

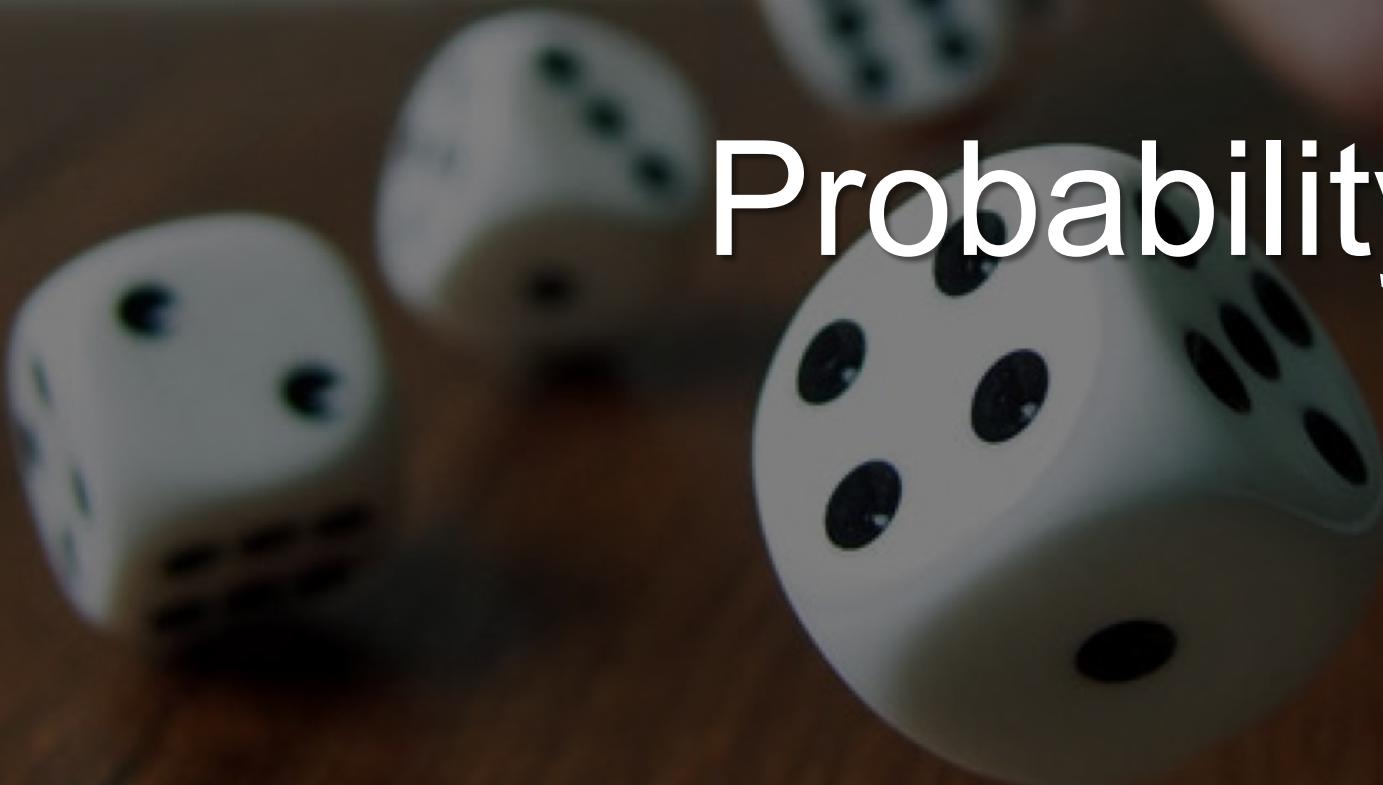
ENG 10: Lecture 7

Spring 2021

Engineering of the week

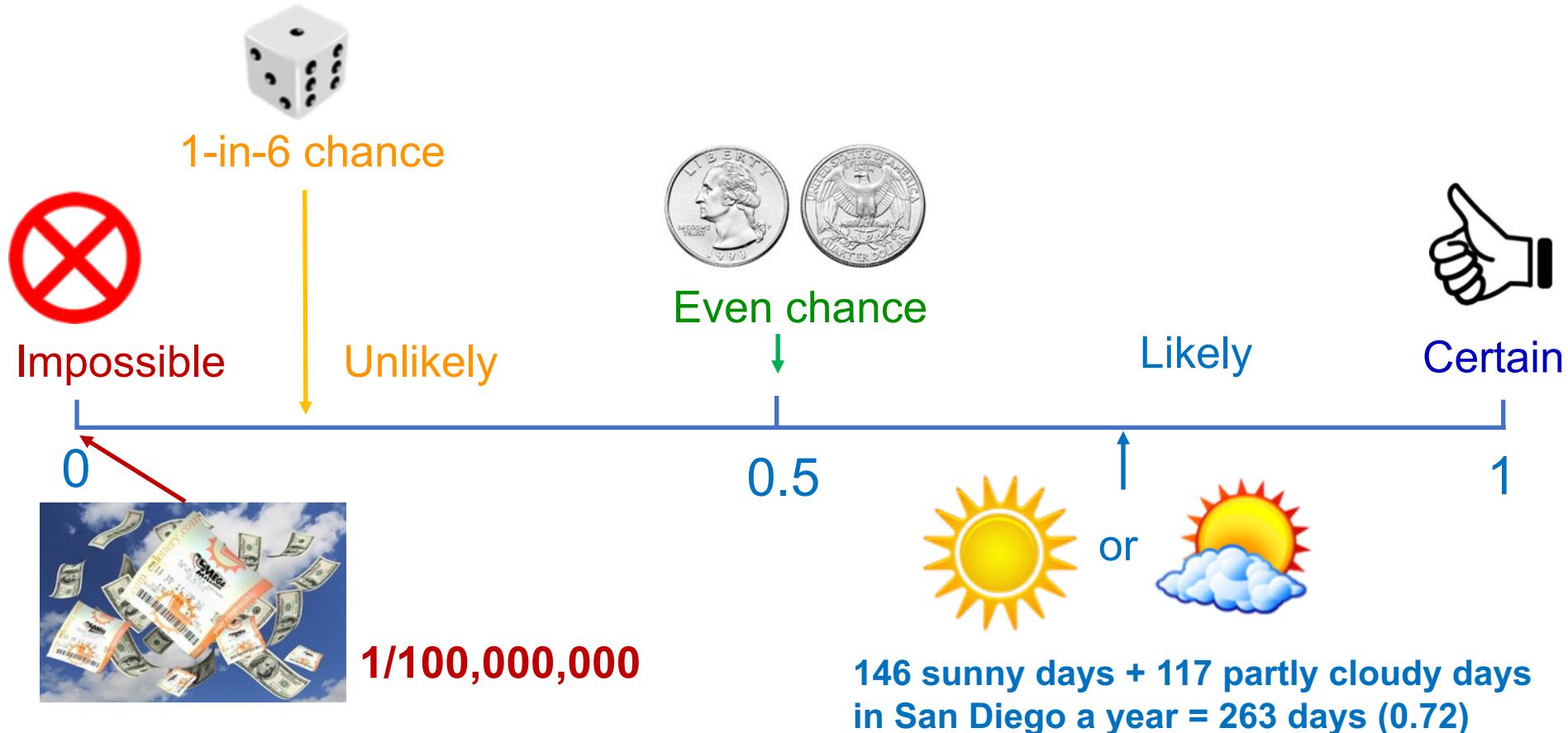
[Tyler Stevens](#) “Blockchain software and its benefits to encrypted currency”

Probability



Probability: Probability scale

- Probabilities can be written as:
 - ① Fractions from 0 to 1
 - ② Decimals from 0 to 1
