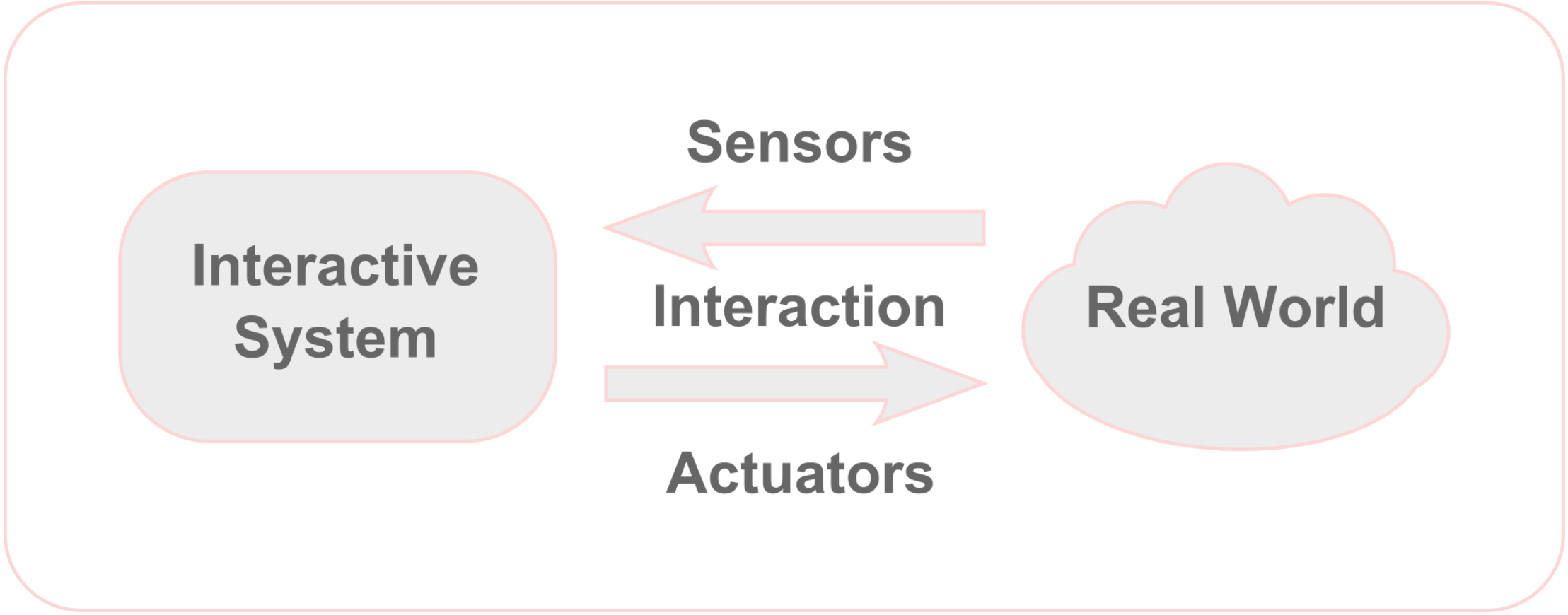
Physical Computing

Agenda

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

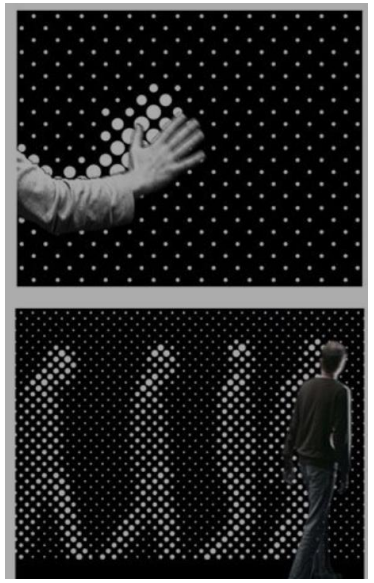
Physical Computing

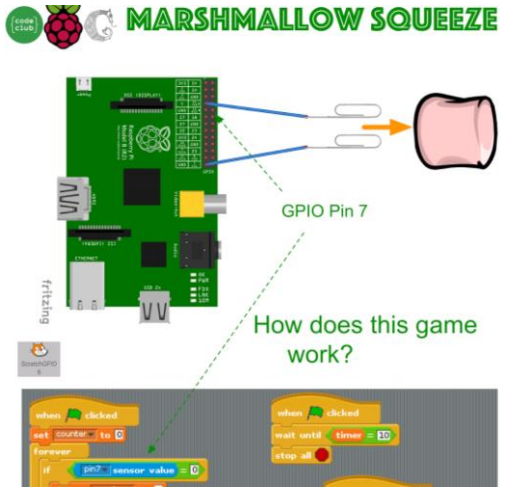
A creative framework for understanding human beings' relationship to the digital world



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**.

