

# Term Project 0x01 - Romi Assembly

- Due No Due Date
- Points 10
- Submitting on paper

## Overview

The following instructions will help guide your assembly sequence so that you don't have to disassemble anything due to poor sequencing of steps.

## Gathering Materials

Before you begin assembly check the provided hardware to make sure you have everything you'll need for assembly.

1. Each group will need the components listed in the table below, provided to you in lab. Make sure you have all the components before you begin assembly.

**Component List**

Quantity	Component
4	M2.5 x 8mm Standoff
4	M2.5 x 10mm Standoff
4	M2.5 x 30mm Standoff
4	M2.5 x 6mm Socket Head Cap Screw
4	M2.5 x 8mm Socket Head Cap Screw
4	M2.5 x 10mm Socket Head Cap Screw
8	M2.5 Nylon Lock Nuts
8	M2.5 Nylon Washer
1	Acrylic Romi-to-Shoe Adapter
1	BNO055 IMU Breakout Board
1	Unmodified Shoe of Brian
1	Modified Shoe of Brian
2	Nucleo L476RG

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Romi Chassis w/ Motors, Encoders, Wheels, and Casters

2. Each group will also need a set of crimped jumper cables, often referred to as "Dupont" style cables. A variety of these will be required with different pin counts. It is easiest to assemble these by re-pinning pre-crimped cable assemblies.

Groups will be provided with enough pre-crimped cables to perform initial assembly of the provided hardware, but additional cables will likely need to be purchased for any additional sensors that teams choose to incorporate.



3. Finally, each group will need a few tools to help with assembly. There are multiple sets of these tools that will be available in lab, but students are encouraged to bring their own tools for temporary use as well to avoid bottleneck in sharing of the tools.

### Tool List

Tool
2mm Hex Driver (for M2.5 SHCS)
5mm Nut Driver (for M2.5 Nuts)
Small Adjustable Wrench or Parallel Pliers
1.8mm Slotted/Flat Blade Screwdriver

⚠ When working with small components and sharing tools (some of which may be shared by your lab instructor personally) it is critical to follow the lab etiquette guidelines. Historically this has been a primary circumstance for students to leave a mess for their classmates.

## Main Assembly

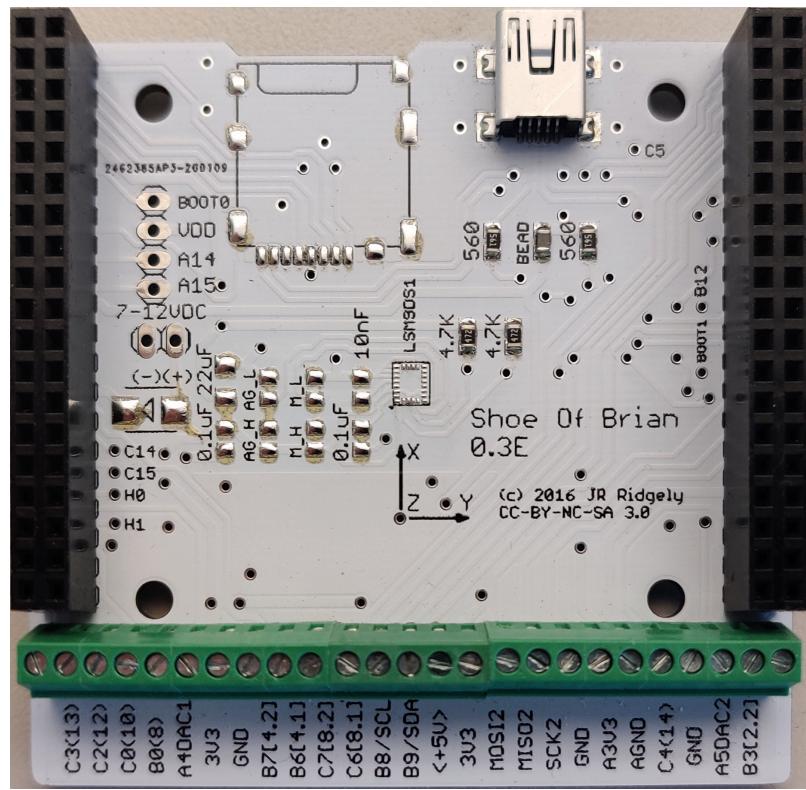
1. Each group will need to have a small modification performed on their Shoe of Brian to allow it to be powered safely by the Romi power distribution board. There is already a class set of modified Shoes of Brian that students may reuse this quarter instead of modifying additional boards. There should also be enough Nucleo boards in the lab to allow each team two Nucleo boards, one to keep attached to the Romi robot for the remainder of the quarter and a second to use for parallel work.