 - ③ Percentages from 0 % to 100 %
- Probability Scale:





Statistics

Data collection methods (**sampling**)

- Surveys



- Observations



- Interviews



- Experiments



Importance of accuracy: Watch out for **Faulty** data!

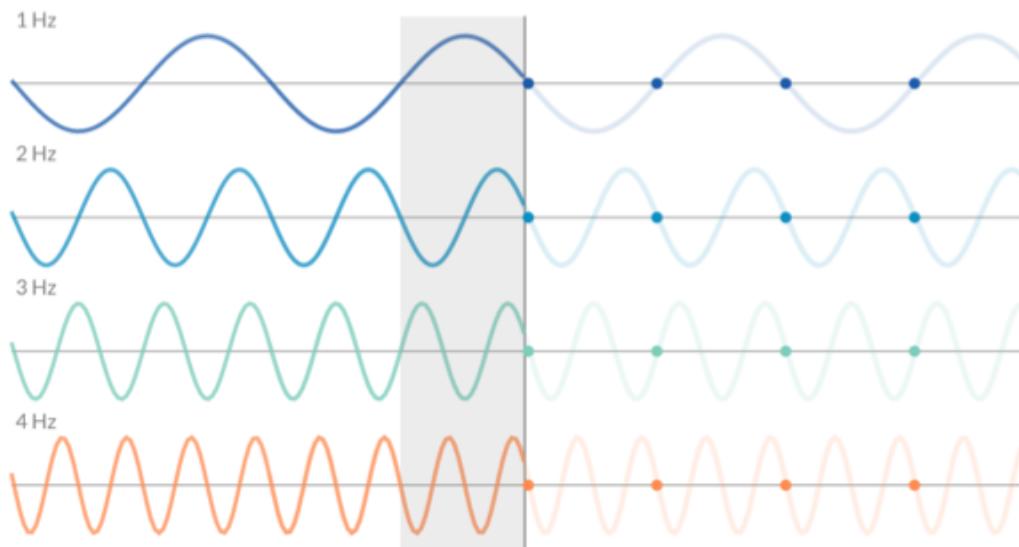
- Lies in survey



- Samples do not represent the whole.



