Bits & Bots

Anna Gerber

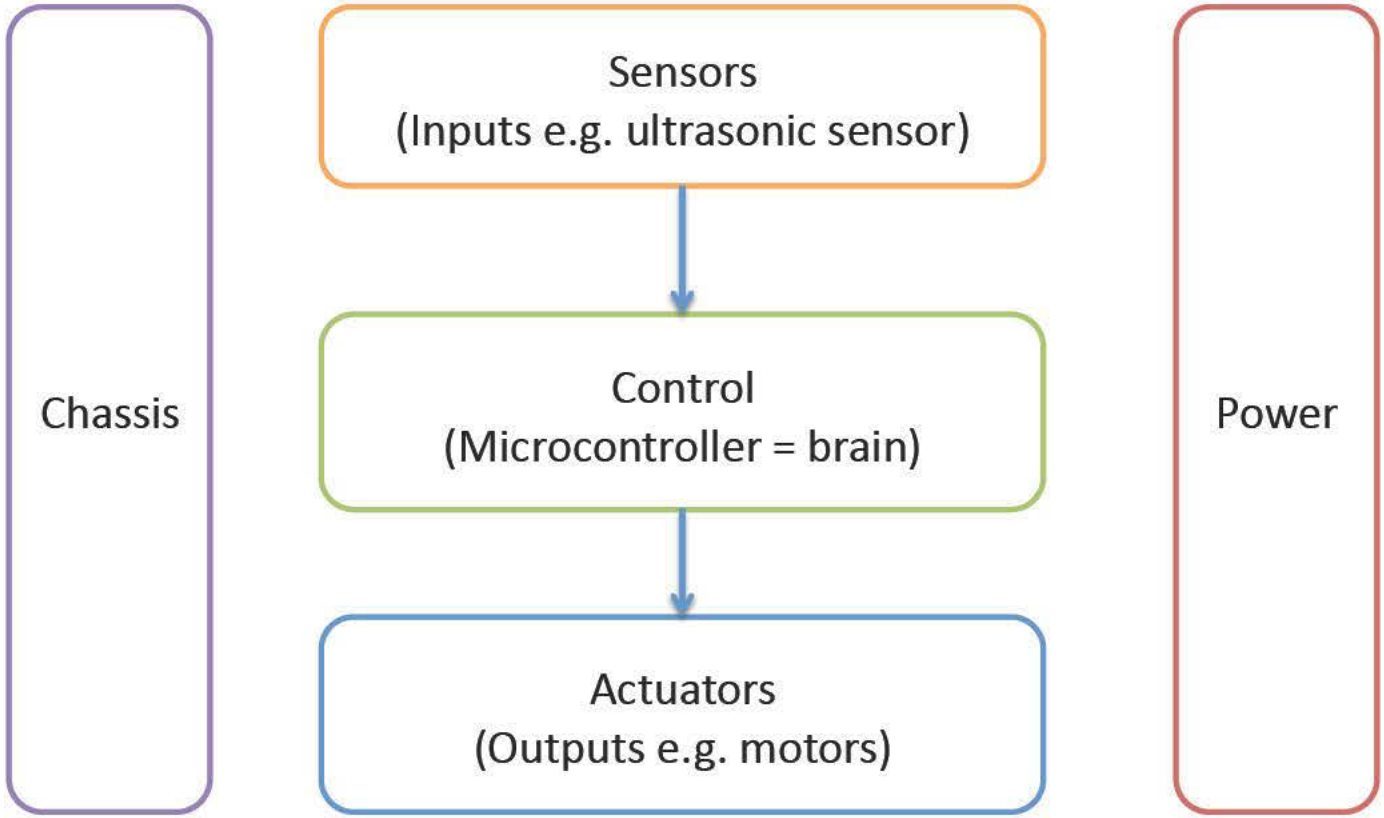
Bits & Bots Sessions

Session	Topic
Tuesday 20th May, 6 – 8pm	**Intro to 3D Design**: Design custom robot parts to print on the 3D printers
Tuesday 27th May, 6 – 8pm	**Intro to Electronics**: Learn how the electronic parts in the kit work, design our robot circuits
Tuesday 3rd Jun,e 6 – 8 pm	**Intro to Arduino**: Write NodeJS programs to read from sensors and control actuators
7th June, 1 – 5 pm	**Intermediate 3D Design**: Design more complex robot parts: gears, claws etc
14th June, 1 – 5 pm	**Intermediate Arduino**: Develop our robots' locomotion, sensing and responding behaviours
21st June, 1 – 6 pm	**Advanced Bits & Bots**: Finalise robot design and assembly, develop advanced robot control programs

