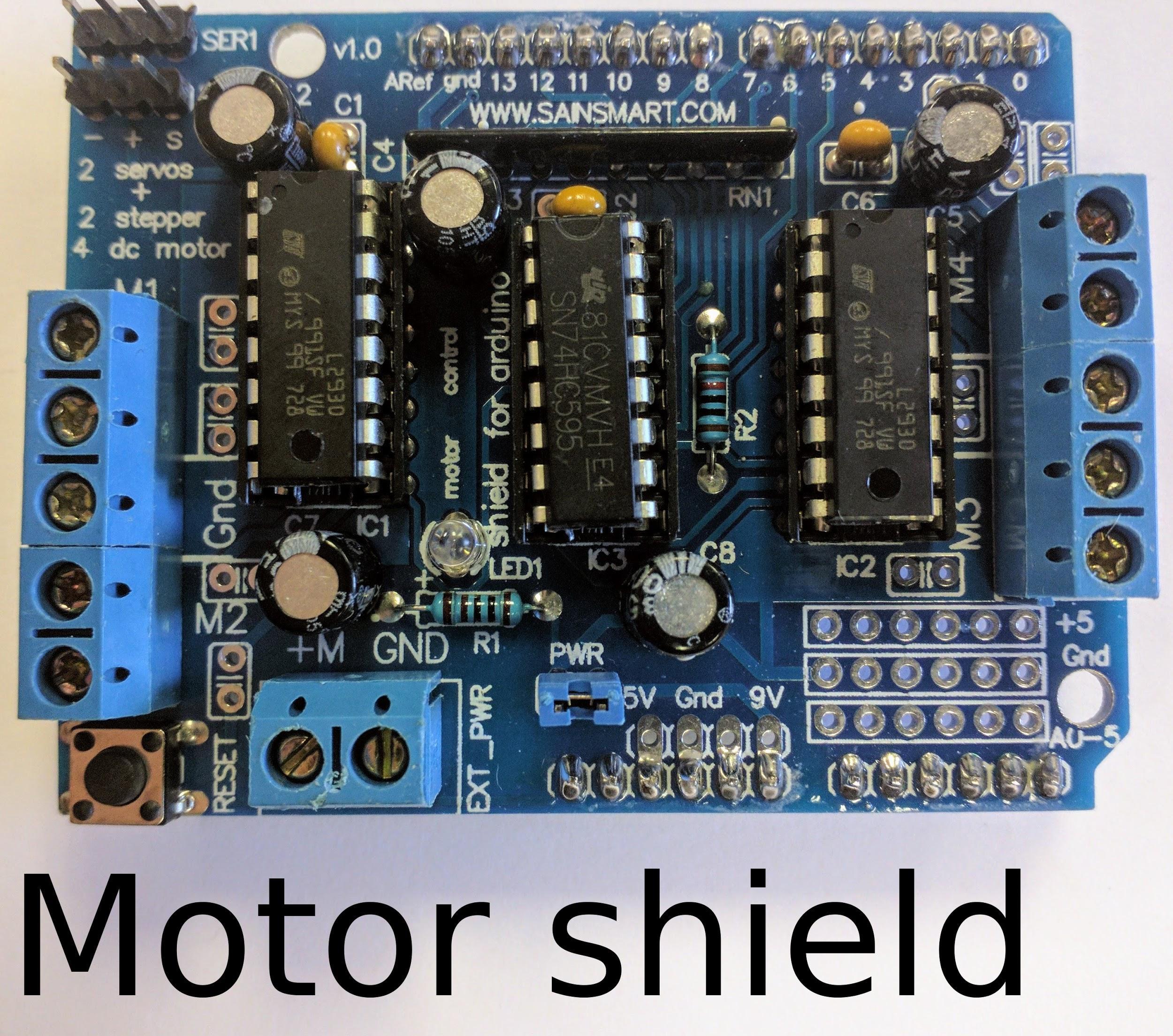
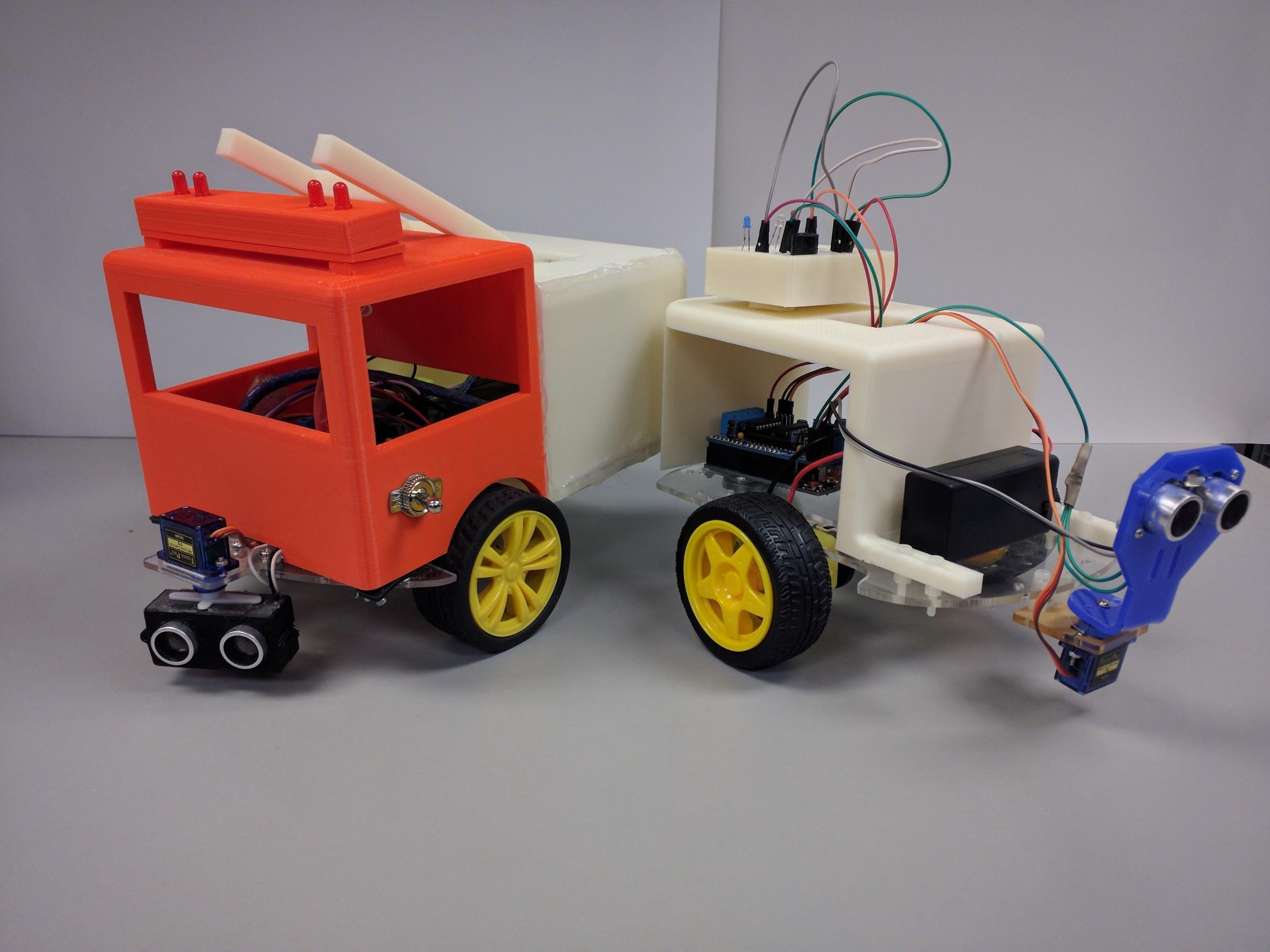