- Not enough # of sampling



- Failed in controlling any independent variables that affect results



- Accurate data collection is essential to minimize errors
- Otherwise, these unreliable data bring wrong decisions or distorted findings

Project Reminders

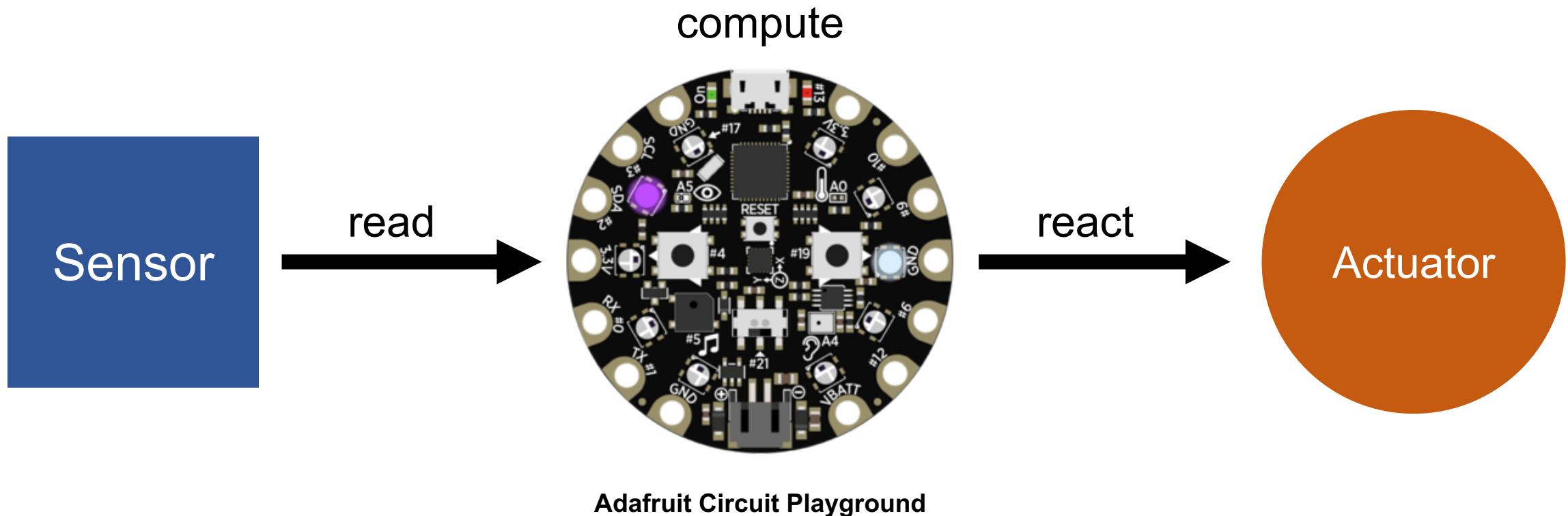
| Deliverable | Week | Due Date |
|---|----------|--------------|
| Design proposal | 5 | 04/28 |
| Group progress report #1 | 8 | 05/19 |
| Group progress report #2 | 9 | 05/26 |
| Proof-of-concept Practice presentation | 9 | 05/26 |
| Final presentation | 10 | 06/02 |

- **Today (Week 7)**
 - Group progress report #1 assigned
 - Final Project Rubric Posted on Canvas
 - Finish Lab 3
 - Project workday in class
- **Week 8**
 - Group progress report #1 due
 - Group progress report #2 assigned
 - Full project workday in class
- **Week 9**
 - Group progress report #2 due
 - Practice presentations for peer feedback
 - Proof-of-concept prototype demonstration
- **Week 10:** Final Presentations!

Before Next Class

- Please, fill out Group Progress Report #1 posted on Canvas - Assignments – Final Project

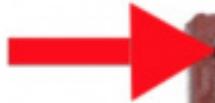
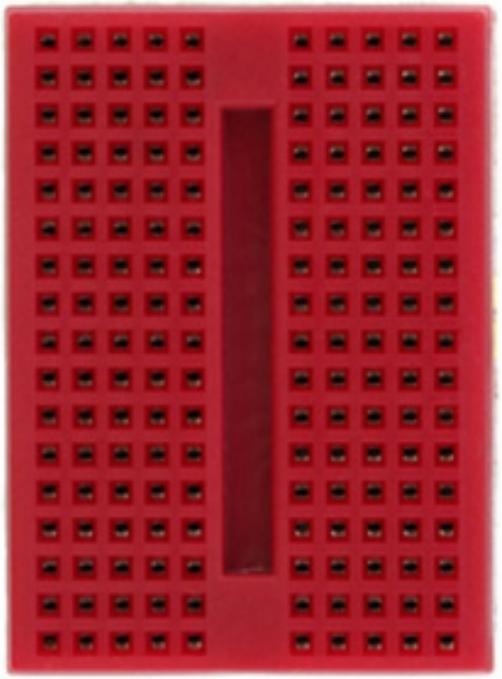
Arduino Microcontrollers