Bits & Bots Slides etc

Slides and other materials for the course will be published after each session here:

https://github.com/AnnaGerber/bits-n-bots

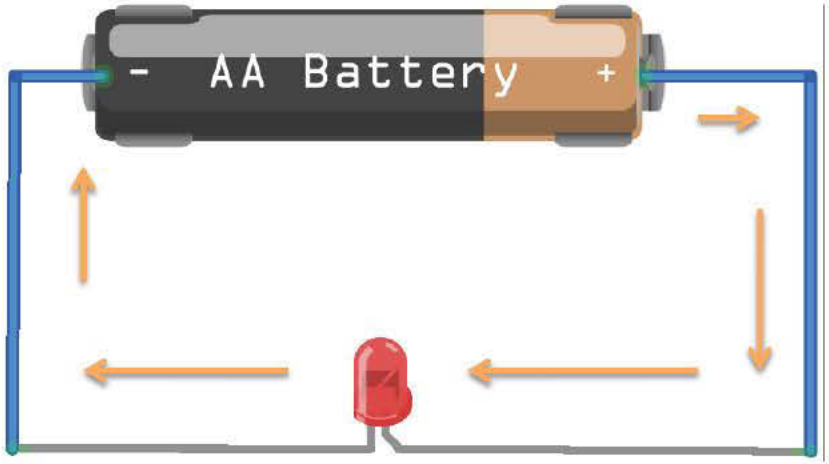

Chassis
Sensors
(Inputs e.g. ultrasonic sensor)
Control
(Microcontroller = brain)
Actuators
(Outputs e.g. motors)
Power

PHYSICAL COMPUTING

Building interactive systems that sense and act on (or respond to) the physical world

Electricity

- Electricity is a form of energy
- We can connect components that convert electrical energy into other forms of energy: light, sound, movement, heat etc, into a circuit
- In a Direct Current (DC) circuit, electrical energy flows from the positive side of a power source to the negative side, i.e. from + (power) to – (ground)



Electrical concepts

- **Current** (Amps): measures the flow of electrical energy through a circuit
- **Voltage** (Volts): measures difference in potential energy between the positive and negative sides of a circuit
- **Resistance** (Ohms): measures a material's opposition to the flow of energy
- **Power** (Watts): the rate at which energy is converted from one form to another

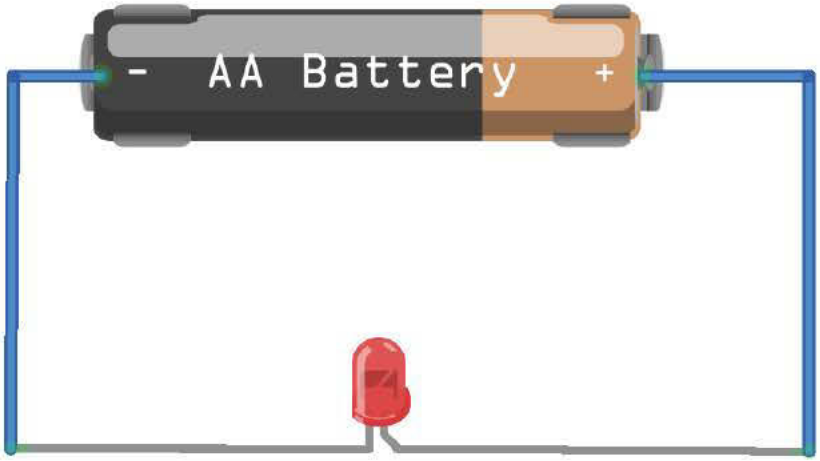
Ohm's Law

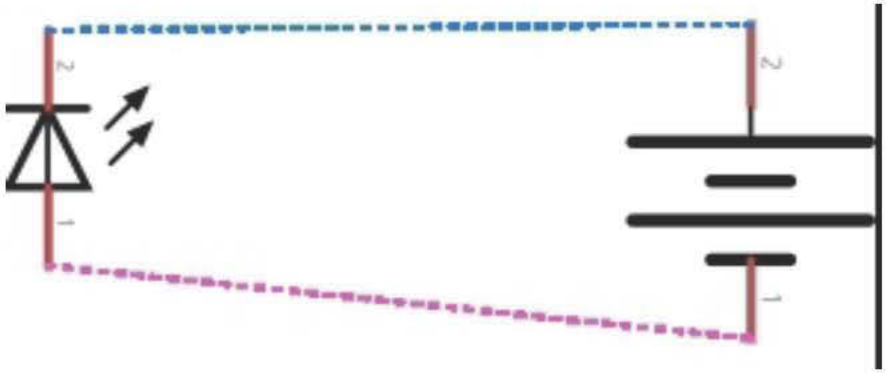
Current = Voltage / Resistance

- Increase the voltage, and the current will increase (i.e. speed up)
- Increase the resistance and the current will decrease