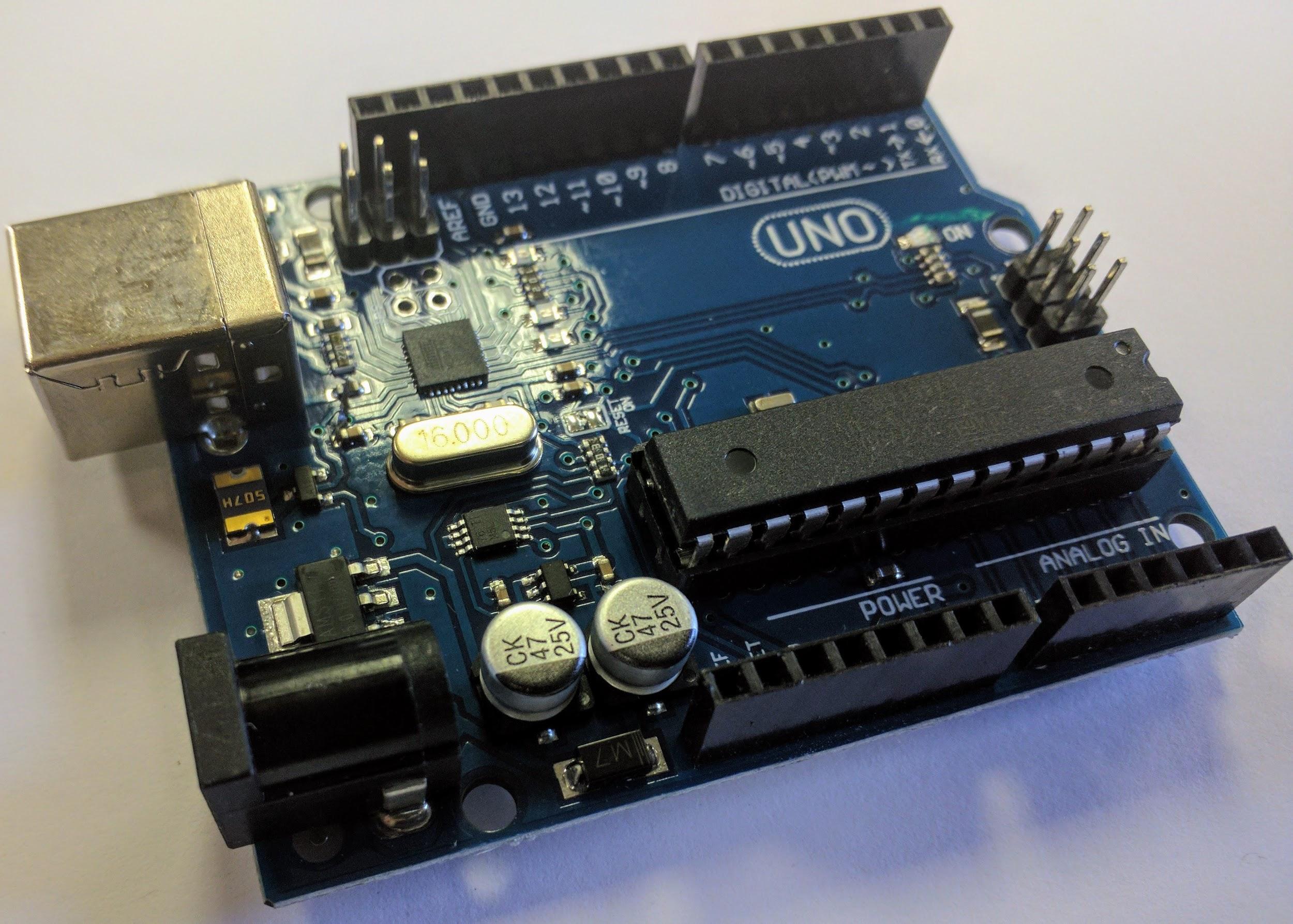
**iCREAT I: Module 7 – LAB- MicroMouse Integration: Motors, Sensors & Coding with Arduino Motor Shield**