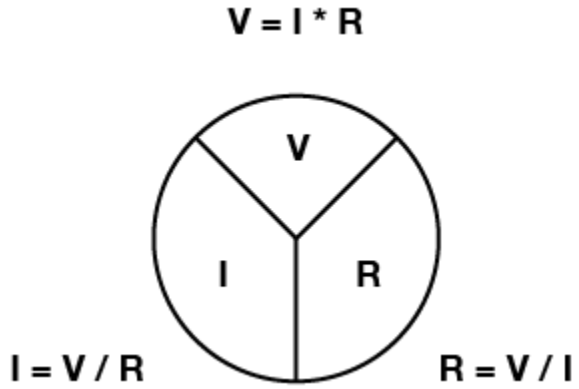
Current is a measure of the magnitude of the flow of electrons through a particular point in a circuit. It is measured in **Amperes**, or **Amps**.

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:

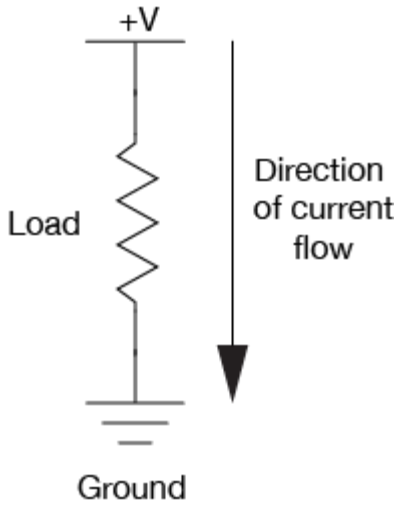
V = I x R



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

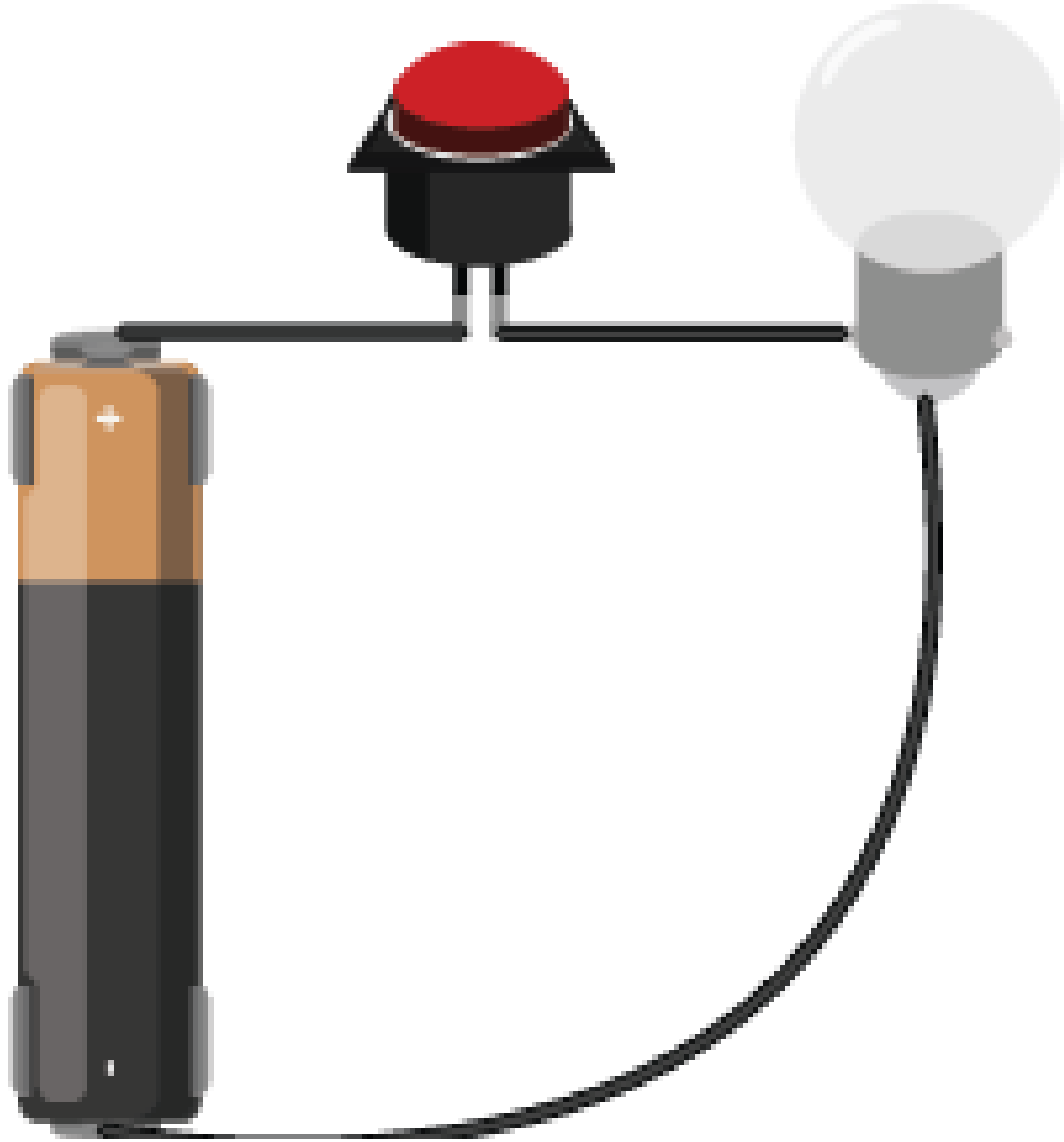
Watts = Volts * Amps