Circuit Schematics

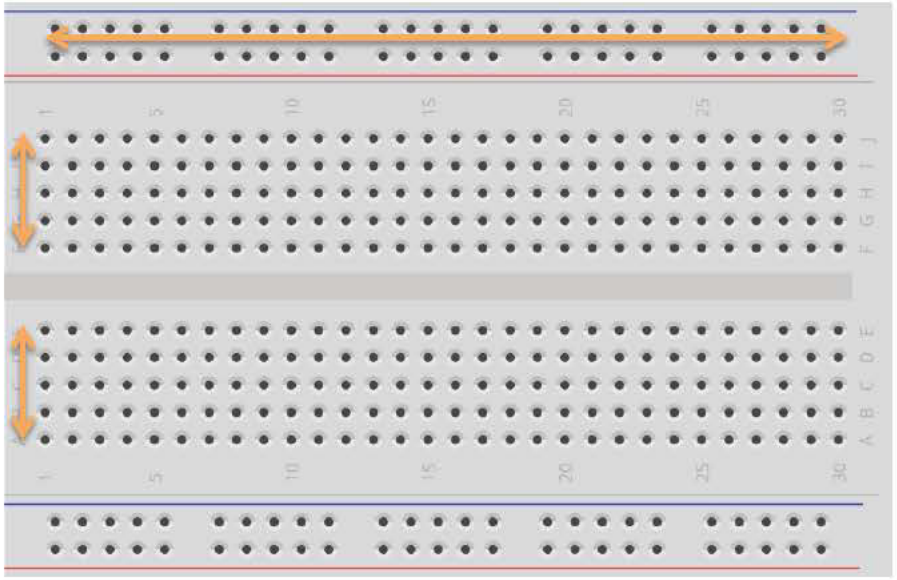
- Diagrammatic representations of components and how they are connected

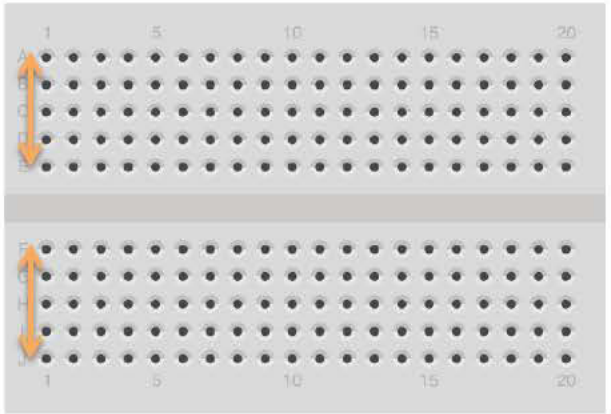




Using a Breadboard

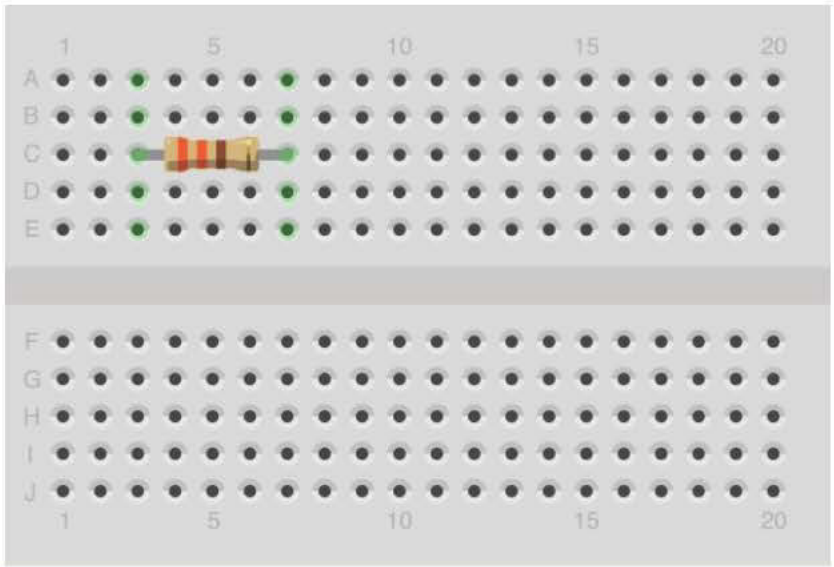
- Use to prototype circuits without soldering by plugging in components and jumper wires
- Numbered rows are connected
- Some have power rails along the sides