horizontal line

# Objectives

* Get familiar with [**Adafruit Motor Shield**](https://www.adafruit.com/product/81) V1.0
* Get familiar with the full documentation for the “[*Adafruit Motor Shield*](https://cdn-learn.adafruit.com/downloads/pdf/adafruit-motor-shield.pdf)”
* Testing the Adafruit Motor Shield Library
* Testing your Servo Motor ([Arduino Servo Library](https://www.arduino.cc/en/Reference/Servo)) with the Motor Shield Library
* Testing your Ultrasonic Distance Sensor (NewPing Library)) with the Motor Shield Library

# Background / Scenario

Once you are comfortable with the Arduino software and using the built-in functions, you may want to extend the ability of your Arduino with additional libraries.

A **Motor Shield** is a driver module that allows you to easily use a microcontroller to control the working speed and direction of the motors. The [**Adafruit Motor Shield**](https://www.adafruit.com/product/81) is a great and quick way to control DC motors, servos or stepper motors. It has the capability of controlling up to 2 stepper motors, 4 DC motors, and 2 servos. In this lab you will learn and experiment with the [**Adafruit Arduino Motor Shield**](https://www.adafruit.com/product/81) and the [Arduino](https://en.wikipedia.org/wiki/Arduino) [microcontroller](https://en.wikipedia.org/wiki/Microcontroller).

# Required Resources:

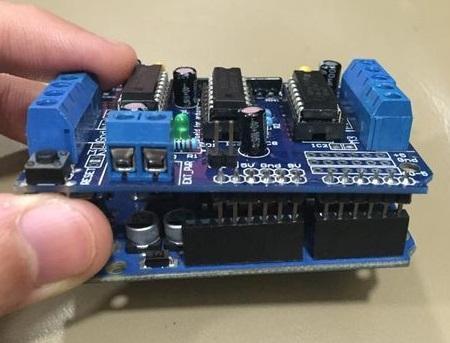
* 1x [Arduino UNO](https://store.arduino.cc/usa/arduino-uno-rev3) board connected to a computer
* 1x Appropriate USB [ca](http://www.robotshop.com/cables-wires-connectors-en.html)b[le](http://www.robotshop.com/cables-wires-connectors-en.html)
* 1x Breadboard
* 1x [Adafruit](https://www.adafruit.com/) [Arduino Motor Shield V1.0](https://www.adafruit.com/product/81)
* 1x car chassis with 2x DC Motors
* 1x Servo Motor
* 1x [Ultrasonic Sensor HC-SR04](http://randomnerdtutorials.com/complete-guide-for-ultrasonic-sensor-hc-sr04/)
* 1x External power supply (4x1.5v battery pack, or a 1x9v battery pack)
* Jumper wires
* Access to the [Arduino IDE](https://www.arduino.cc/en/Guide/Environment)
* Adafruit Motor Shield Library

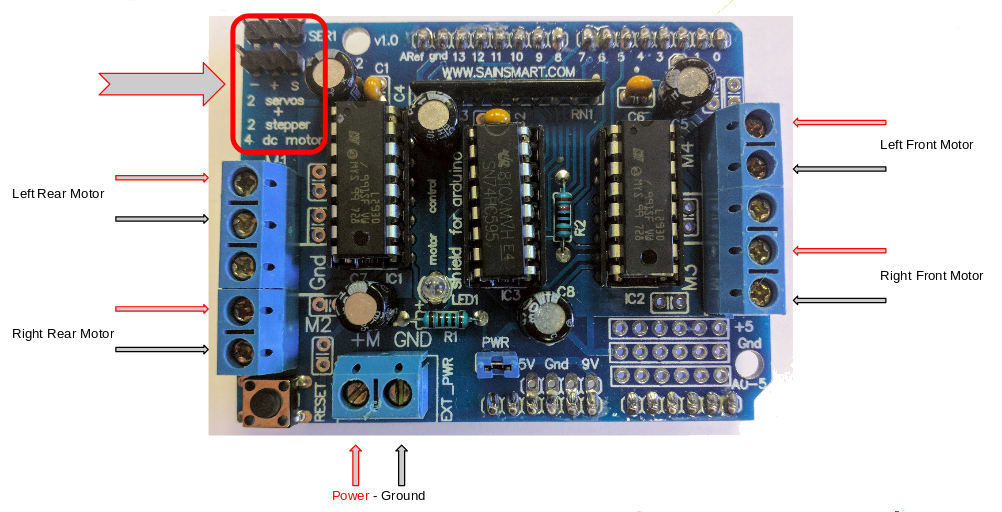
***IMPORTANT****: USE* ***MotorTest-iCREAT-Skeleton\_Solution.ino*** *solution in Module 7*