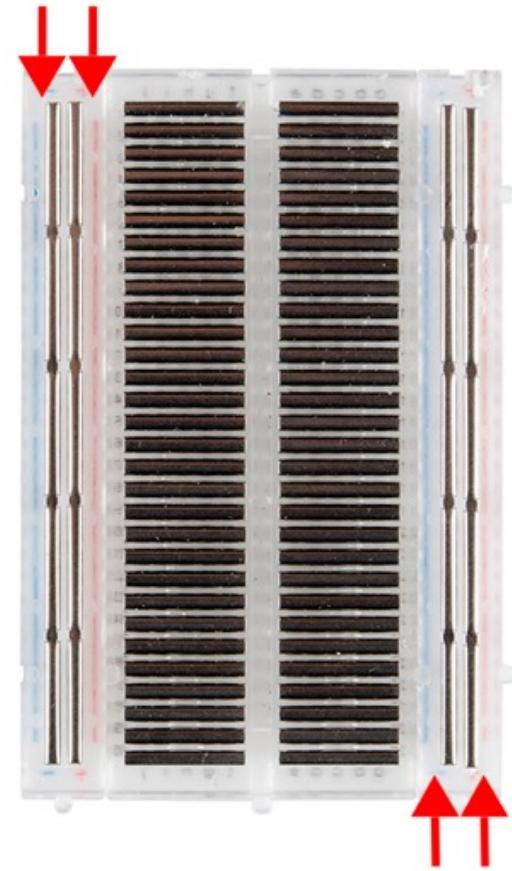
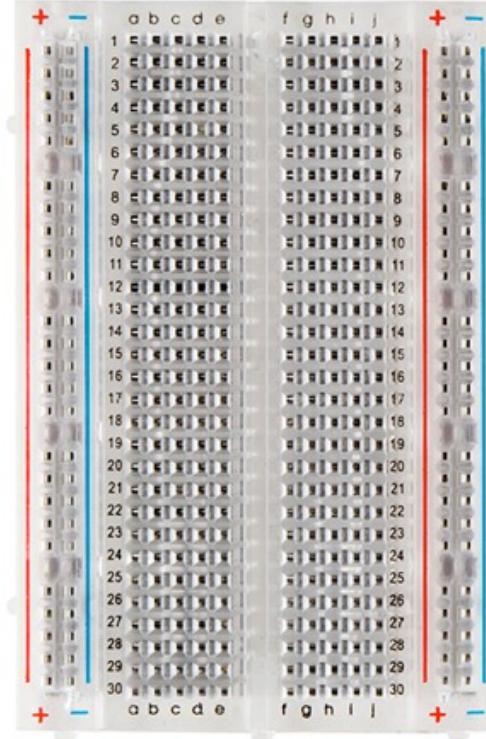
How many of you have watched "How to start a project" movie posted on
Canvas – Modules - Tutorials?

Breadboards

Fundamental tool to build circuits by allowing multiple connections between devices

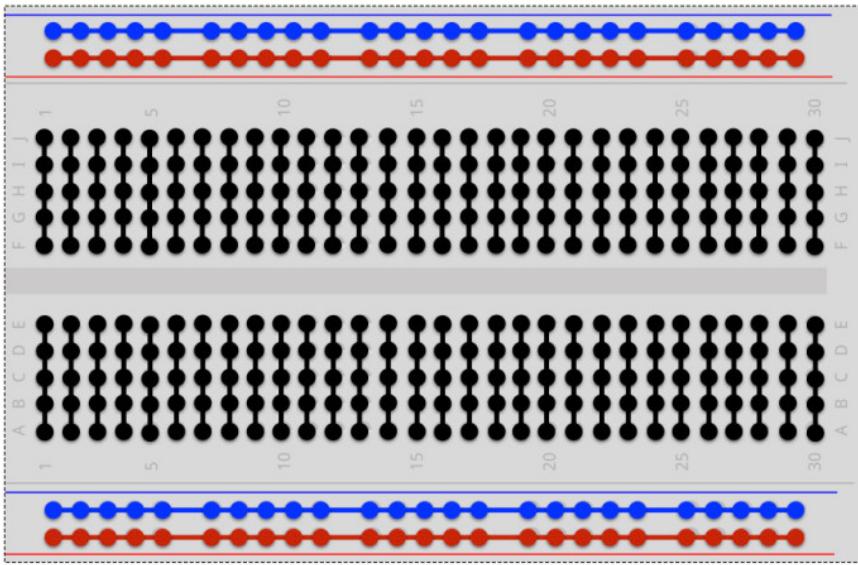


Metal connects each row beneath the plastic which allows for connections between each element plugged into the **terminal strips** (rows)