**⚠️** To proceed with these instructions, or later in the quarter, you may need to separate a Nucleo from a Shoe. If someone on your team "zippers" the board apart it will likely result in all 76 of the Morpho header pins being bent. In such a case, your team will need to go through and readjust each of these pins manually.

The Shoe of Brian boards each include a ferrite bead that helps prevent USB noise from affecting the MCU. Ferrite beads are small chunks of ferrous material (iron) that have similar impedance characteristics to inductors. These beads are placed in series with the input power coming from the USB connector on the Shoe.

**⚠️** In order to power Romi from an external source it's important to prevent current from back-feeding through the USB cable into your laptop. Therefore the power connection must be severed between the USB connector on the Shoe of Brian and the Nucleo. Conveniently, we can simply remove the ferrite bead from the Shoe to break the connection.

The photograph below shows the Shoe of Brian board. In the upper right quadrant of the image you can see the USB connector and the bead just underneath it. Double check your two Shoes of Brian to confirm that the bead has been removed from one of them (meant for Romi) but not the other. Do not attach the Shoe and the Nucleo until you are instructed to do so later in these instructions.



**⚠️** Once the ferrite bead has been removed, you will not be able to power the Nucleo through the USB port. All work must be done using both battery power and your USB connection.

- For the first assembly step, you will need four (4) M2.5 x 30mm standoffs, four (4) M2.5 nylon lock nuts, a 5mm nut driver, and a small wrench or pair of parallel pliers. Attach each standoff to the Romi chassis using one of the nylon lock nuts. Refer to the image below to know which holes to use for the standoffs. Install all four standoffs extending upward from the top of Romi (the side with the power distribution board).



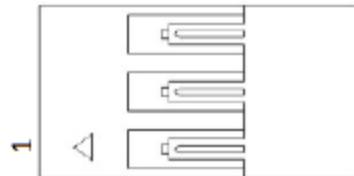
⚠ Two of the standoff locations are open slots instead of holes. Take care to align the standoffs with the closed end of the slots; that is, once installed, the standoffs in the slots should be as close as possible to one another.

⚠ Do not over tighten the screws! The ABS plastic of Romi's chassis is soft and may be damaged by too much screw torque. Snug is tight enough.

3. Now that you've installed the standoffs, it is a good time to install the cables that will go between the power distribution board and the Nucleo. Start by re-pinning some of the pre-crimped cables commonly referred to as "Dupont" cables. Try to use the same color convention shown below, especially for power and ground. The lab may have a few spare "multi-conductor" housings in 1x2, 1x3, 2x3, etc. sizes, but each team will likely want to purchase additional housings to make it easier to work with Romi; for example, if you need to unplug something temporarily, it'll be a lot easier if all the wires are in a single housing instead of each wire having its own housing.

**⚠** Each Romi will need one power cable and two each of the encoder and motor cables.

**⚠** Before you plug anything in, make sure that you understand the polarity markings on the connectors. Refer to the diagram below showing the triangular "Pin 1" marking that you will find on the rectangular connector housings. You can also rely solely on the color of the wires if you prefer.