Resistors

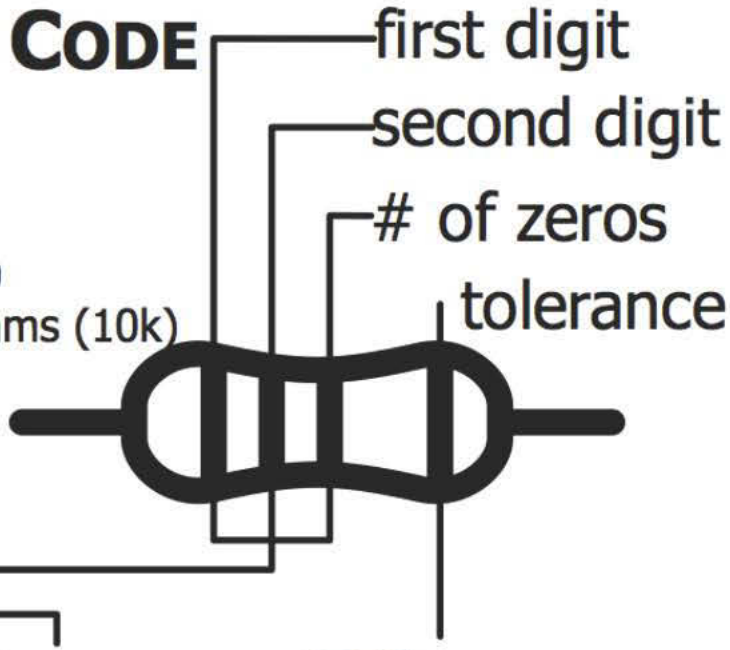
- Introduces resistance, so restricts the amount of current that can flow through a circuit
- Can be connected in either direction
- Bend and trim the leads to approx 1cm each make it easier to use with the breadboard



Resistor Color Code

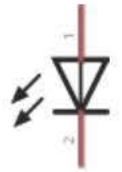
Examples:

green-blue-brown - 560 ohms
red-red-red - 2 200 ohms (2.2k)
brown-black-orange - 10 000 ohms (10k)

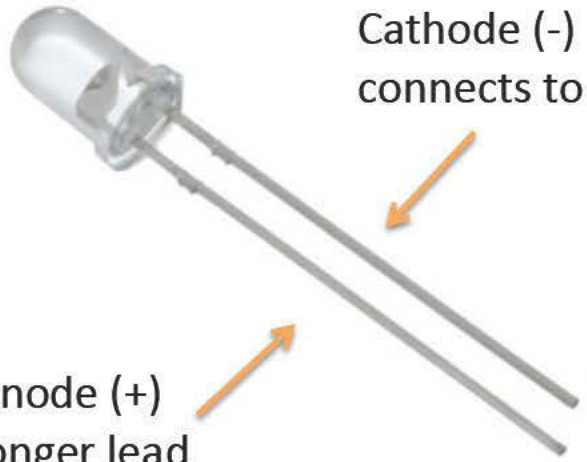


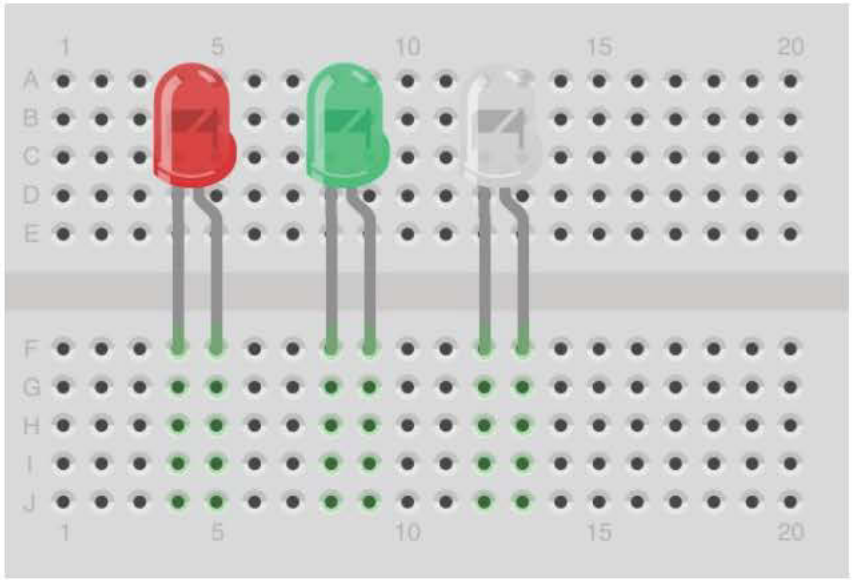
0 - Black	5 - Green	20% - none
1 - Brown	6 - Blue	10% - silver
2 - Red	7 - Purple	5% - gold
3 - Orange	8 - Grey	
4 - Yellow	9 - White	