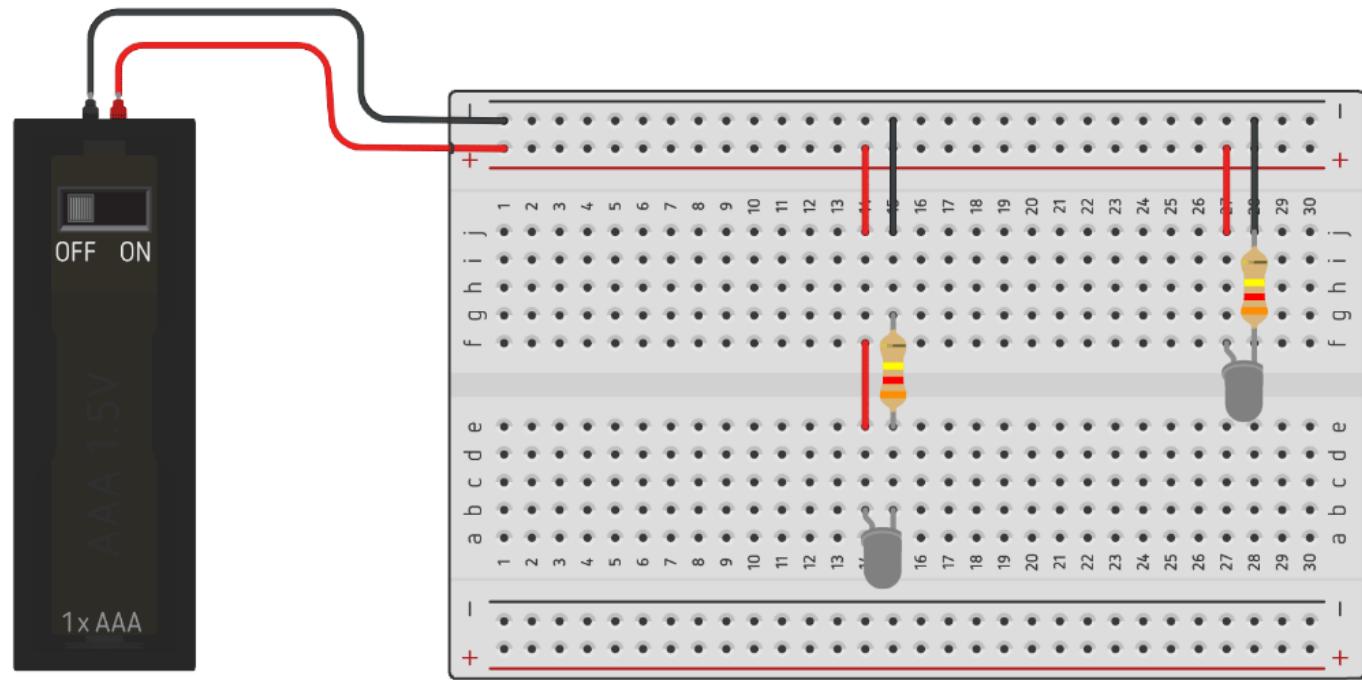


Most breadboards also have **power rails** which are two columns on each end that are connected to each other

Breadboard in action😊



Breadboard diagram



Input Options (Sensors)

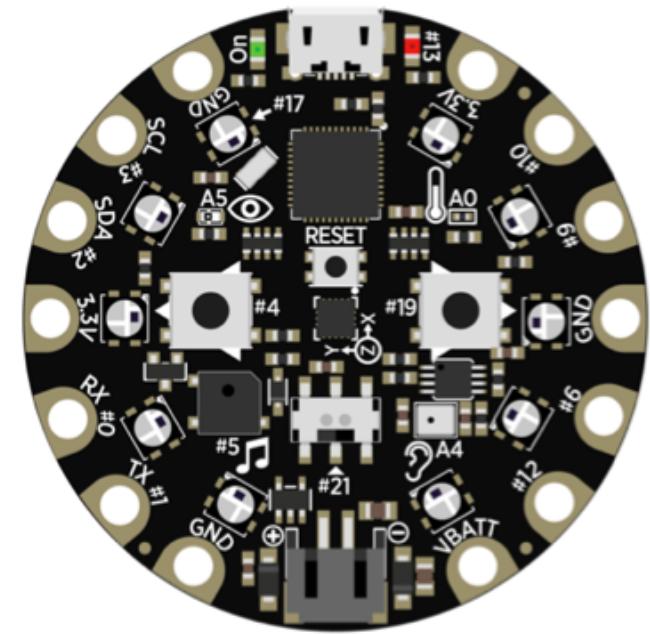
Built-in sensors on the Circuit Playground:

Sound: Noise levels, sound signals, frequencies

Temperature

Light: Brightness, color (using LEDs)

Accelerometer: Acceleration, tilt



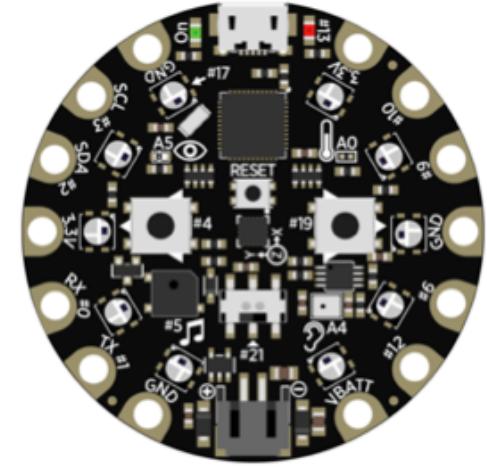
Today's external sensor

Proximity: Measures distance of object from sensor

by detecting ultrasonic wave reflection

Output Options (Actuators)

- **Built-in devices on the Circuit Playground**
 - Speaker
 - LEDs
- **Today's external actuator**
 - Servo motor



Arduino Tutorial: External Sensors

Lab 3: External Sensors for Arduino with CircuitPython

Introduction

At this point, we have covered most of the important concepts and setup for designing and developing on Arduino with Circuit Python. This lab focuses on using external sensors (input devices), which is very similar to using external actuators. As with actuators, the CPX has many built-in sensors, but there may be additional sensors (like owl meters) that need to be attached externally. In addition, most other Arduino devices don't have as many built-in sensors, so all sensors for a project must be attached externally. We will then provide examples combining internal and external sensors and actuators.

Lab 3: External Sensors for Arduino with CircuitPython
A. Trahan, P.E.
October 20, 2019

Introduction
At this point, we have covered most of the important concepts and setup for designing and developing on Arduino with Circuit Python. This lab focuses on using external sensors (input devices), which is very similar to using external actuators. As with actuators, the CPX has many built-in sensors, but there may be additional sensors (like owl meters) that need to be attached externally. In addition, most other Arduino devices don't have as many built-in sensors, so all sensors for a project must be attached externally. We will then provide examples combining internal and external sensors and actuators.