*Review this file prior to proceeding to the next steps.*

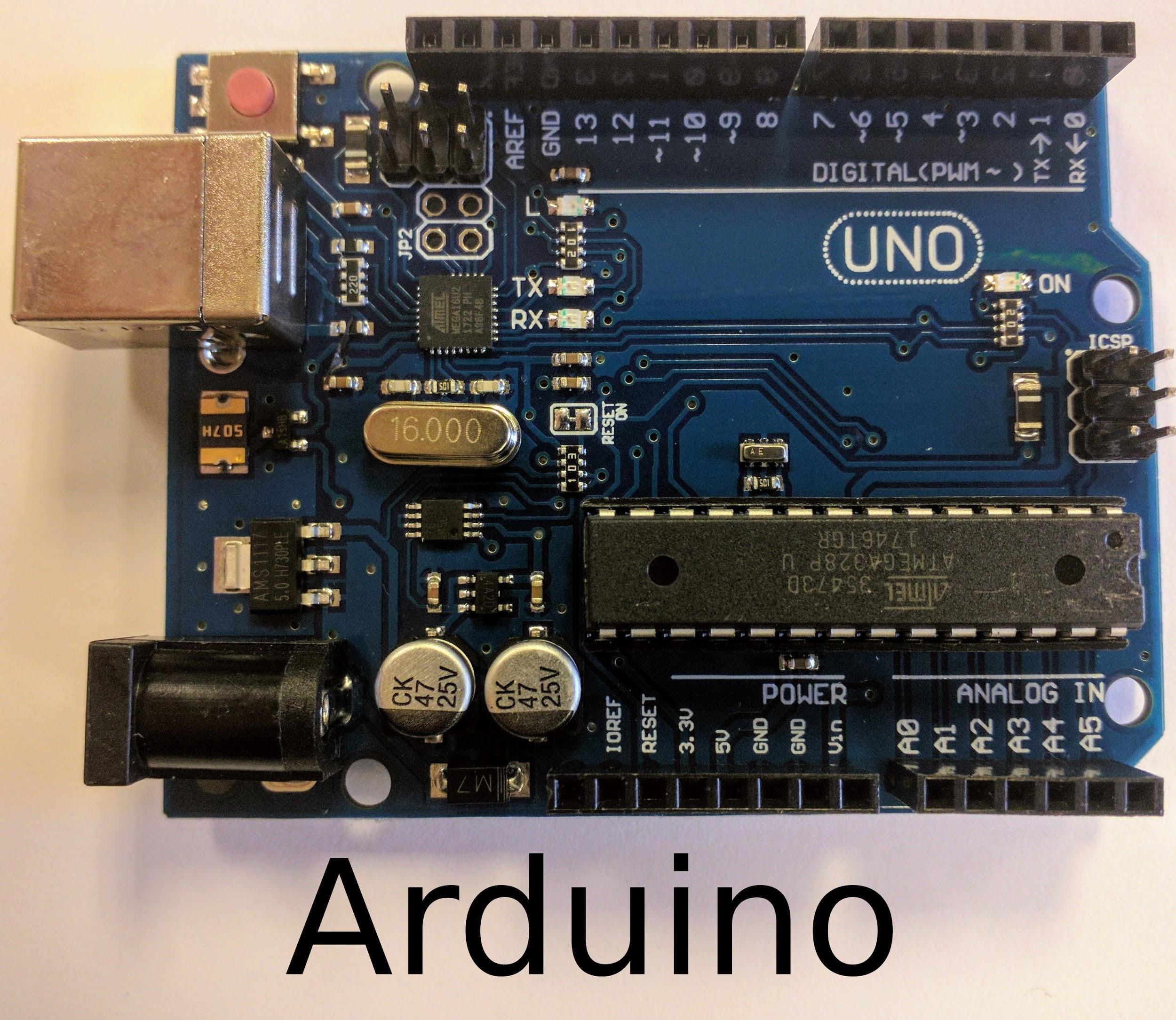
**Part 1. Testing the Adafruit Motor Shield Library**

In this section you will learn how to use and test the Adafruit Motor Library, and play with some of the sample code provided. Full documentation for the [Adafruit Motor Shield V.1.0](https://www.adafruit.com/product/81) can be found here: “[***Adafruit Motor Shield***](https://cdn-learn.adafruit.com/downloads/pdf/adafruit-motor-shield.pdf)”. To make life easier for the final project, you may use the book titled: “[***Make an Arduino-Controlled Robot***](http://shop.oreilly.com/product/0636920028024.do)” by [Michael Margolis](https://youtu.be/UubLEOP-C8s) as a reference.   
NOTE: The Adafruit motor library should be pre-installed on PCs (for more info you can check: **iCREAT I-Module 6-LAB 2-Arduino Motor Shield**).