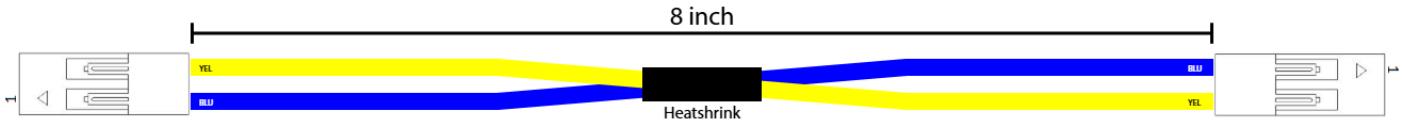
The three cable varieties are meant to be pinned as described in the table below:

**Cable Pinouts**

Cable	Contact	Color	Signal	Nucleo Pin	Romi PDB Pin
Encoder	1	Blue	Encoder Ch. A	Timer Pin, Ch.1	ELA or ERA
	2	Yellow	Encoder Ch. B	Timer Pin, Ch.2	ELB or ERB
Motor	1	Yellow	Motor Enable	Digital Output	nSLP
	2	Blue	Motor Direction	Digital Output	DIR
	3	Green	Motor Effort	Timer Pin	PWM
Power	1	Black	Ground	GND	GND
	2	Red	Battery Power	VIN	VSW

Before you plug anything in, confirm that the cables match the pinout above and the diagrams below. Note that the lengths shown are approximate only. It is also optional, but recommended, to twist the power cable wires but do not twist together any other wires.

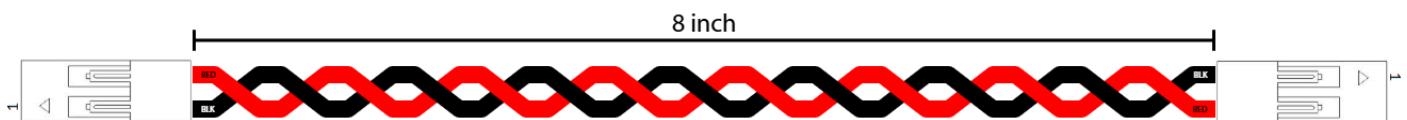
**Encoder Cable**  
(Not to Scale)



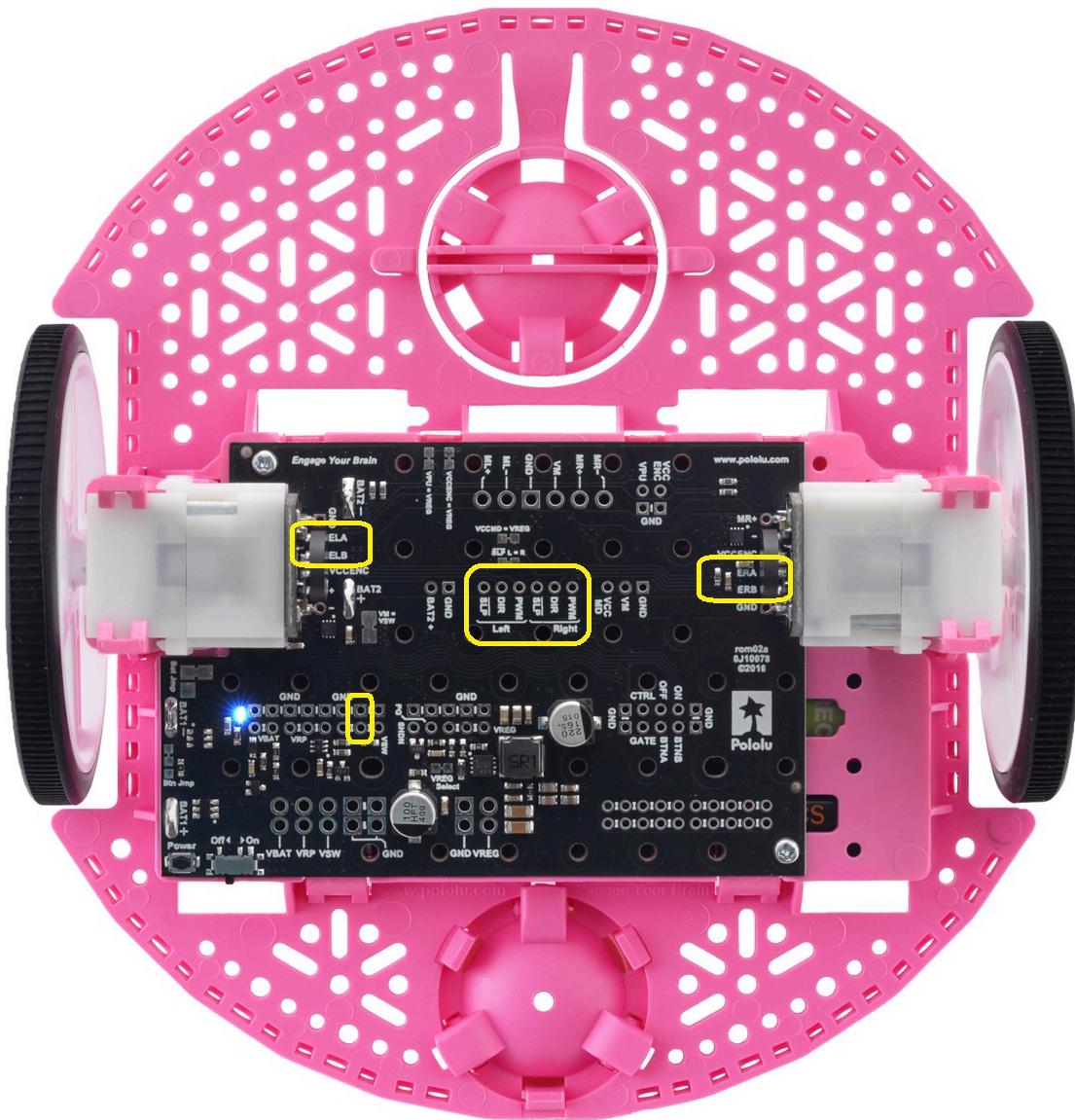
### Motor Control Cable (Not to Scale)