In this lab we will:

1. Connect an external sensor to the CPX
2. Try examples using combinations of internal and external sensors and actuators

Required materials (per group):

- (1) Circuit Playground Express (CPX)
- (1) Micro USB cable
- (1) Breadboard
- (1) Ultrasonic Proximity Sensor (HCWL-1001 or similar)

(a) Breadboard layout (b) Circuit diagram

Figure 1: Diagrams for attaching external proximity sensor to CPX

6. Enter the code below in Mu, and save to the CPX as code.py, and note the following:

(a) We import HC0504 to control the proximity sensor. This requires an external library - adafruit_hcsr04.py, which must be copied from the library bundle (see Lab 2) onto the CPX.
(b) Sometimes the sensor has trouble getting a signal and throws a RuntimeError, so a try/except statement is used to catch this and continue the loop.

6. Open the Serial console or the Plotter pane to see the distance measured from the sensor (cm)

```
#-- ExternalProximitySensor.py - CircuitPython code for CPX --#  
# Import Section  
import board  
from adafruit_hcsr04 import HCSR04  
from time import sleep  
# Setup Section  
sensor = HCSR04(trigger_pin=board.A7, echo_pin=board.M0)  
# Function Section
```

2.1 Add a needle gauge to the proximity sensor
This example combines the proximity sensor from this lab with the light gauge from Lab 2. (internal sensor, external actuator)
1. Connect the proximity sensor and servo to the CPX as shown in Figure 2
2. Enter the code below in Mu, and save to the CPX as code.py. Note how it directly combines two previous examples, except for the function mapping proximity to servo position.

(a) Breadboard layout (b) Circuit diagram

How many of you have read the description of this Lab posted online?

Full Arduino tutorial is available on [Canvas – Modules - Tutorials](#) in **Arduino CPX Tutorials.zip** folder

1. Connecting an External Proximity Sensor (shows the distance from the external proximity sensor in cm)

1. Attach the proximity sensor to a breadboard, using four rows
2. Attach the **3.3V** and **GND** pads to the power and ground columns of a breadboard and use jumpers to attach those to the VCC and GND rows for the proximity sensor
3. Attach pad **A7** to the TRIG row for the proximity sensor
4. Attach pad **A6** to the ECHO row for the proximity sensor
5. Enter the code below in Mu, and save to the CPX as **code.py**, and note the following: Page 3
 - (a) We import **HCSR04** to control the proximity sensor. This requires an external library - **adafruit_hcsr04.mpy** - which must be copied from the library bundle (see Lab 2) onto the CPX.
 - (b) Sometimes the sensor has trouble getting a signal and throws a **RuntimeError**, so a **try/except** statement is used to catch this and continue the loop.
6. Open the Serial console or the Plotter pane to see the distance measured from the sensor (cm)

5. Enter the code below in Mu, and save to the CPX as **code.py**

```
#-- ExternalProximitySensor.py - CircuitPython code for CPX --#

# Import Section
import board
from adafruit_hcsr04 import HCSR04
from time import sleep

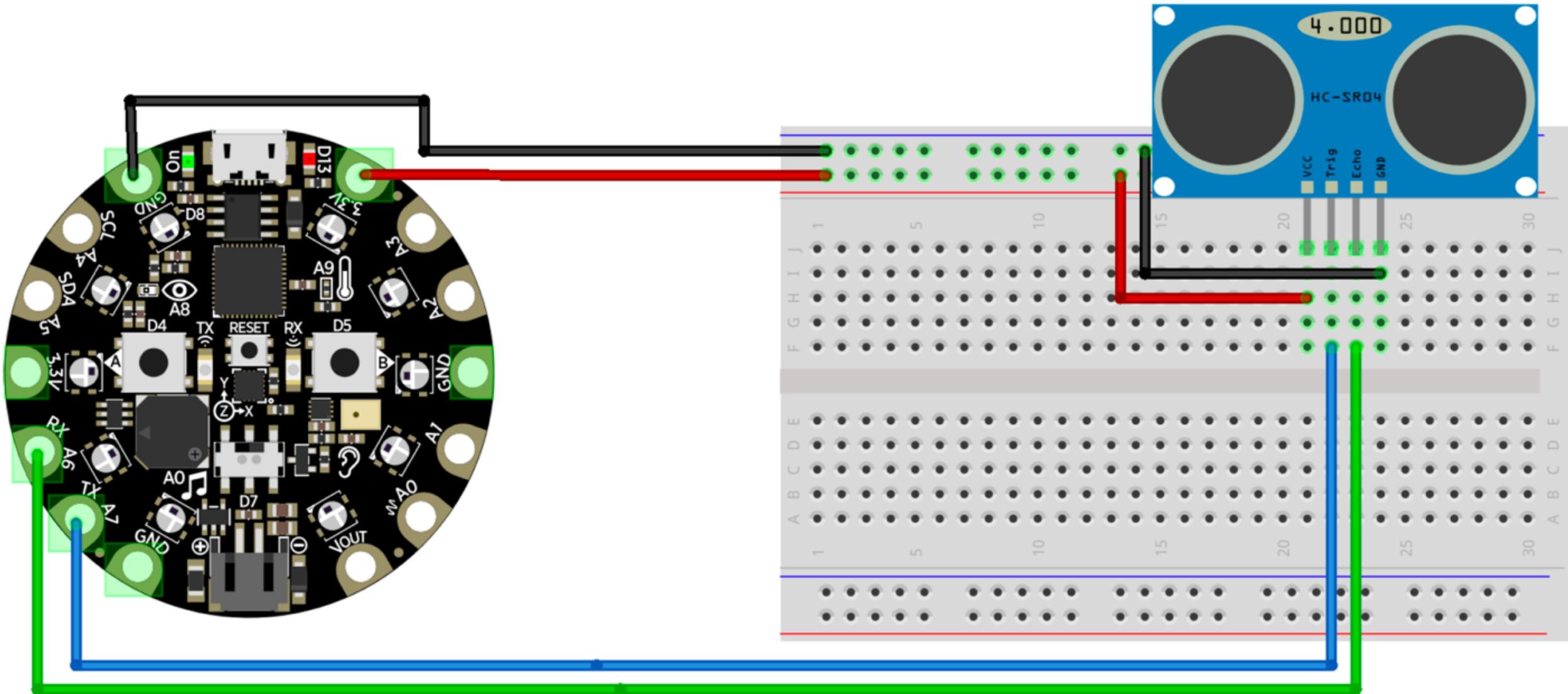
# Setup Section
sonar = HCSR04(trigger_pin=board.A7, echo_pin=board.A6)

# Function Section

# Loop Section
while True:
    try:
        print((sonar.distance,))
    except RuntimeError:
        print("Retrying!")
    sleep(0.5)
```