1. **Attach (connect)** the motor shield on top of the Arduino as described in the following diagram: 
2. **Connect the two DC motors from the chassis** to the **M1** (***Left Rear Motor***) and **M2** (***Right Rear Motor***) ports in the motor shield as shown in the diagram below (please pay attention to the polarity!). Motors **M3** and **M4** will not be used for this project. Note that **DC Motors #1**, **#2**, **#3**, and **#4** are associated to **Digital Pins 11**, **3**, **5**, and **6** respectively (see Adafruit Motor Shield - FAQ):



1. **The best way to power your Micromouse** is from the DC power supply using a 9v battery:



9V Battery + Battery Clip

Or 9V Adapter

USB Cable

It could be also convenient to use a small breadboard to provide power to the motor shield by using the external power (2-pin screw terminal: **EXT\_PWD**). This will allow you to use a **4xAA 1.5v**, **9v**, or **2x18650 3.7v** battery pack (see Module-6 Adafruit Motor Shield - Power Usage):

1. **The best way to test your motors** is by connecting your Arduino + Motor Shield to your computer using a USB cable, and uploading some test programs. There is a collection of sample programs that are already in your Arduino folder. The sample sketches can be accessed on the Arduino IDE by clicking on ***File->SketchBook->*** (see Adafruit Motor Shield - Using DC Motors). In particular, you could download and test the code for:
   1. “***MotorTest***” sketch ***See Module-6-Lab2 for more info.***
   2. “***MotorTest2wd***” sketch ***See Module-6-Lab2 for more info.***

Here, we have a modification on the original “***MotorTest***” and “***MotorTest2wd***” programs located in the Arduino Sketch folder: ***File->SketchBook->***:

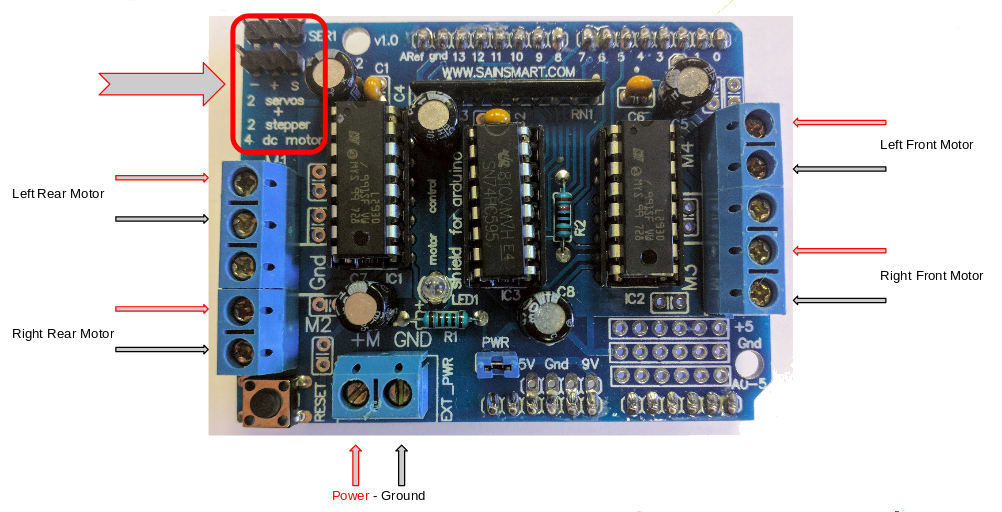
* **“MotorTest-iCREAT”** sketch ***See Module-6-Lab2 for more info.***
* **“MotorTest2wd-iCREAT”** sketch ***See Module-6-Lab2 for more info.***

1. In order for you to test your Micromouse, you will be using the chassis provided. Read and understand the code, and make sure you perform the proper adjustment (motor, servos, output lines, etc).
2. **Have fun and experiment** with your code.
3. ***NOTE****:* ***Once you understand how to work with your DC motors and the motor shield, you will need to “calibrate” them so they run at the same speed. More info about it later!***
4. **Show us your** working test programs before you move to the next section.

