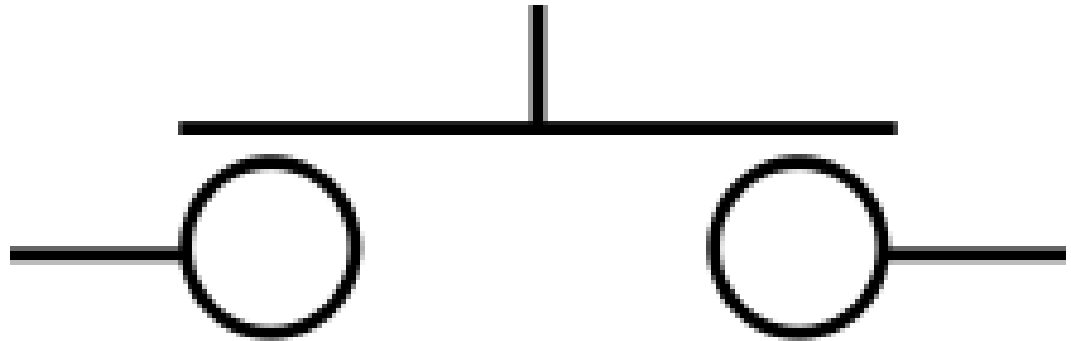
# Resistors

- Reduce current and voltage to components
- Ohm Law:  $I = V/R$



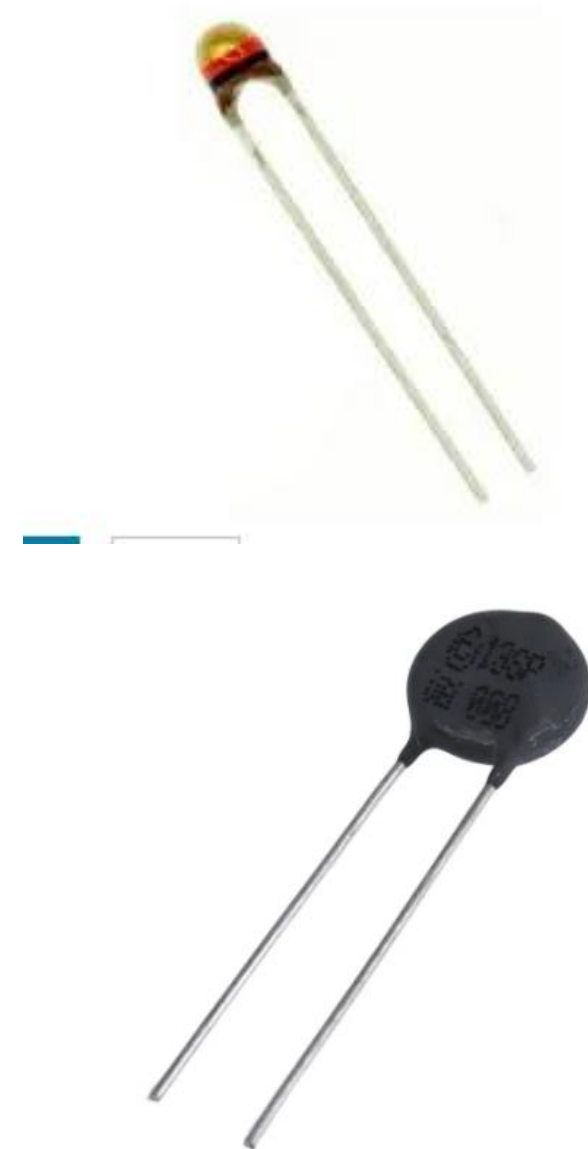
# Push Button

- **pushbuttons** control the flow of current through a junction in a circuit



# Thermistor

- Thermistors are used as temperature sensors.
- They can be found in every day appliances such as fire alarms, ovens and refrigerators.
- They are also used in digital thermometers and in many automotive applications to measure temperature.
- Resistance is dependent on temperature
  - combination of “thermal” and “resistor”.