P = V * I



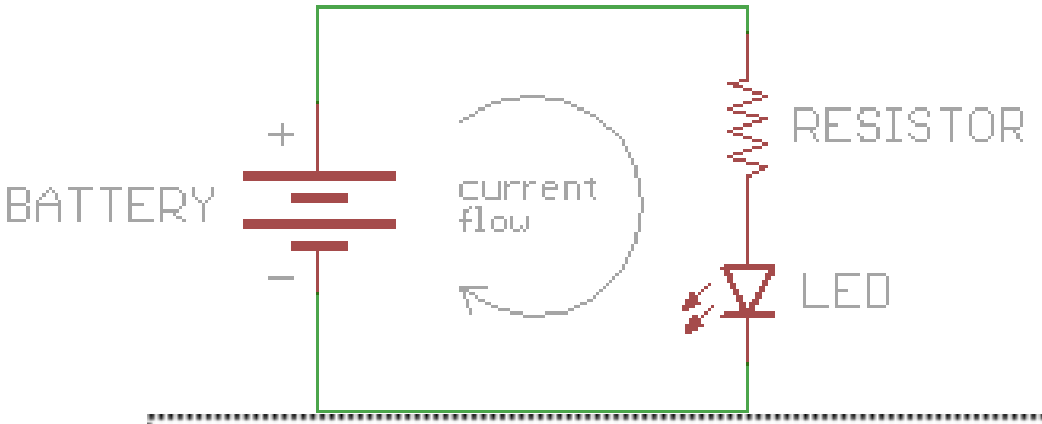
Circuit

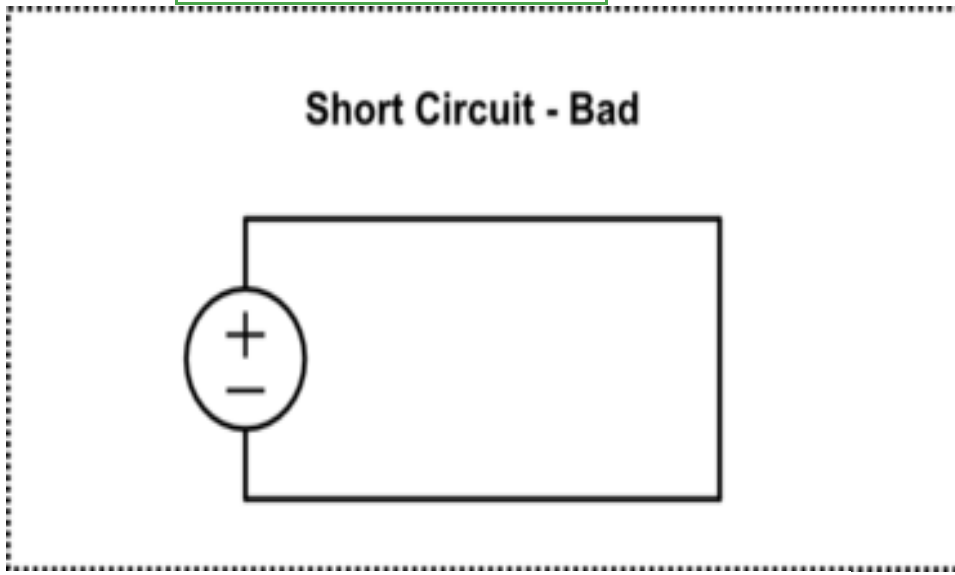
- Physical Computing usually involves interfacing a computing device with electrical circuit(s).
- A circuit needs a:
  - Electrical Energy Source (e.g. battery)
  - Load (Converts elec energy to something else)



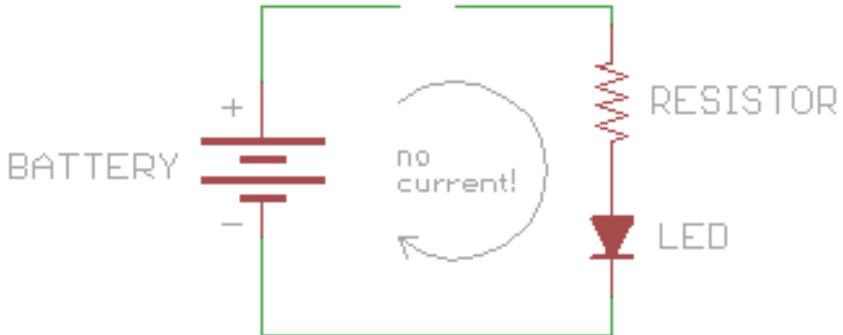
Circuit 2

- 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.