LEDs



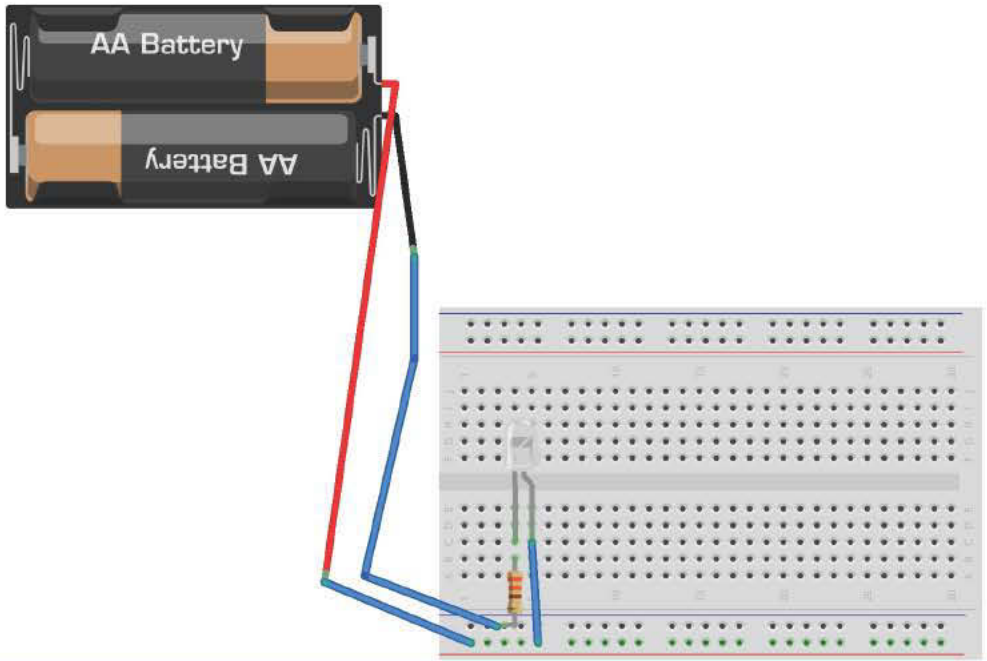
- Light Emitting Diode
- Polarized: diodes act like one way valves so must be connected in a certain direction
- Emits light when a current passes through





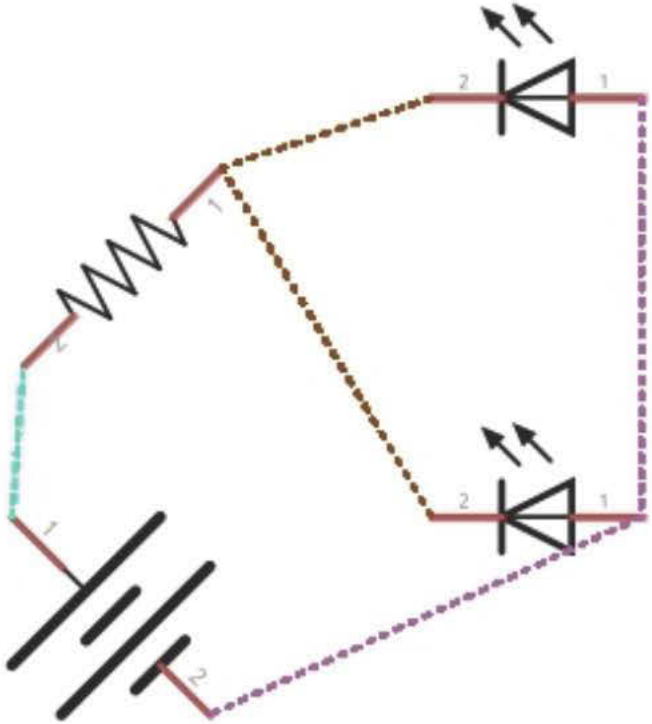
Creating a circuit

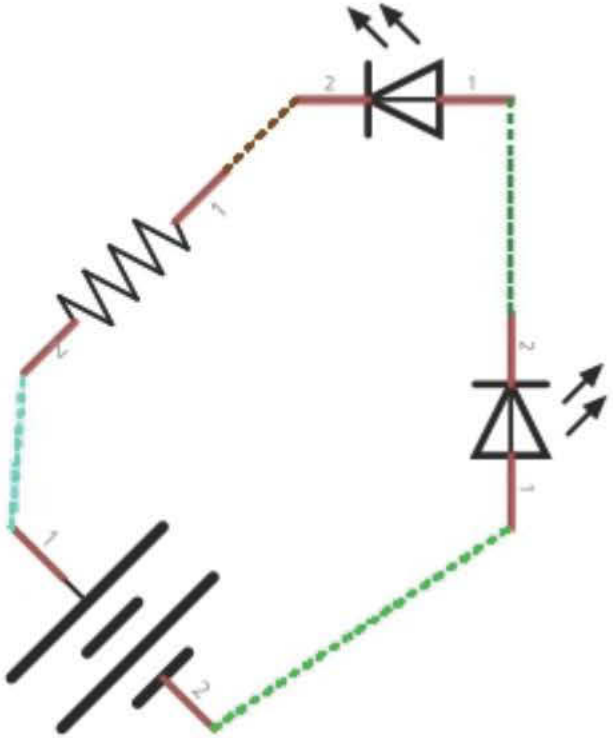
- Hook up an LED to a power source: anode to + and cathode to -
- Include a current limiting resistor to avoid damaging the LED



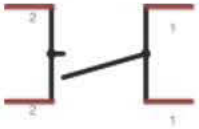
Adding more components

- Add a second LED to your circuit, experiment with connecting the LEDs in parallel vs series