**Part 2. Testing your Servo Motor with the Motor Shield Library**

In this section you will learn how to use and test your servo motor with the Motor Shield Library and play with some of the sample code provided. Full documentation for the [Adafruit Motor Shield V.1.0](https://www.adafruit.com/product/81) can be found here: “[***Adafruit Motor Shield***](https://cdn-learn.adafruit.com/downloads/pdf/adafruit-motor-shield.pdf)”. This motor shield supports two (2) servos, or some other digital I/O pins (i.e. ultrasonic distance sensor).

1. **Attach (connect)** the ***micro servo*** provided to the **Servo 2** (**S2**) line (Digital I/O **pin 9**) on the motor shield, as described in the following diagram (see Module-6 Adafruit Motor Shield - Using RC Servos):

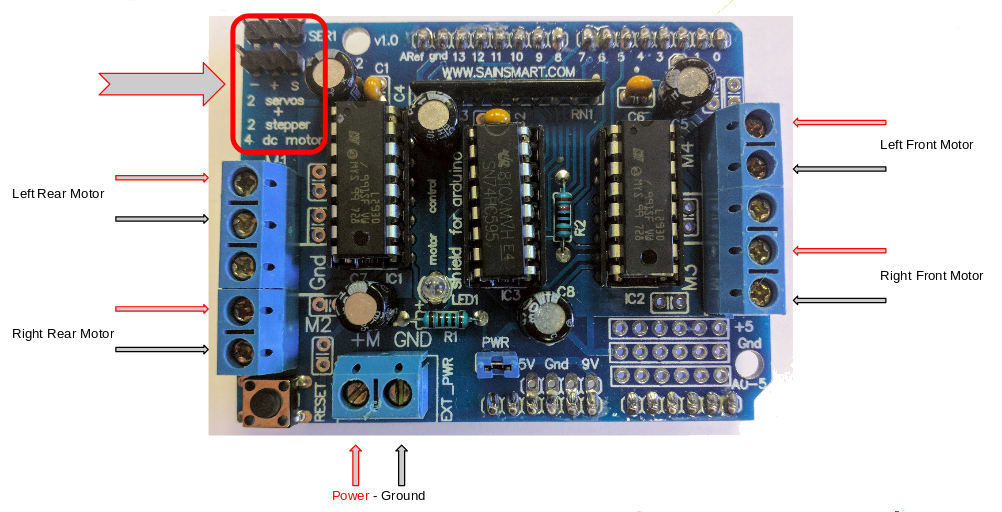


1. **Determine the best location to attach your servo to the chassis.** You could use Velcro, and a servo bracket (to be provided).
2. **Refer** to the “iCREAT I Module-6 LAB 1 Arduino Servo Motors” lab in order to test your servo. Use the “[**Knob**](https://www.arduino.cc/en/Tutorial/Knob)” and “[**Sweep**](https://www.arduino.cc/en/Tutorial/Sweep)” tutorials in order to test your Micromouse.
3. **Look through the sample code provided** in the motor shield library. The sample sketches can be accessed on the Arduino IDE by clicking on ***File->SketchBook-> (See Module-6-Lab2 for more info.)***
4. In order to test your Micromouse, you will be using the chassis provided. Read and understand the code, and make sure you perform the proper adjustment (motor, servos, output lines, etc).
5. **Have fun and experiment** with your code.
6. **Show us your** working test programs before you move to the next section.