### Nucleo Power Cable (Not to Scale)



Refer to the diagram below for locations where the cables connect.



**⚠ DO NOT** turn power on until you double- and triple-check that everything is connected properly. An incorrectly connected power cable will destroy your Nucleo instantly if the power is turned on.

4. Now you can install the Romi-to-Shoe adapter plate using the four (4) M2.5x10mm screws and the 2mm hex driver. Be careful not to crack the Acrylic by tightening the screws too much. The adapter plate is symmetrical, so the orientation will not matter during installation.

After installing the adapter plate feed the two encoder cables and the two motor cables through the center cutout in the adapter plate.

5. Install four (4) M2.5x8mm standoffs into the threaded holes in the adapter plate using the 5mm nut driver.

**⚠** Do not cross thread the standoffs as you install them.

**⚠** Do not over tighten the standoffs in the threaded holes or you will strip the small threads cut into the acrylic.

6. Attach the Shoe of Brian to the 8mm standoffs using the four (4) M2.5x6mm screws, four (4) nylon washers, and the 2mm hex driver. Make sure that the washers are placed between the screw heads and the Shoe of Brian.

**⚠** Tighten the screws enough to barely compress the plastic washers so that the compression force will help retain the screws. Avoid over tightening or you will crush the washers.

**⚠** Pay attention to the orientation of the Shoe of Brian when you attach it to the standoffs. You can orient the Shoe with the USB connector extending forward or backward depending on your group's preferences.

**⚠** Make sure to route the cables between the standoffs strategically so that the cables emerge near their associated pin locations on the Nucleo. You will be able to fish the wires through later, but it will be easier to get them routed smartly during initial assembly.

7. Reinstall the Nucleo onto the Shoe of Brian.

**⚠** Make sure that you align the Morpho headers correctly before mating the components. Confirm that the USB ports on the Nucleo and Shoe emerge on the same side of the stackup.

**⚠** Apply force with your fingers between the Shoe and the Nucleo only. Do not apply force through

Romi's chassis or through the adapter plate while mating the Nucleo.

8. Attach the free end of each cable to the appropriate locations on the Nucleo. As stated previously, your team should be absolutely certain that all wires are connected properly before power is switched on.