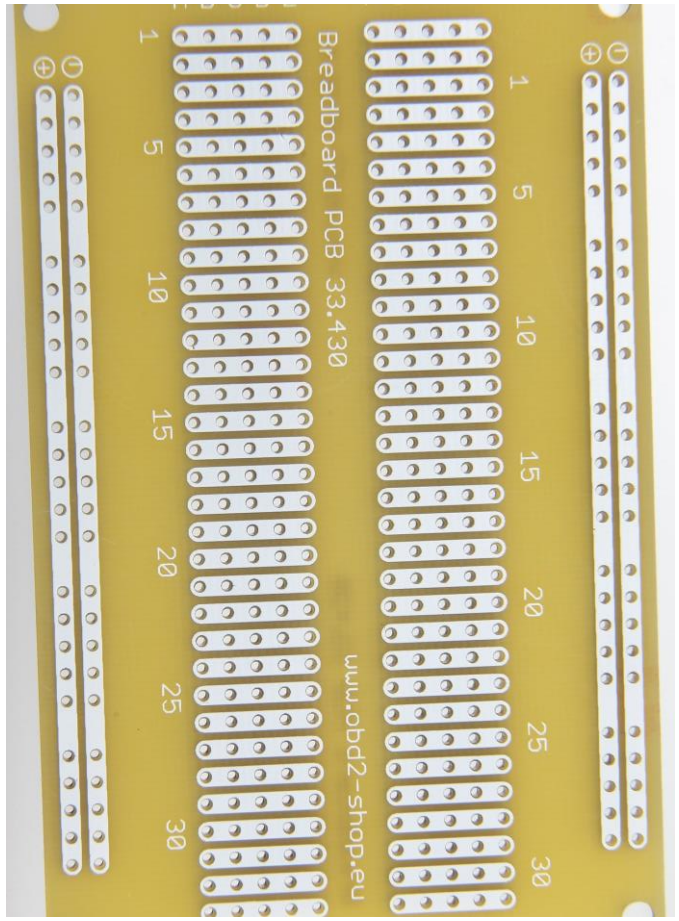


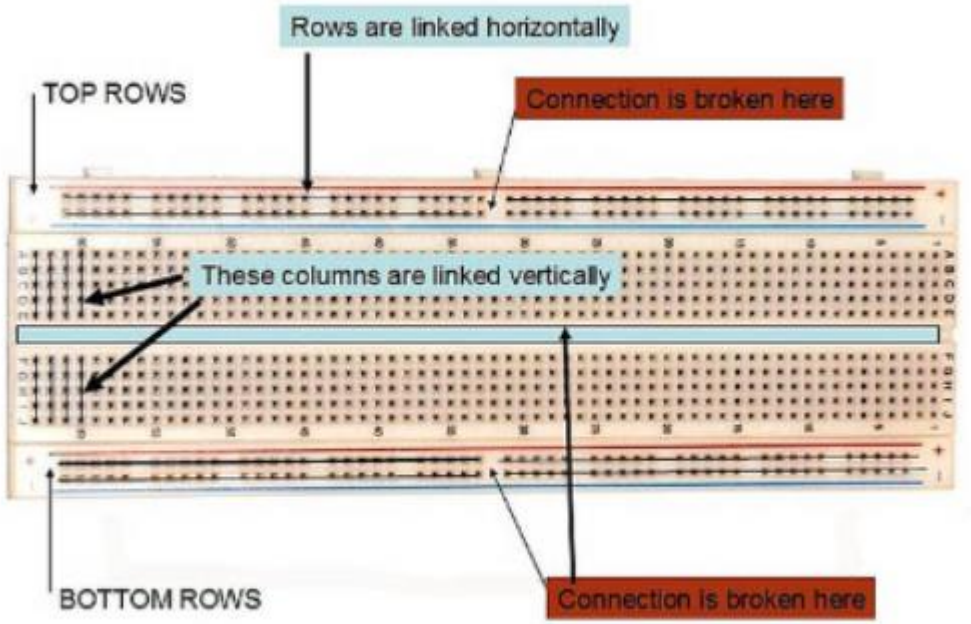
oops!