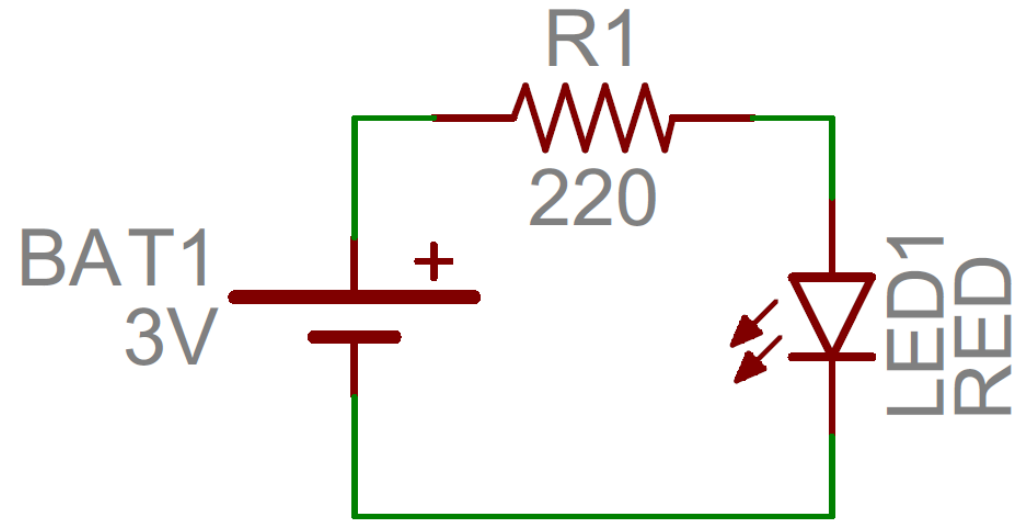
# PhotoResistor

- also known as a light-dependent resistor, LDR, or photo-conductive cel
- Decreases resistance with respect to receiving luminosity (light) on the component's sensitive surface
- **measure the light intensity**



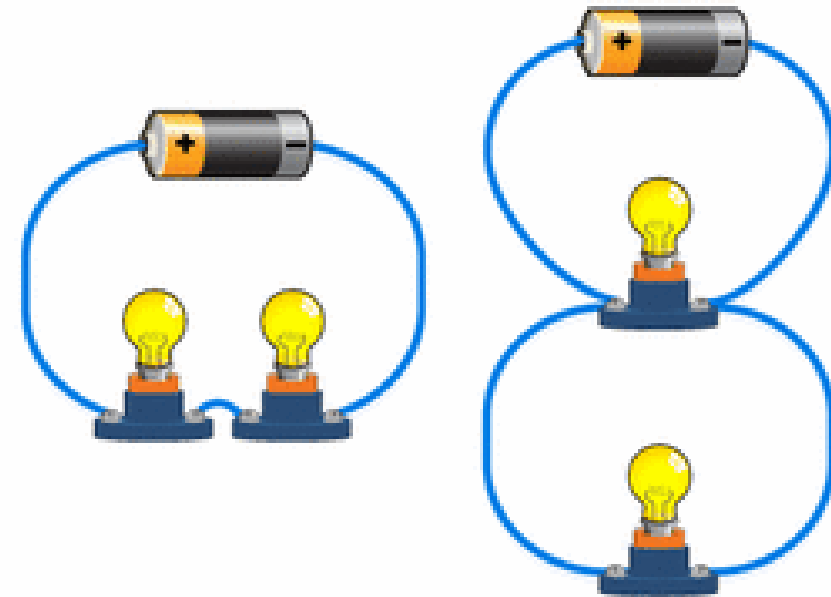
# Circuit Schematics

- Circuit Schematic illustrate you how components are connected in a circuit.
- For more info follow this [link](#)



# Electrical Flow

- Components can be arranged in series/parallel
- Current tends to follow the path of least resistance to the ground
- In any given circuit, the total voltage around the path of the circuit is zero
- The amount of current going into any point in a circuit is the same as the amount coming out of that point.





# Analogue / Digital

- We live in Analogue world
  - Infinite number of colours/sounds/smells
- Technology is Digital
  - Finite, “discrete”
- Realworld -> Digital World often requires Analogue -> Digital conversion.
- Example, Photoresistor:
  - Analogue Voltage measured across Photoresistor is converted to digital value (a number) by Arduino

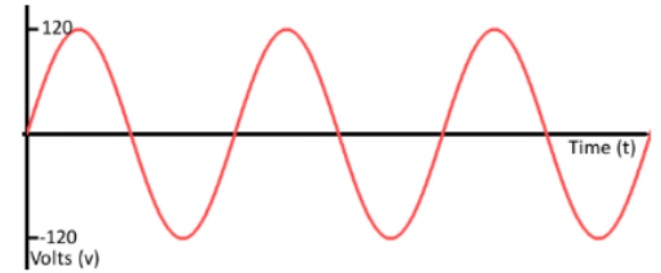


Fig. 7: Analogue Signal [Lindblom, 2015]