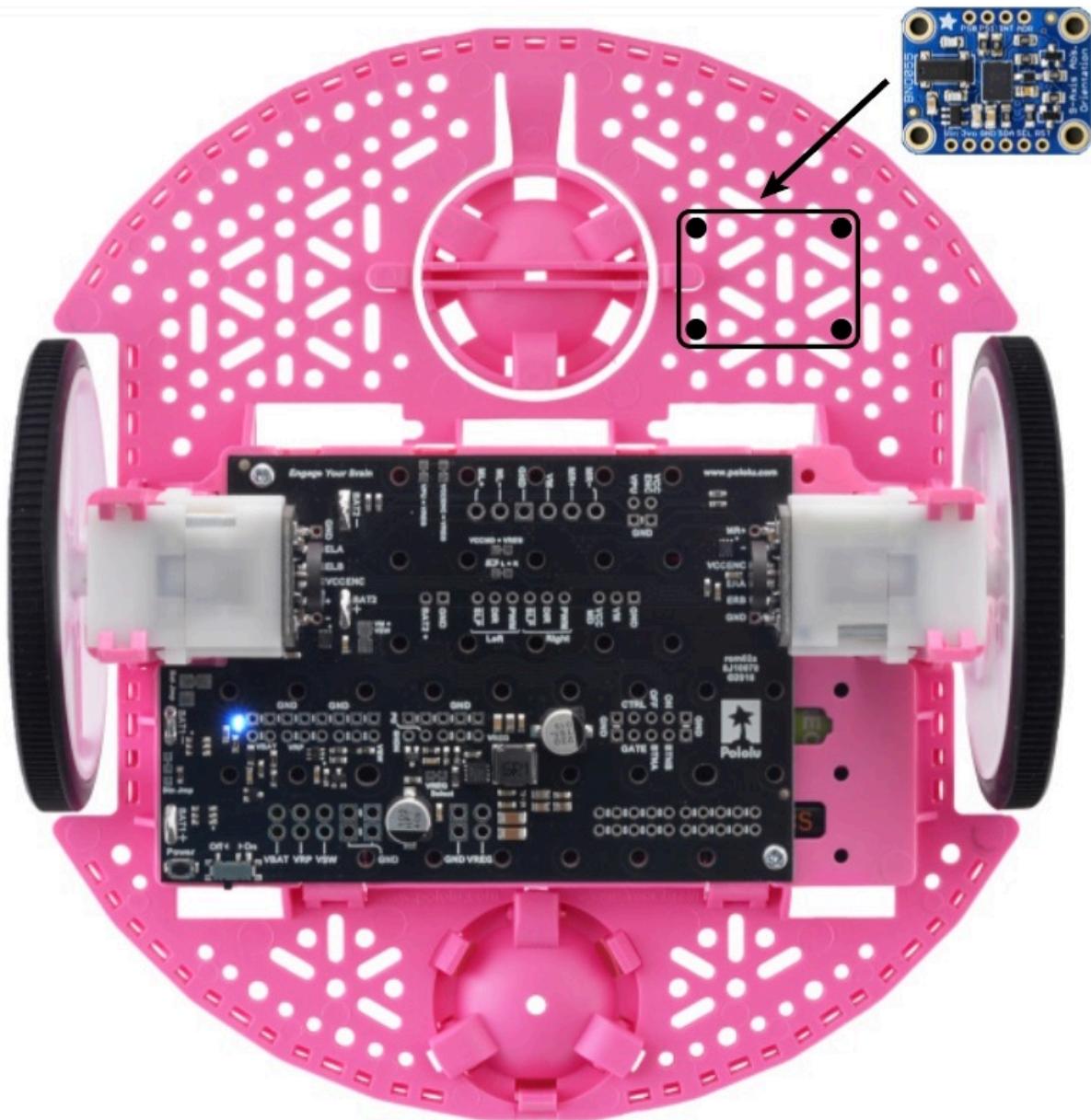
**⚠ DO NOT** turn power on until you double- and triple-check that everything is connected properly. An incorrectly connected power cable will destroy your Nucleo instantly if the power is turned on.

## IMU Assembly

1. Install the BNO055 IMU onto the Romi chassis using the holes shown in the photograph below, or the same holes on the opposite side of Romi. Use the remaining four (4) M2.5x10mm standoffs, four (4) M2.5x8mm screws, four (4) M2.5 nylon lock nuts, and four (4) nylon washers. As with the Shoe of Brian, make sure that the nylon washers are between the screw heads and the BNO055.

**⚠ It will likely be more convenient for you to install the BNO055 underneath the Romi chassis, instead of on top.** With the BNO055 installed on top of the chassis it is likely to interfere with mounting of bump sensors on the front of Romi.