Electronics: Breadboard

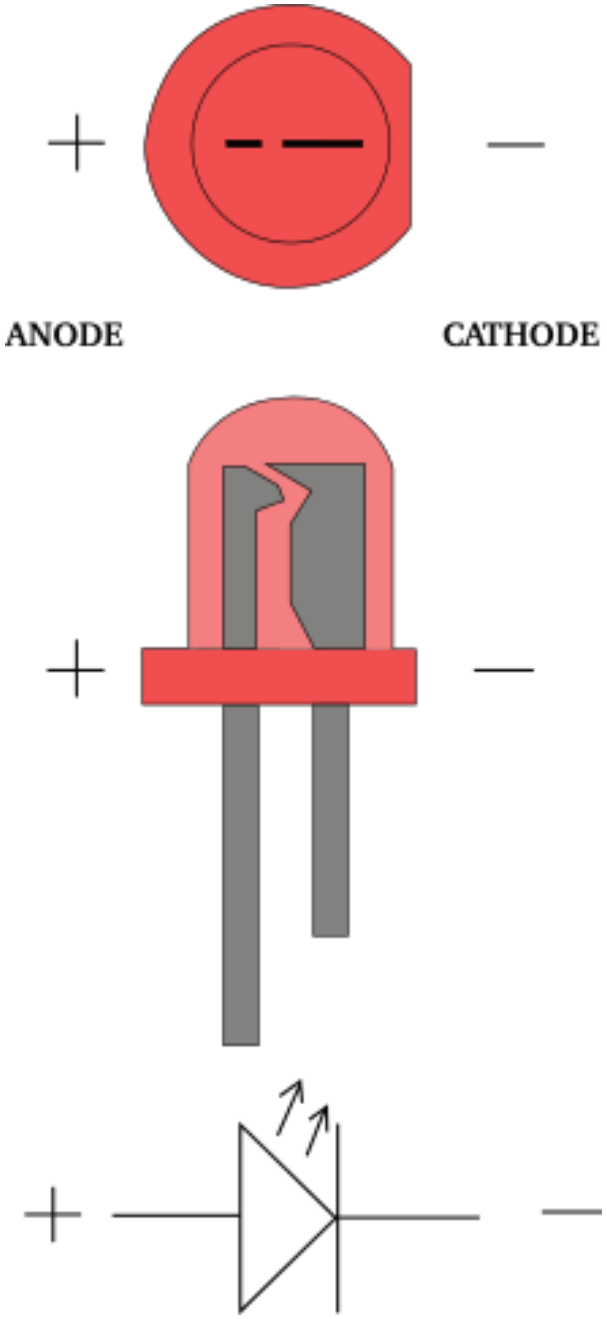
Used for prototyping electronic solutions





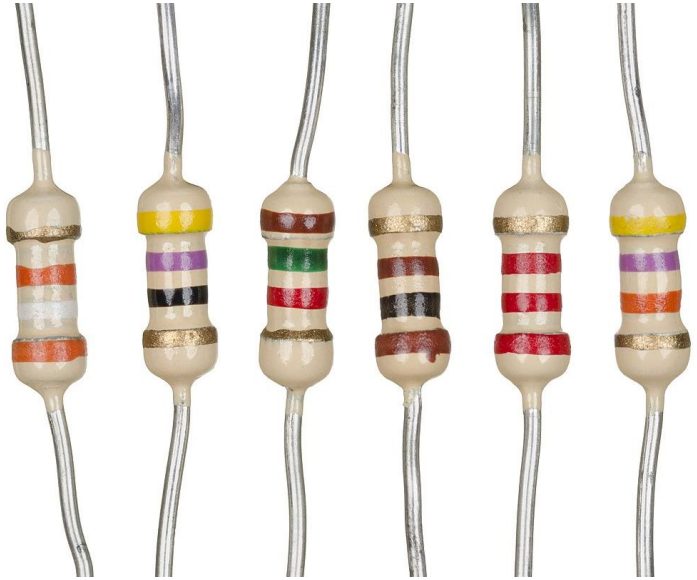
LEDs

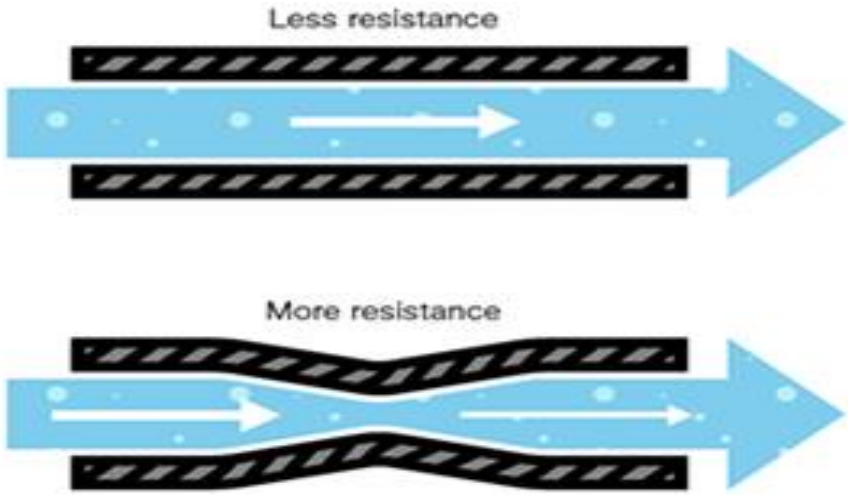
- Emits light when current passes through
- Typical LED requires 2V at 20mA
- RGB LEDs, LED strips, IR LEDs, Ultrabright



Resistors

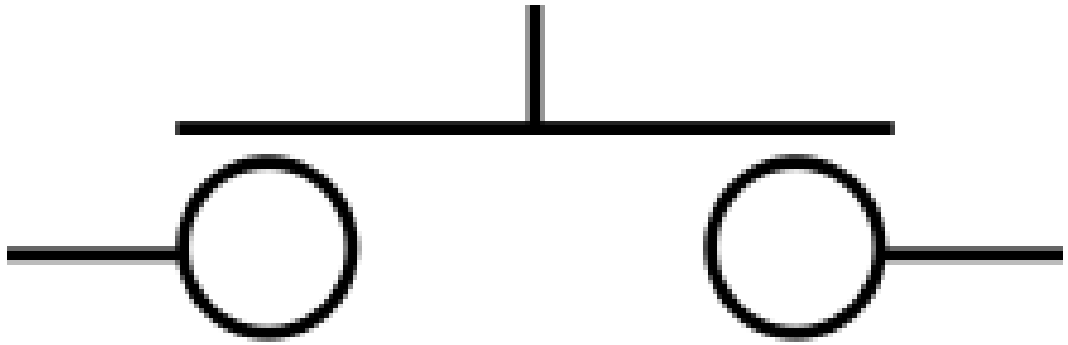
- Reduce current and voltage to components
- Ohm Law: I=V/R





