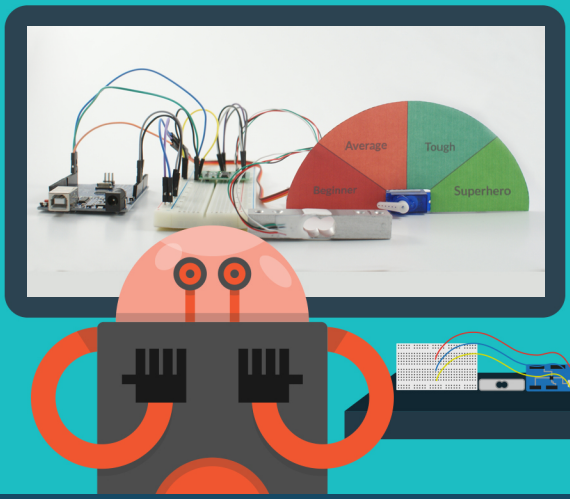
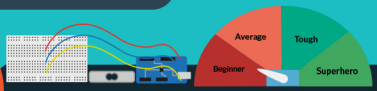
STRENGTH GAUGE





Creation Crate

BUILDING THE MAKERS OF TOMORROW

INDEX

INTRODUCTION

Welcome to Month 12!

What are we creating?

Test your strength!
Introducing this month's build: **Strength Gauge!**

With this project, you will learn how to use a strain gauge to measure force, and how to use a servo motor to visualize this measurement.

How do we make it?

In two steps:

1. Build the hardware:

This month we will be using a strain gauge, and an amplifier board to turn the tiny voltage measurements into something the Uno R3 can read. We will output this measurement to a servo motor, which will rotate to indicate the measurement.

2. Programming it:

The program will use the HX711 library to communicate with the amplifier board, as well as the servo library to set the servo position.

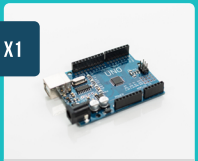
Support Page

https://mycreationcrate.com/month-12

KGWO65

PART LIST

X1

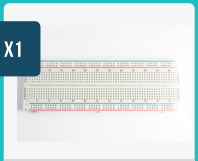


UNO R3

X1

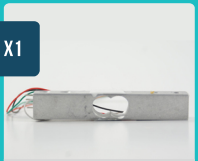
USB CABLE

X1



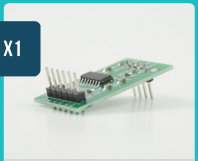
BREADBOARD

X1



5KG STRAIN GAUGE

X1



HX711 AMPLIFIER

X1

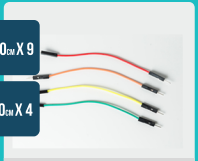
SERVO MOTOR

X6

JUMPER WIRE MALE-TO-FEMALE

20cm X 9

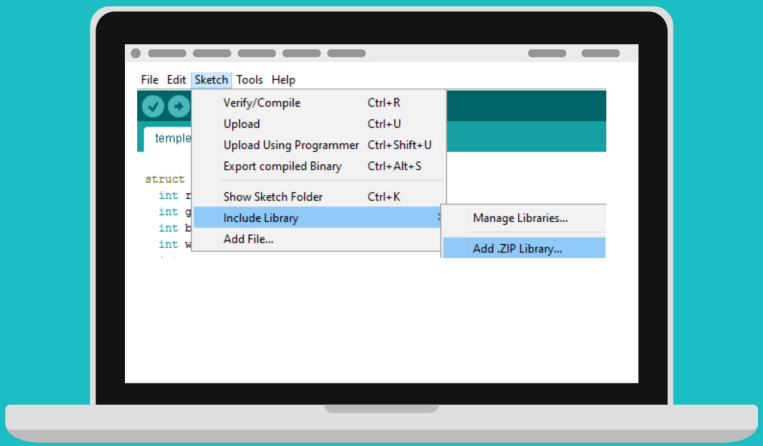
10cm X 4



JUMPER WIRE

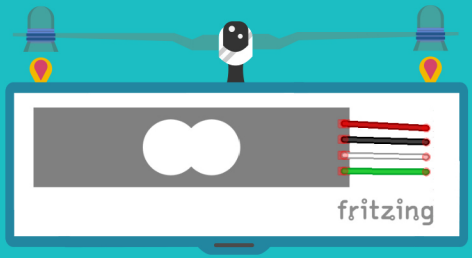
EXTERNAL LIBRARY

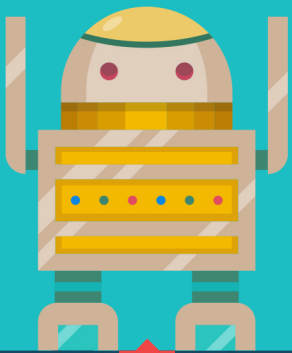
- The library used in this project is not available in the Arduino IDE, so it needs to be downloaded separately. This download is available on the support page labeled "Strain Sensor Library". Once you download the file, in the Arduino IDE go to Sketch>Include Library>Add .ZIP Library... and select the downloaded .ZIP file.