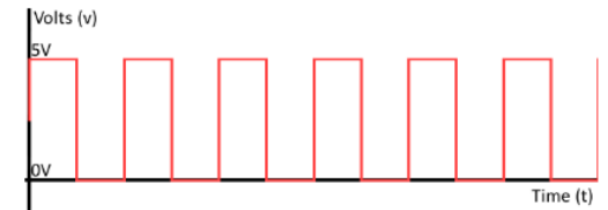
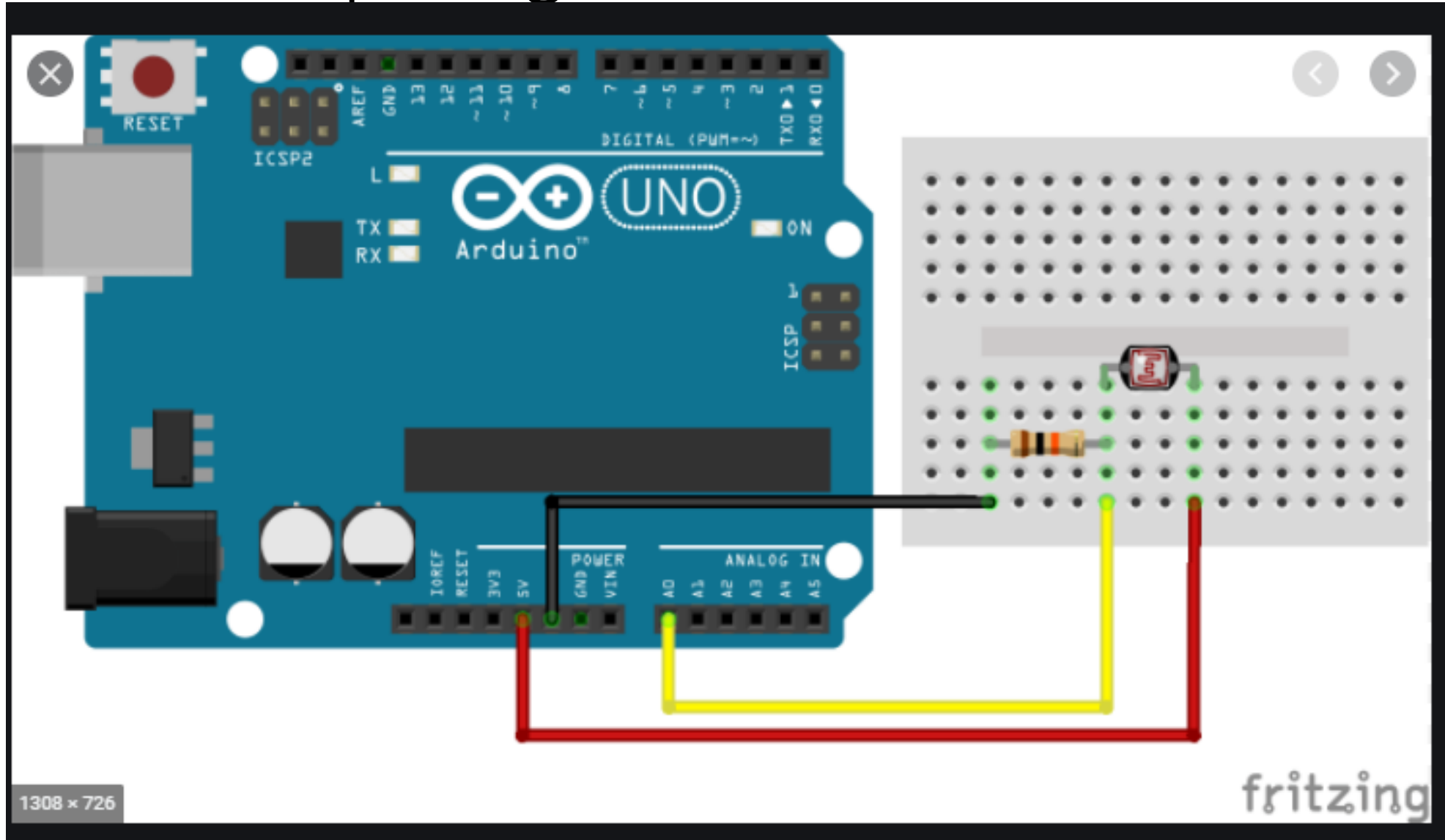


Fig. 8: Digital Signal [Lindblom, 2015]

# Physical Computing with Arduino



# Programming with Arduino: Basics

- Programs called Arduino “Sketch”
- **setup()** function
  - Used to initialise stuff
- **loop()** function
  - After setup(), loop() runs continuously, getting input from sensors etc.

```
sketch_jul19a
void setup() {
  // put your setup code here, to run once:
}

void loop() {
  // put your main code here, to run repeatedly:
}
```