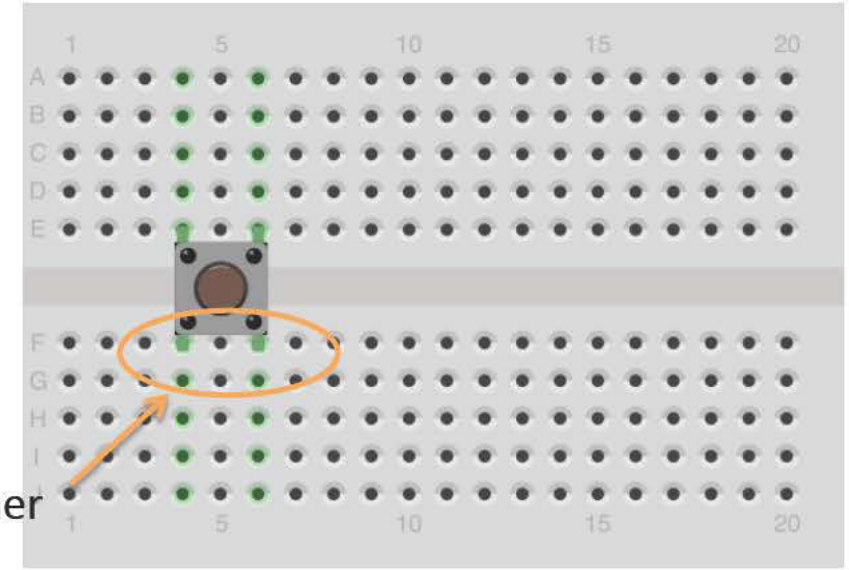




Pushbuttons

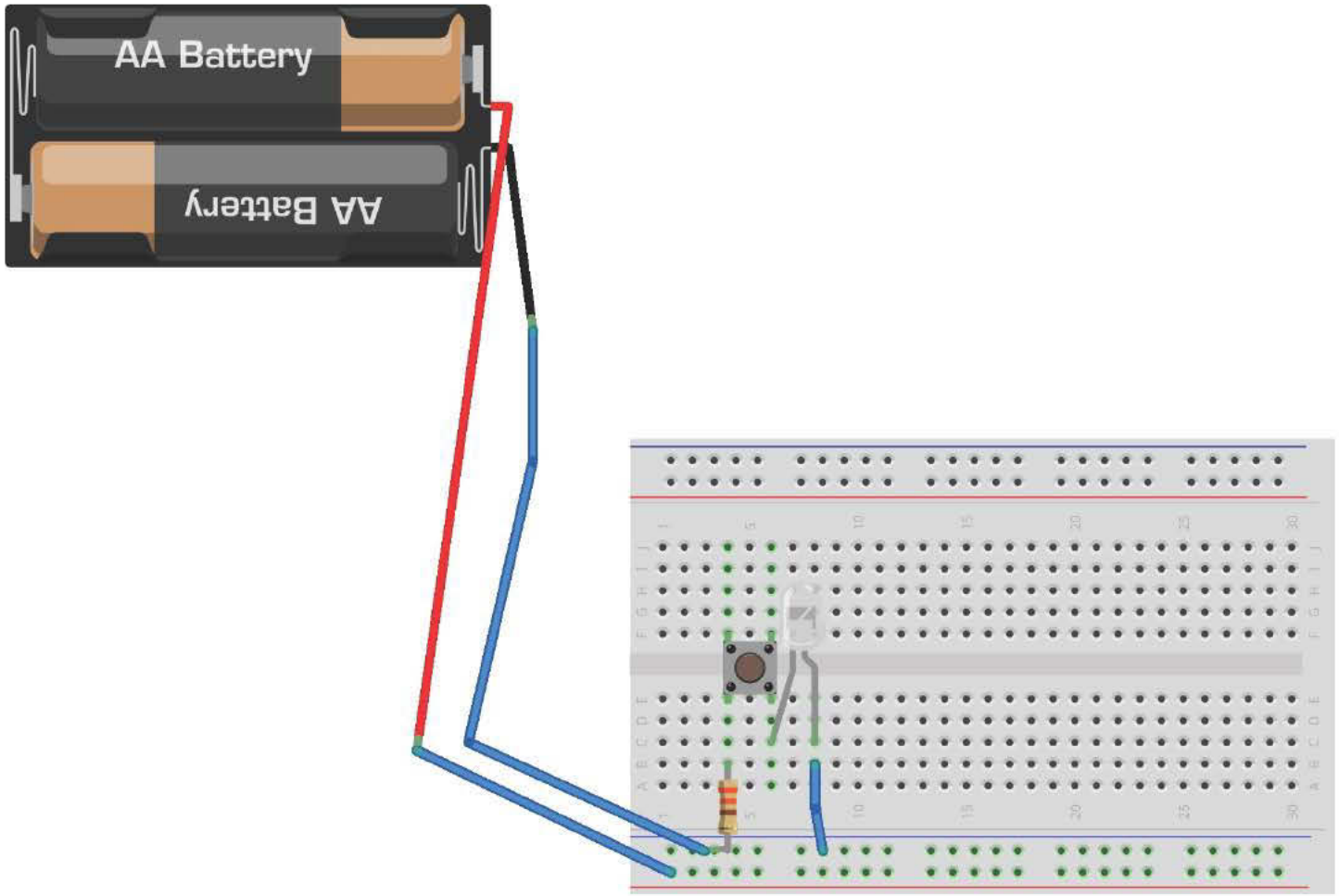


- Also known as a momentary switch
- Can be connected in either direction
- Has two sets of leads on either side