Import the external library
“*adafruit hcsr04.mpy*” into
the **lib** folder in **your CPX**

1. Connecting an External Proximity Sensor to CPX



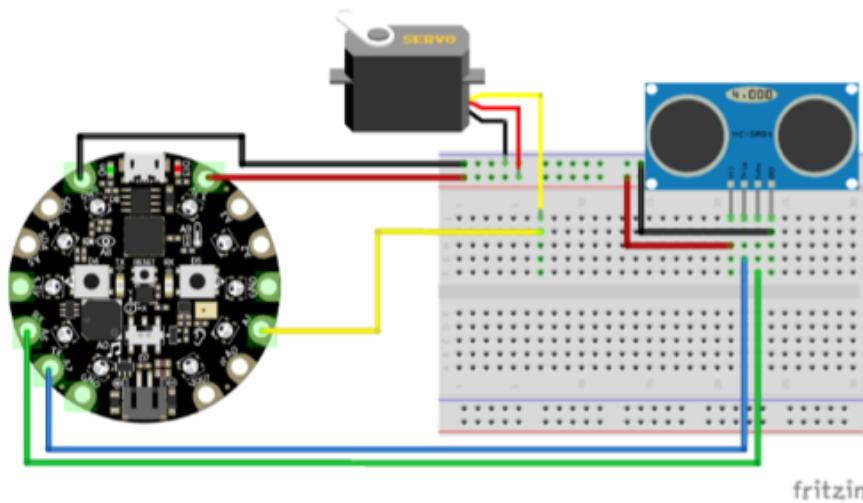
2.1. Combining Ext. Sensors and Actuators

“Add a needle gauge to the proximity sensor” for mapping proximity to servo position

No need to disassemble the proximity sensor setup!

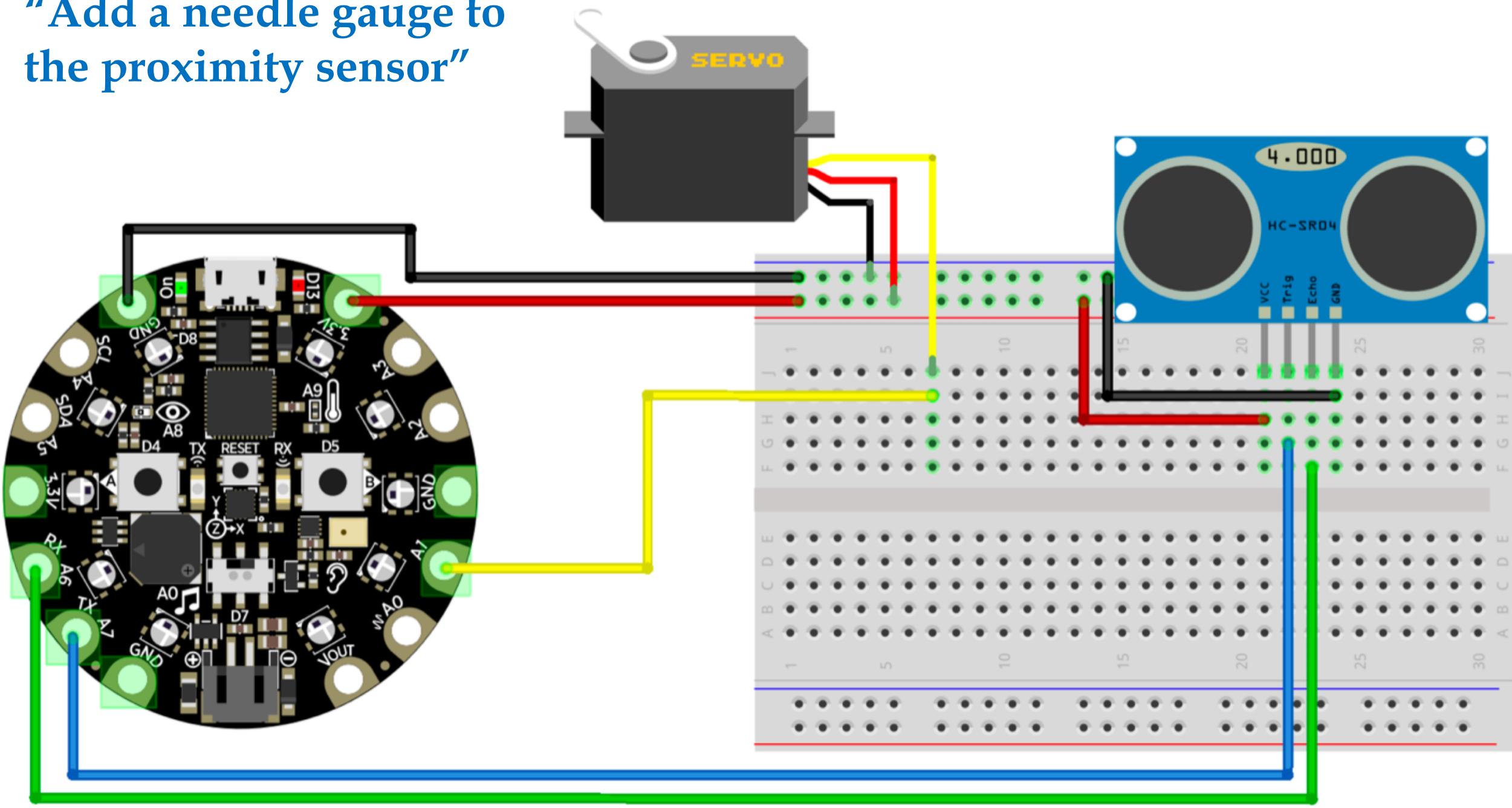
Just add the servo motor connections!