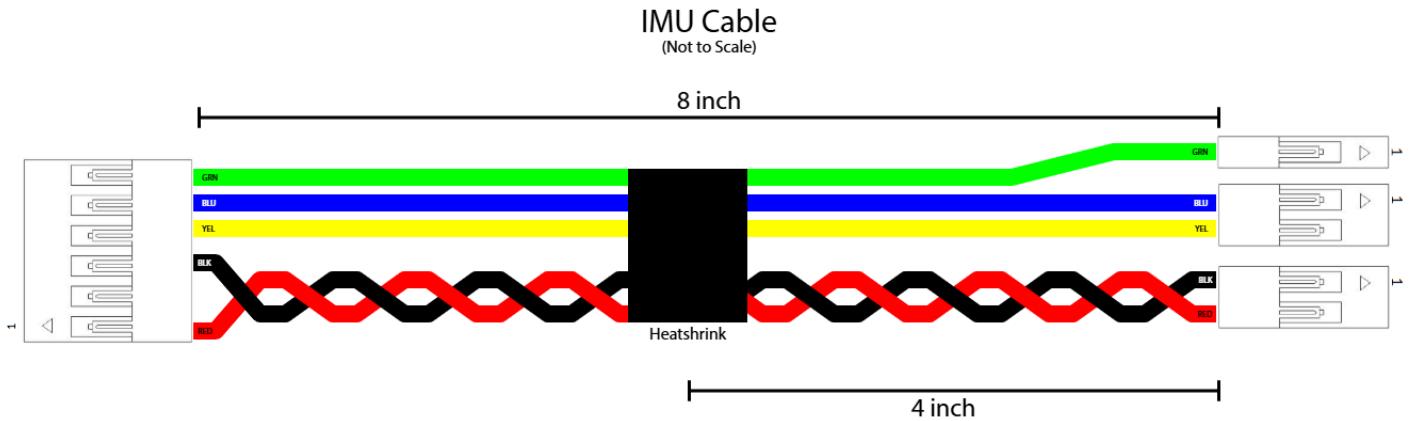
**⚠** It may help with alignment if you install the standoffs on the BNO055 first, and then install that assembly onto Romi. That way you don't need to place the standoffs as carefully within the slots on Romi.



2. As mentioned above, cabling has been provided for the power, motor, and encoder connections between the Romi power distribution board and the Nucleo, but your team will need to create cable assemblies for all of your other sensors and actuators, including the BNO055.

The cable assemblies should be constructed in the same manner as the provided cable assemblies with attention to detail regarding the color of each wire and their location within the rectangular housings.

You will be responsible for all cable assemblies but you can use the drawing below to inform your construction of the IMU cable while also referencing the pinout for the BNO055 breakout board. The lengths shown in the diagram are approximate only. Longer cables will be easier to route, but will get in the way more once plugged in. The colors shown are also just suggestions, but it is strongly recommended to keep using red and black for power and ground as possible.



## Looking Ahead

Over the next several weeks you will be working with Romi as assembled to develop drivers for the various actuators and sensors on the robot. Initially you will focus on making the wheels spin by driving DC motors, measuring the wheel motion by reading from the encoders; then, you will use both together to perform closed loop control of the robot. Next, you will incorporate additional feedback from the IMU and any other sensors that your team adds to the robot (at the very least, line detection and bump detection sensors).

Discuss with your team about purchasing things your robot will need with plenty of advanced notice:

1. *You will need a set of 6xAA batteries ASAP.* Throughout the quarter it may be a cost-saver to invest in rechargeable batteries, but a large pack of Alkaline batteries may get you through the quarter as well.
2. Remaining items can be purchased after further discussion in lecture. An initial list of items that are recommended (not required) can be seen here: [Recommended Items for Purchase](#) (<https://canvas.calpoly.edu/courses/161863/pages/recommended-items-for-purchase>). Note that this list is subject to updates or changes throughout the quarter.

## Submission

There will be no online submission for this assignment. Instead you will show your instructor at the beginning of lab during Week 2 (Thursday 9/25) that the assembly is complete so that you may begin working with the Romi hardware.

**Note:** you will not need the IMU for several weeks, but it is recommended to include it in the initial assembly anyway to mitigate the amount of rewiring you must do throughout the quarter.