STRAIN GAUGE

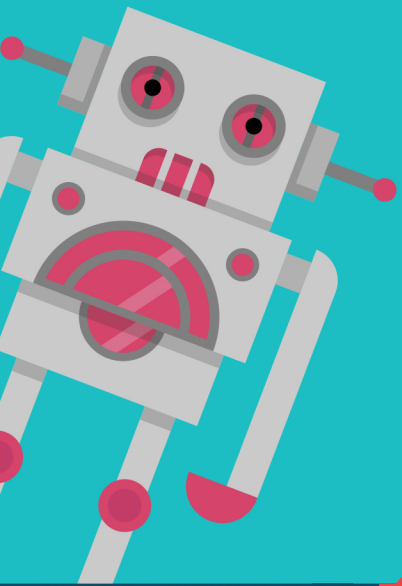
- This project uses a strain gauge to measure a force. When you apply a force to the metal bar, the bar stretches and compresses ever so slightly. This is by such a small amount that you would need a microscope to see it! This growing or shrinking is known as strain. By using precise sensors, we can measure this strain. Then using the library, we can find out the force applied.





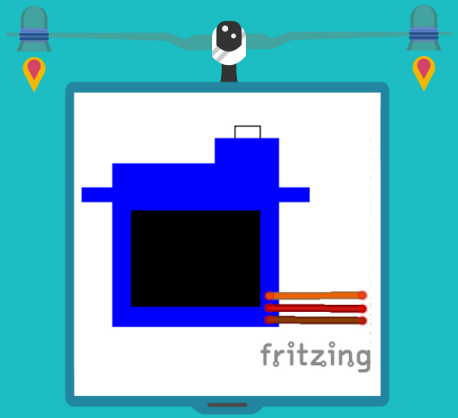
HX711 AMPLIFIER

- The strain gauge can't be plugged into the Uno R3. The way the strain gauge works is similar to the voltage divider that we learned in the Multimeter project. However, because the strain measurements are so small, the voltage output is too small to measure on the analog pins. Therefore, we need an amplifier to convert these small changes in voltage to large changes. The HX711 is an amplifier built specifically for strain gauges, so it is easy to wire up and use.



SERVO MOTOR

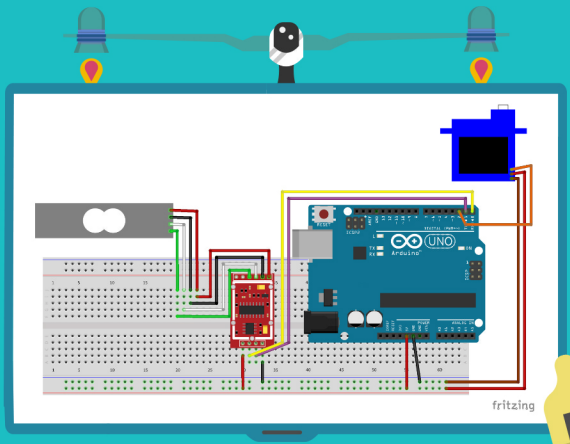
- With a regular motor, you can set the speed and direction, but it is hard to get it to stop exactly where you want. On the other hand, servo motors stop at the exact angle you specify. We will use the servo to show the force measurement of the strain gauge by pointing the servo arm to the right location. This will point to a value on the paper cutout attached to the servo that we will make.



- The servo has three wires: brown, which connects to ground, red, which connects to 5V, and orange, which connects to a pin on the Uno R3. Using the orange wire, the servo library can communicate with the servo to tell it the position to go to. The circular white piece on the top of the servo is the output axle and is where we will attach the servo arm later on.