1. **Brown** is ground, connect to GND
2. **Red** is power, connects to 3.3V
3. **Yellow** is control (Pulse-Width Modulation (PWM)), connect to A1



(a) Breadboard layout

**“Add a needle gauge to
the proximity sensor”**

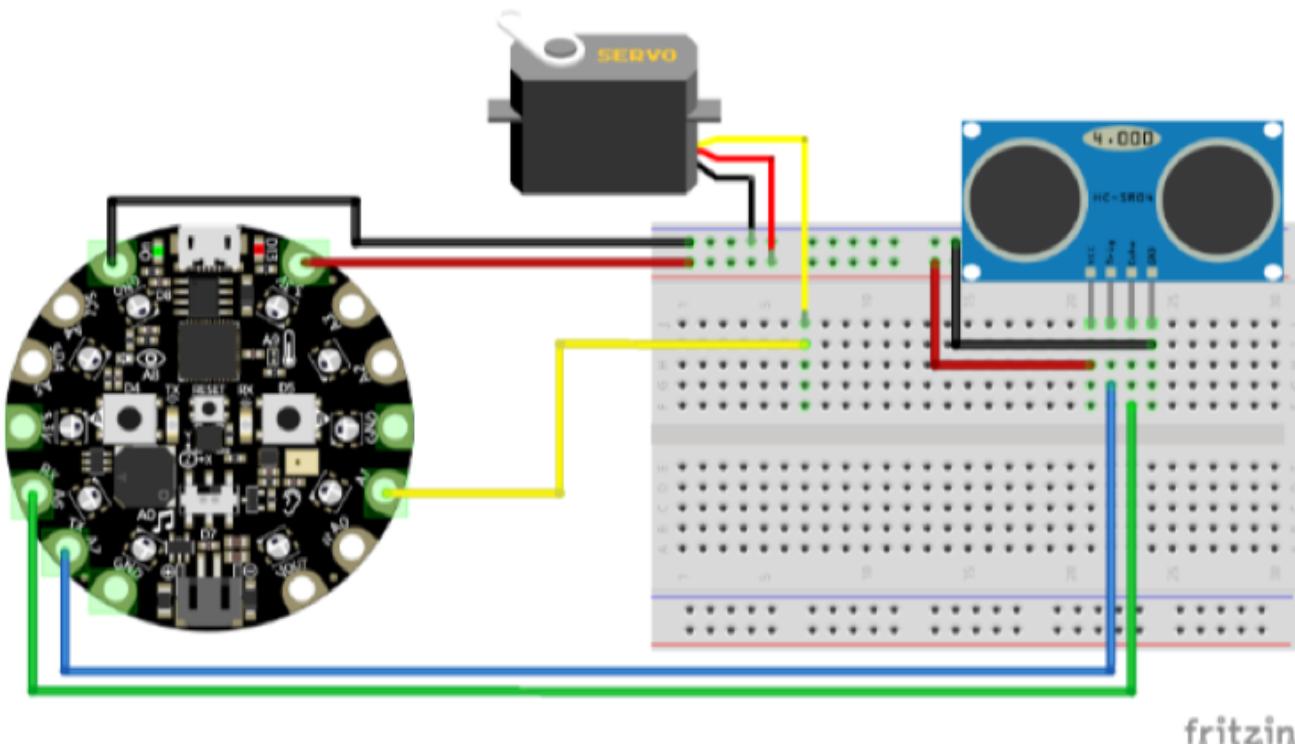


2.2. Multiple Actuation

“Add warning lights/sounds to the proximity sensor”

No need to disassemble the proximity sensor/servo motor setup!

Just change the code (**from pp. 6-7**) to add additional actuation of warning lights and sounds!



(a) Breadboard layout