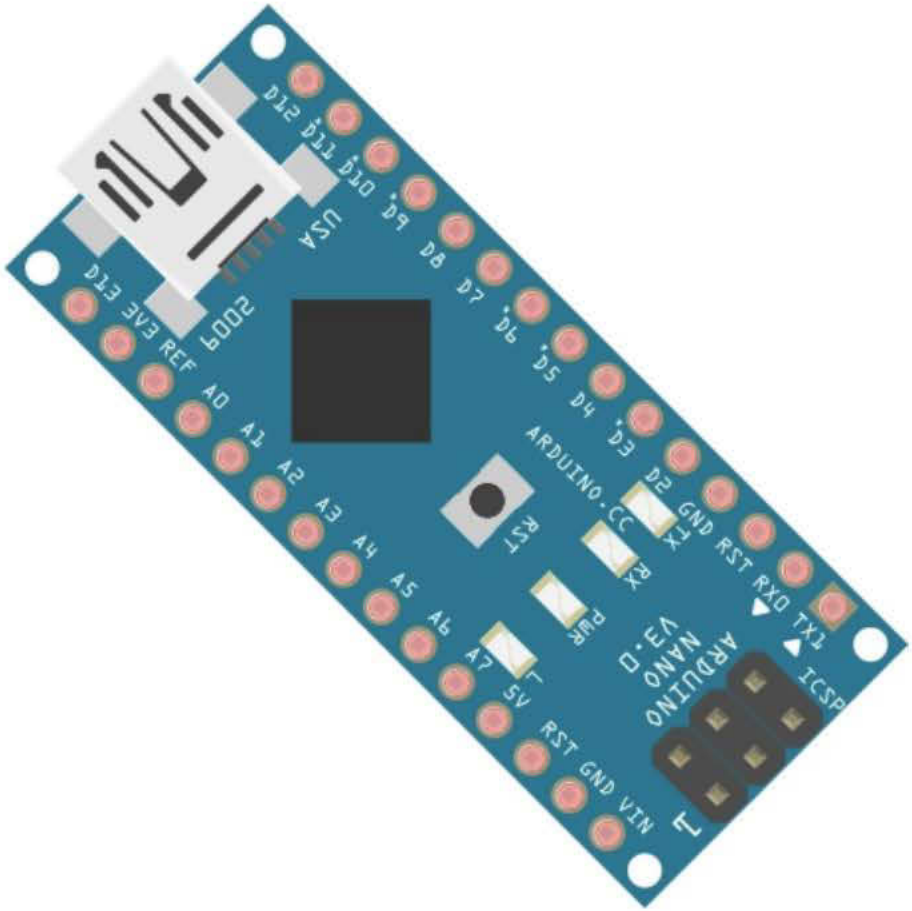


Use leads from the same side together

Add a button to your circuit



Control



- Microcontroller co-ordinates robot inputs (sensors) and outputs (actuators)
- We are using an Arduino Nano clone
- See http://arduino.cc/

Sensors

- Environmental conditions
  (e.g. temperature, humidity, smoke)
- Magnetic (e.g. hall effect sensor)
- Light (e.g. photo resistor)
- Sound (e.g. microphone)
- Motion (e.g. accelerometer, tilt, pressure)
- User / Physical Input (e.g. button)

Sensors in our kits

PHOTO RESISTOR

Produces a variable resistance dependant on the amount of incident light.

ULTRASONIC SENSOR

Used to detect distance from objects.

PUSHBUTTON

Can be used as a bump sensor: indicates that the robot has bumped into something when pressed

Actuators

- Light & Displays (e.g. LED, LCD)
- Sound (e.g. Piezo buzzer)
- Motion (e.g. Servo, DC Motor, Solenoid)
- Power (e.g. Relay)

Actuators in our kits: Light and Sound

PIEZO ELEMENT

A pulse of current will cause it to click. A stream of pulses will cause it to emit a tone.