HARDWARE

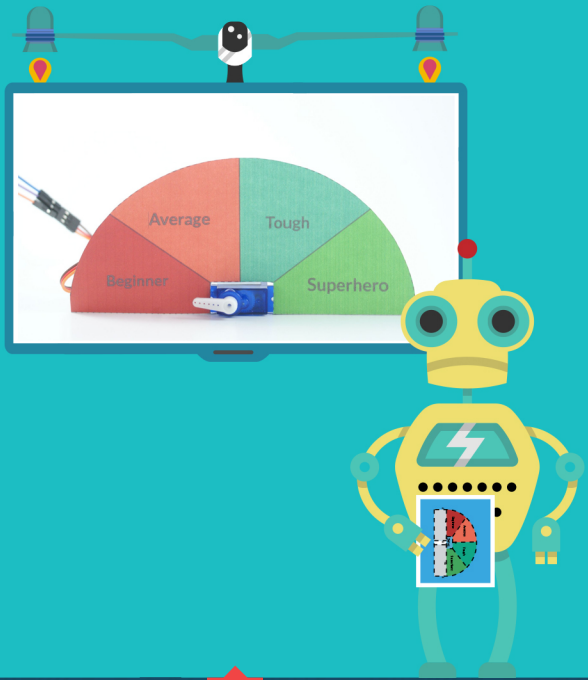
- Connect the hardware as shown. Make sure to connect the right color wire to the right pin with the strain gauge.



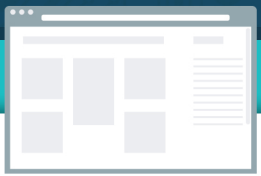
- Note: the wires on your strain gauge may be in a different order. However, the color of the wires are important here. Make sure you match up the correct colored wire to each pin on the HX711 board.

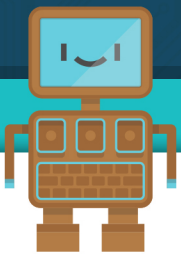
SERVO CUTOUT ASSEMBLY

- Cut the paper servo cutout from the back of the booklet. Fold along the dotted "fold" lines, and unfold them so the cutout stands up on its own when placed down. Next, insert the servo through the rectangular gap so that just the front face with the servo's white axel sticks out. You may want to use tape to make sure the servo stays in place. Now, plug in the Uno R3. This will zero out the strain sensor and set the servo to the starting position. Lastly, attach the servo arm to the servo output shaft so that it points directly to the left.



PROGRAM

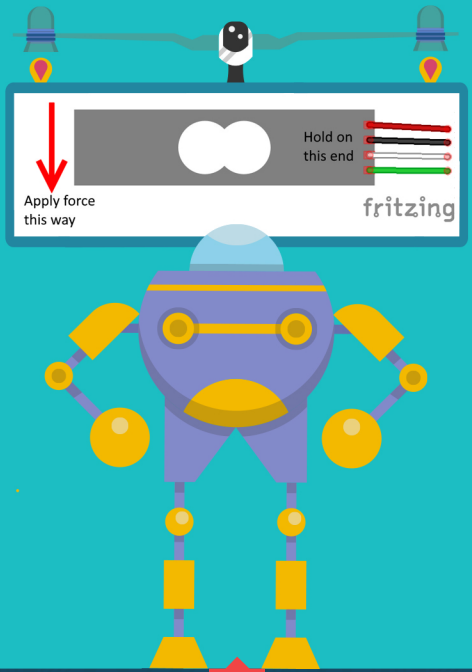




```
#include <Servo.h>
#include "HX711.h"

#define CALIBRATION_FACTOR -150000 //Used to make the strain
sensor more accurate (every gauge is slightly different, but
this number should be accurate for the included gauge)

#define SCKPIN  0
#define DTPIN  1
#define SERVOPIN 2

HX711 scale(DTPIN, SCKPIN); //Used to interface with the
strain sensor
Servo myservo; //Used to interface with the servo motor
int angle; //Holds the direction the servo is set to

void setup()
{
  scale.set_scale(CALIBRATION_FACTOR); //Set up the scale
  scale.tare(); //Zero's out the scale

  myservo.attach(SERVOPIN); //Sets up the servo
}

void loop()
{
  angle = map(scale.get_units(), 0, 8, 180, 15); //maps a
reading from 0-8 pounds to 180-15 degrees
  myservo.write(angle); //Sets the servo direction
}
```