Push Button

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

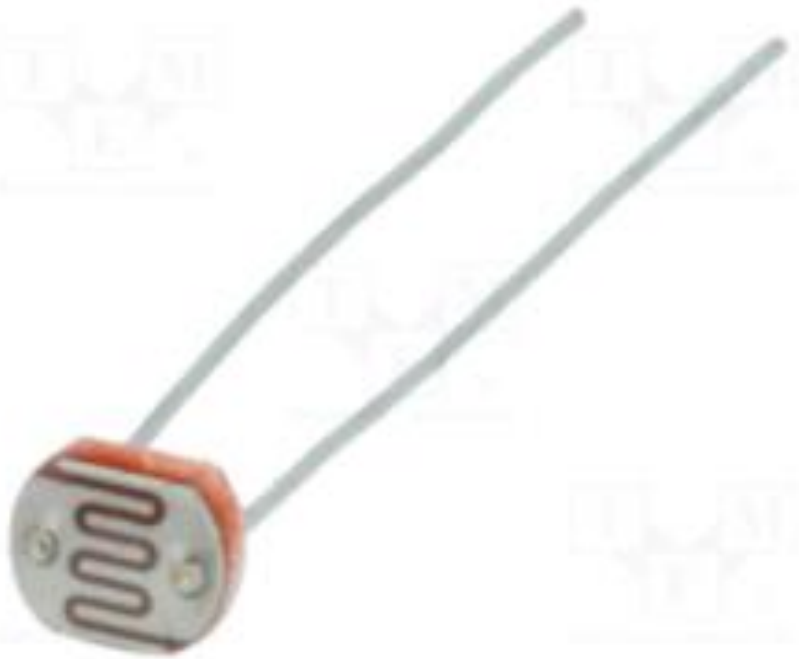


Thermistor

- 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”.