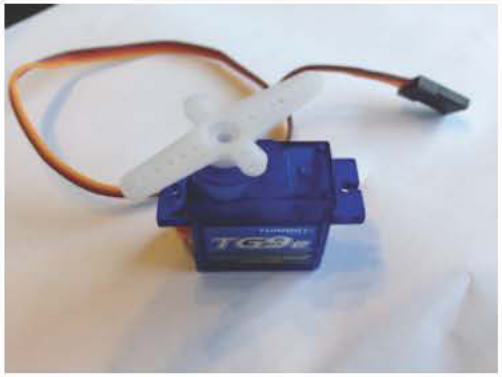
LED & RGB LED

We are using Common Cathode RGB LEDs. The longer lead is the common lead which connects to ground. The three other leads are for Red, Green and Blue signal

LED Matrix

8 x 8 matrix of single colour LEDs. One row 8 pins corresponds to rows and the other to columns. We will connect to these pins via shift registers.

Actutators in our kit: Motors



9G HOBBY SERVO

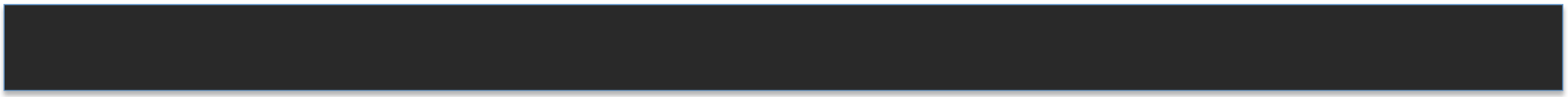
A box containing a motor with gears to make it positionable from 0 to 180 degrees. Positioning is controlled through a timed pulse, between 1.25 milliseconds (0 degrees) and 1.75 milliseconds (180 degrees) (1.5 milliseconds for 90 degrees).

CONTINUOUS ROTATION SERVO

A servo that rotates 360 degrees

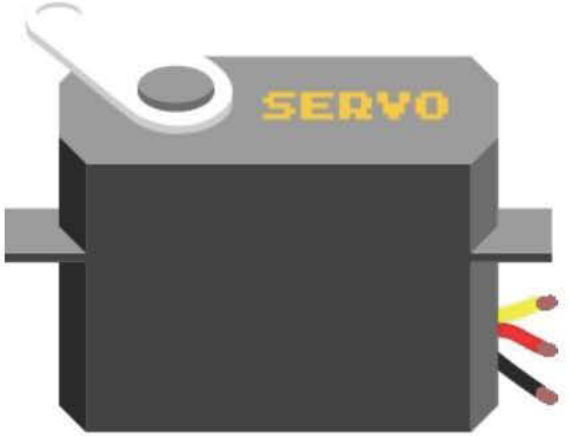
Digital vs Analog

- Digital
  - discrete values (0 or 1)
  - Examples: tilt sensor, push button
- Analog
  - continuous values
  - typically values for analog sensors are constrained within a range e.g. 0 – 255, 0 – 1023
  - Example: photo resistor
- Some sensors and actuators support both digital and analog modes



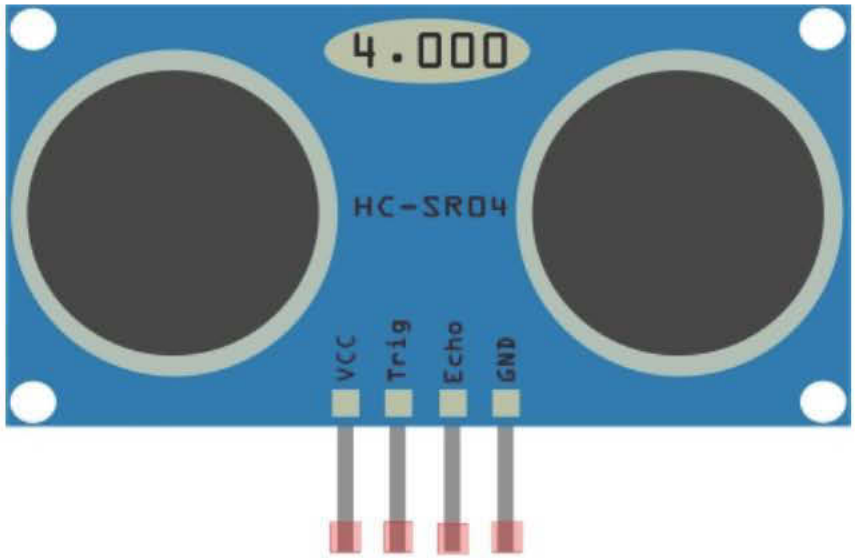
Connecting a servo

- Connect the red lead to power
- Connect the brown (sometimes black) lead to ground
- Connect the orange (sometimes yellow) signal lead to one of the I/O pins on the Arduino that supports Pulse Width Modulation (PWM):
  3, 5, 6, 9, 10, 11



Connecting a sensor

- Connect VCC to power
- Connect GND to ground
- Connect the other pin(s) to I/O pins on the Arduino



Credits

- Some of the images in these slides were taken from the Arduino Experimenters Guide created by .:oomlout:. and SparkFun and are used under a CC-BY-SA license.
- See http://node-ardx.org for more details