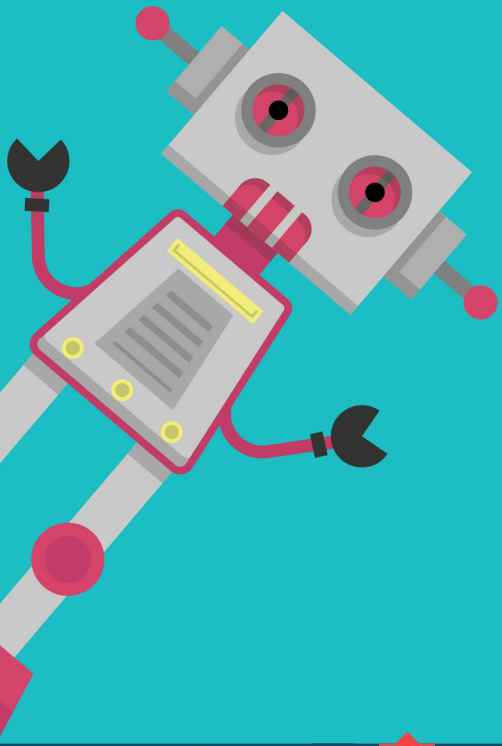
WHAT YOU SHOULD SEE

When everything is plugged in, the servo arm should point all the way to the left. You can adjust this by removing the servo arm and putting it back on so that it points in the right direction. To activate the strain gauge and measure your strength, hold onto both sides of the strain gauge, with the circular cutouts facing you. On one end, there should be an arrow pointing up or down. Apply a force in this direction, while keeping the other end still. The servo arm should rotate, pointing in the direction of how much force is applied.



MONTHLY CHALLENGE

- **Flip the direction of the servo so it turns from right to left as you apply force to the strain gauge. Make your own reversed cutout that goes from right to left so the servo still points to the right section!**



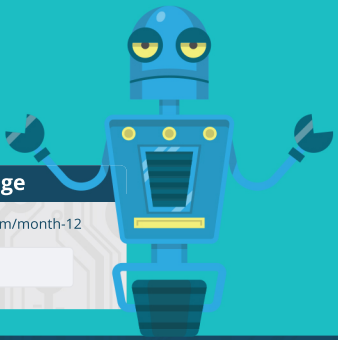
EXERCISES

Solve these problems and write the answers below.

1.) What happens when you swap the red and black wires connecting the strain gauge and the HX711? How about the green and white? Why do you think this happens?
Answer:

2.) How does changing the calibration factor affect the sensitivity of the gauge? Try really big and really small numbers.
Answer:

3.) Save the high score to a variable and print it out to the serial monitor. (Hint: you will have to use different pins for the HX711, because printing to the serial monitor uses pins 0 and 1).
Answer:



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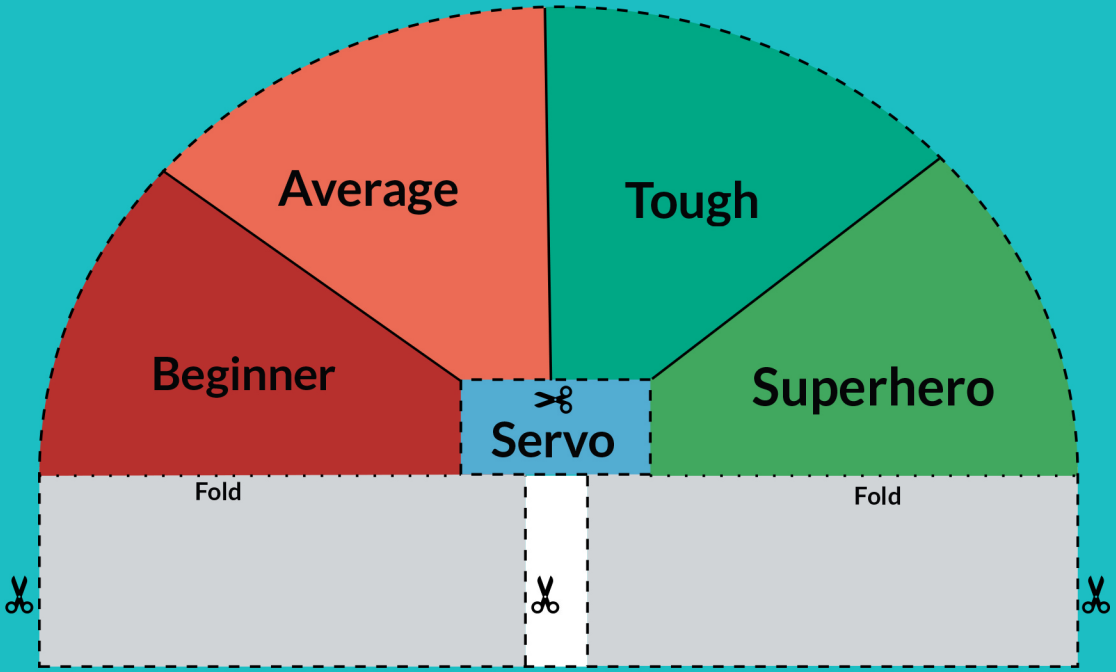
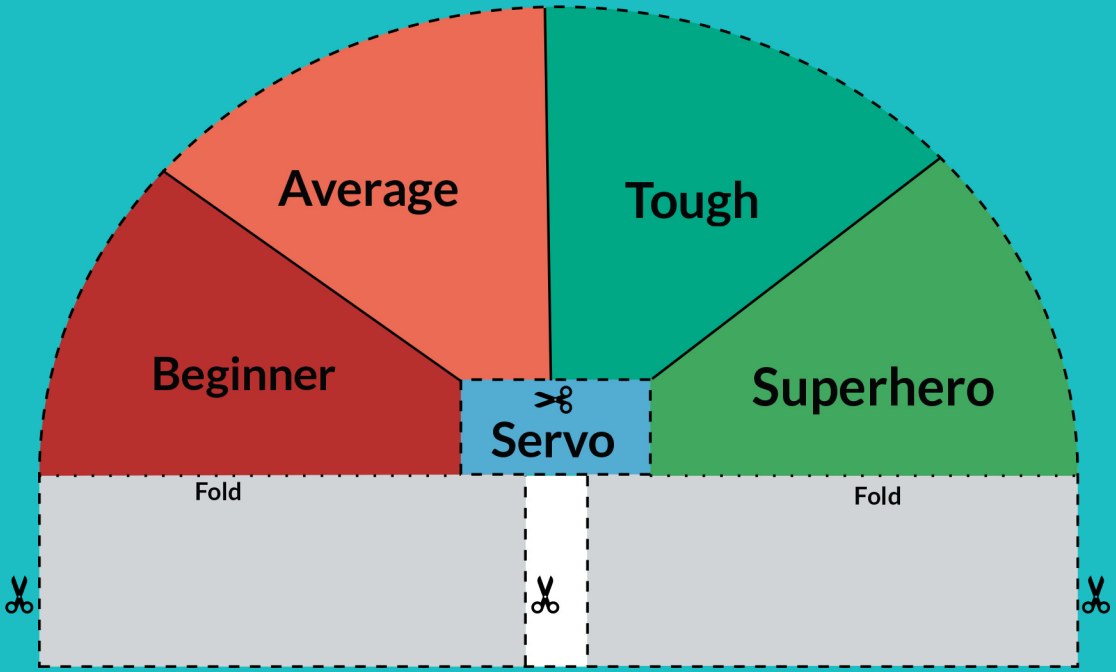