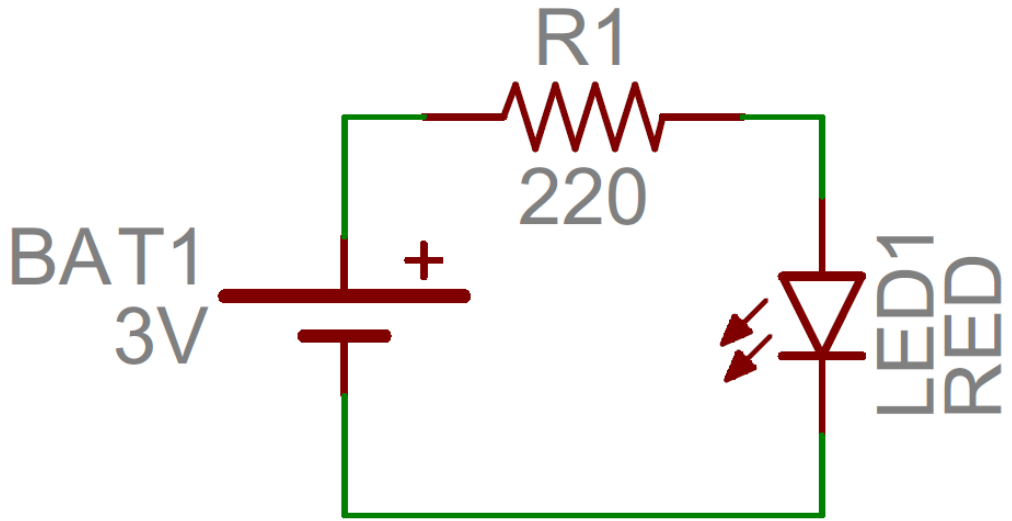
PhotoResistor

- 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



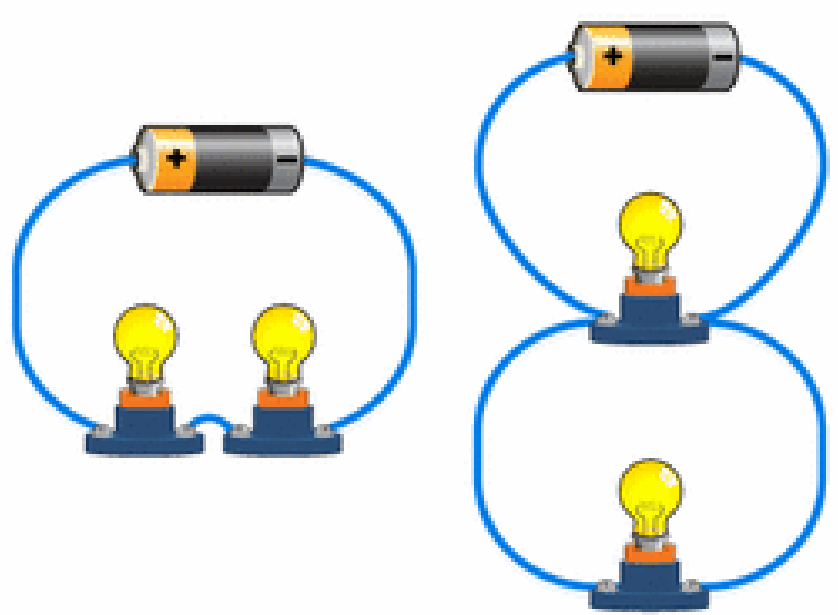
Circuit Schematics

- 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
  - Infinte 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

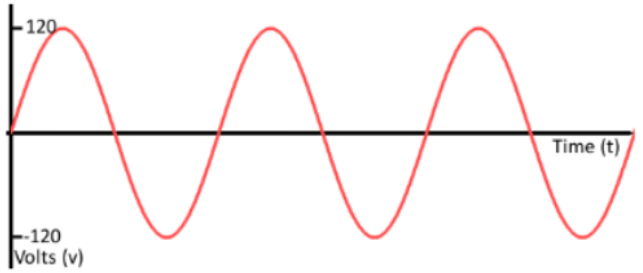


Fig. 7: Analogue Signal [Lindblom, 2015]

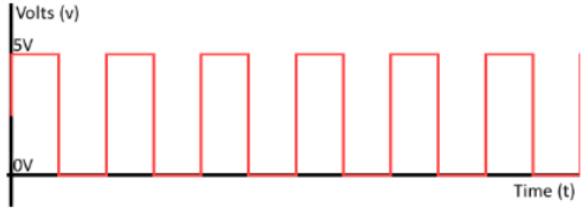
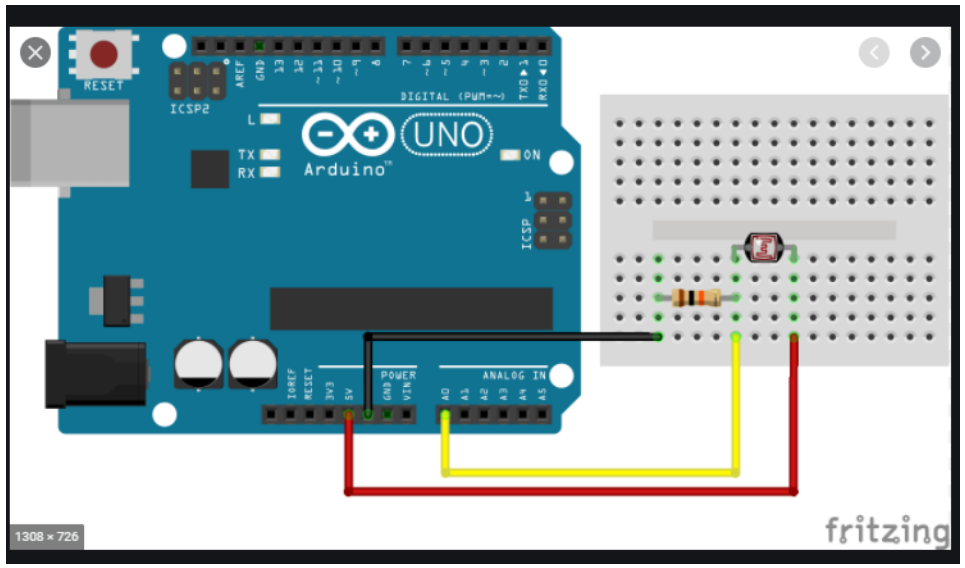
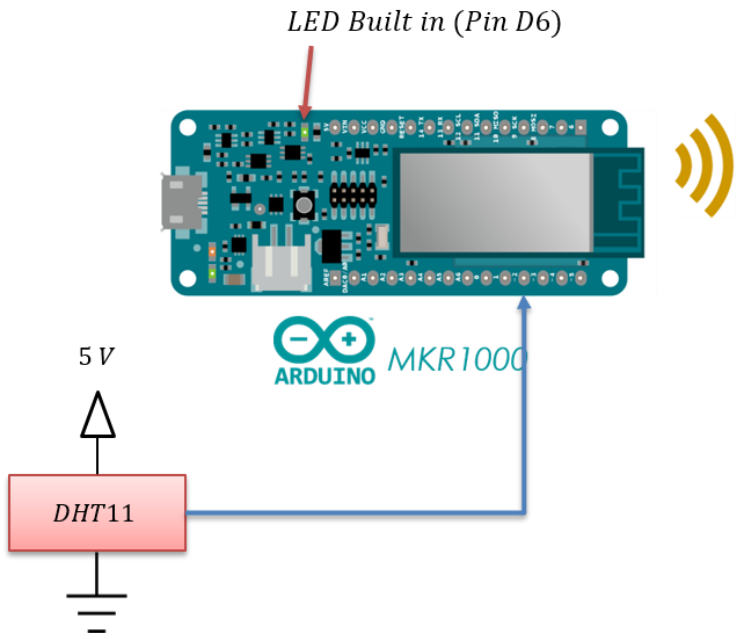
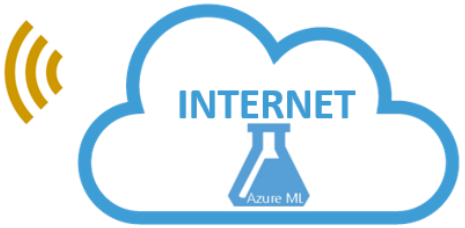