Average
Tough
Beginner
Servo
Superhero
Fold
Fold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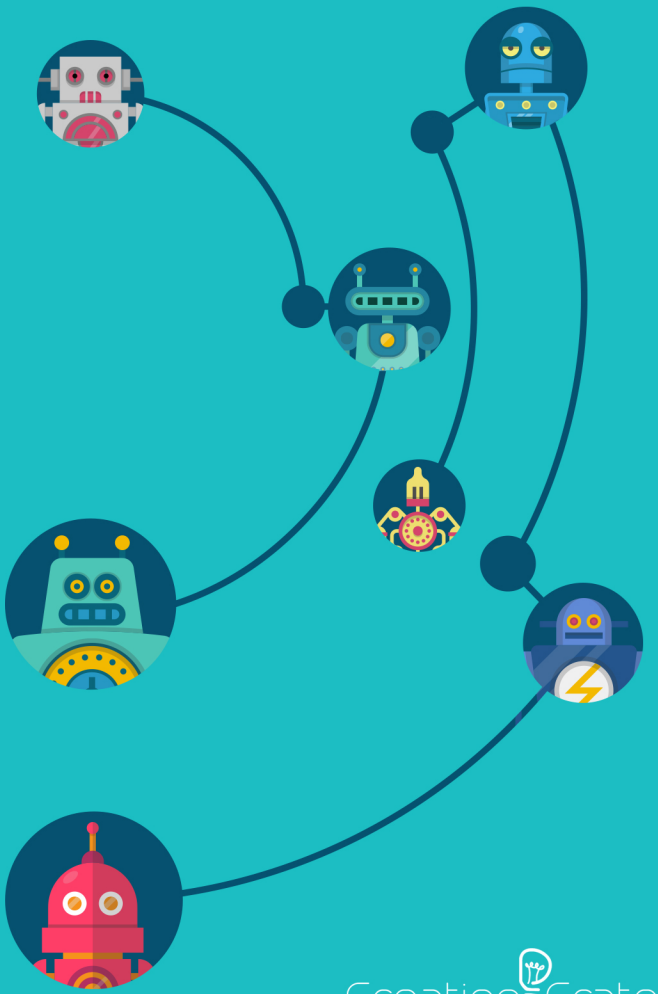

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