Fig. 8: Digital Signal [Lindblom, 2015]

Physical Computing with Arduino







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Learning

Programming with Arduino: Basics

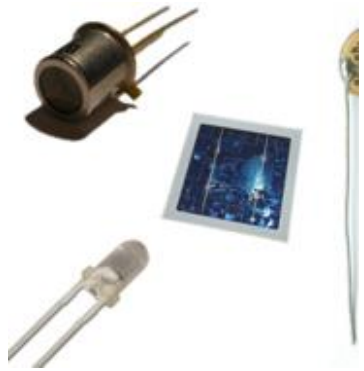
- Programs called Arduino "Sketch"
- **setup()** function
  - Used to initialise stuff
- **loop()** function
  - After setup(), loop() runs continuously, getting input from sensors etc.

sketch_jul19a

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

}

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

}
```

Sensors

- Many IoT systems have the following characteristics:
  - "…ability to harvest information, the intelligence to process the information, and the connectivity capabilities to communicate the results…"
- Sensors are used to "harvest information"
- Sensors
  - receives a signal or stimulus (e.g. heat or pressure or light or motion etc.) and responds to it in a distinctive manner
  - **produces an output signal for the purpose of sensing a physical phenomenon**.



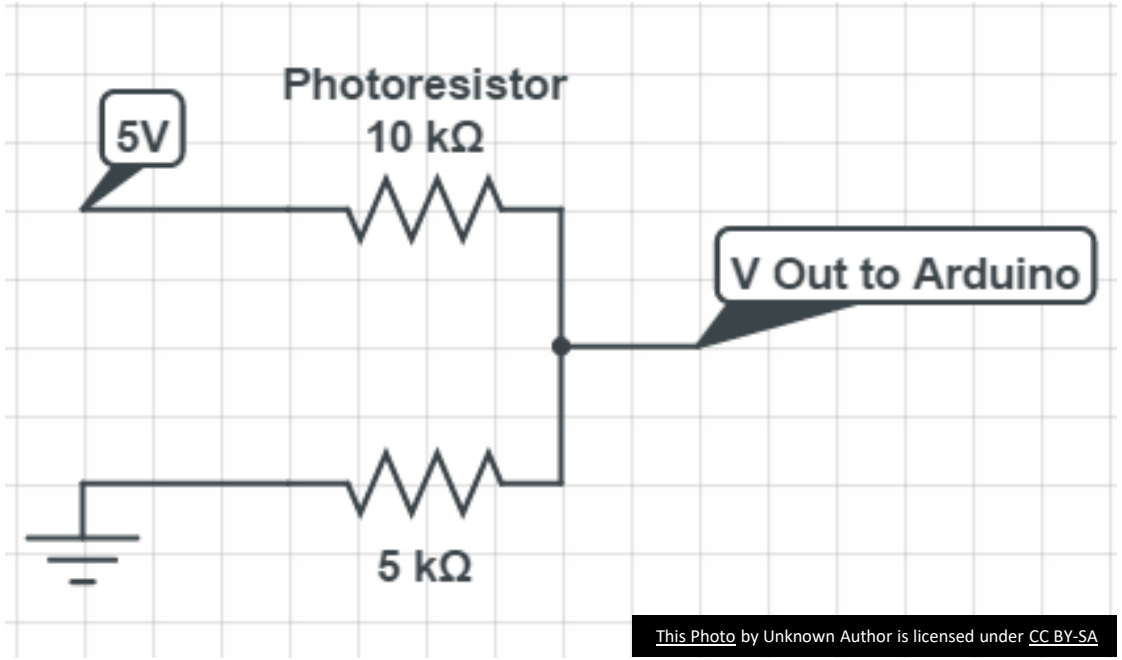
Sensor Example: Photoresistor

…"receives a signal or stimulus (e.g. heat or pressure or light or motion etc.) and responds to it in a distinctive manner…"

- Input signal/stimulus: Light
- Response: change in Resistance

How do we use this to "sense" light?

1. Put in a circuit
2. measure voltage across Photoresistor
3. Convert to digital value (a number) by Arduino



Sensor Example: Button

…"receives a signal or stimulus (e.g. heat or pressure or light or motion etc.) and responds to it in a distinctive manner…"

- Input signal/stimulus: Mechanical (press the button)
- Response: Close/Open Circuit

How do we use this to "sense" button press?

1. Put in a circuit
2. measure voltage across Button
3. Convert to digital value (a number) by Arduino