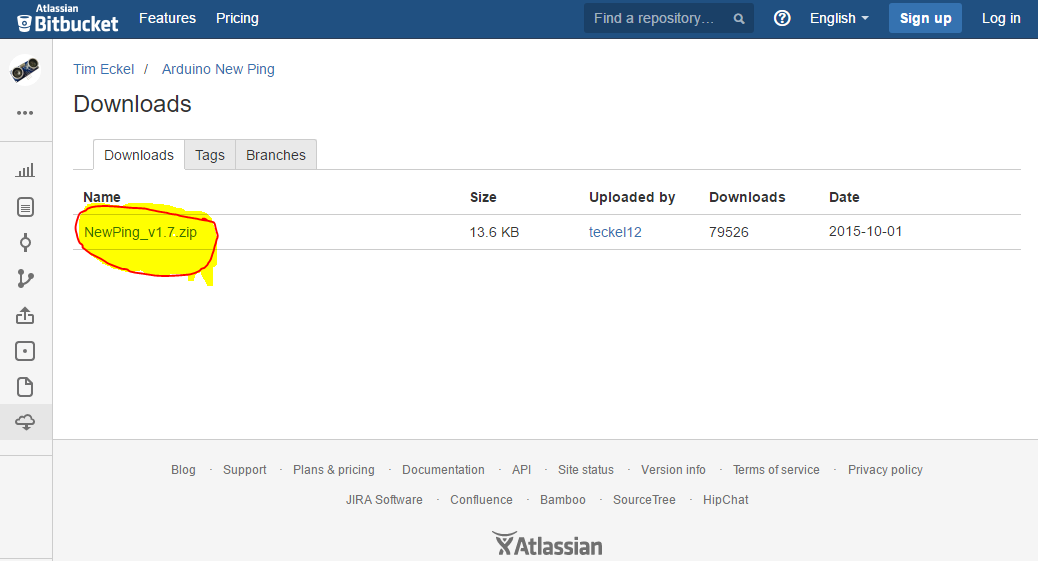
**Part 3. Testing your Ultrasonic Distance Sensor with the Motor Shield Library**

In this section you will learn how to use and test your [ultrasonic distance sensor](https://www.arduino.cc/en/Tutorial/Ping?from=Tutorial.UltrasoundSensor) with the Motor Shield Library, and play with some of the sample code provided. The ultrasonic distance sensor you will be using for the final project is the [**HC-SR04**](http://randomnerdtutorials.com/complete-guide-for-ultrasonic-sensor-hc-sr04/). Full documentation for the [Adafruit Motor Shield V.1.0](https://www.adafruit.com/product/81) can be found here: “[***Adafruit Motor Shield***](https://cdn-learn.adafruit.com/downloads/pdf/adafruit-motor-shield.pdf)”. This motor shield supports two (2) servos, or some other digital I/O pins (i.e. ultrasonic distance sensor).

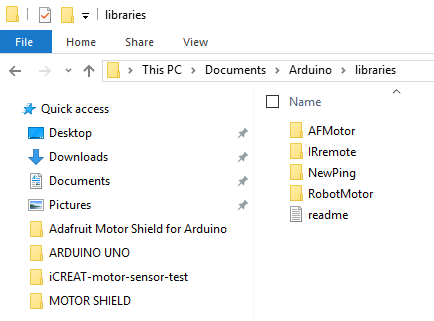
1. **Attach (connect)** the [***ultrasonic distance sensor***](http://randomnerdtutorials.com/complete-guide-for-ultrasonic-sensor-hc-sr04/) provided to the **Servo 1** (**S1**) line (Digital I/O **pin 10**) on the motor shield, as described in the following diagram (see Module-6 Adafruit Motor Shield - Using RC Servos):



1. **Attach your ultrasonic distance sensor to the servo.** You could use Velcro, and a sensor bracket (to be provided).
2. **Download and** [**manually install**](https://www.arduino.cc/en/Guide/Libraries#toc5)the new and improved [**Arduino NewPing library**](http://playground.arduino.cc/Code/NewPing), that will greatly simplify your programming task.
   1. To install the library, first quit the [Arduino IDE](https://www.arduino.cc/en/Main/Software).
   2. **Click** the following link to get the documentation for the [**NewPing Library for Arduino**](http://playground.arduino.cc/Code/NewPing).
   3. **Click** here to download the [**NewPing Library for Arduino**](https://bitbucket.org/teckel12/arduino-new-ping/downloads).
   4. **Click** on the file called: “[**NewPing\_v1.7.zip**](https://bitbucket.org/teckel12/arduino-new-ping/downloads/NewPing_v1.7.zip)” zip (compressed) file containing the **NewPing** library that you will be used for your project.:

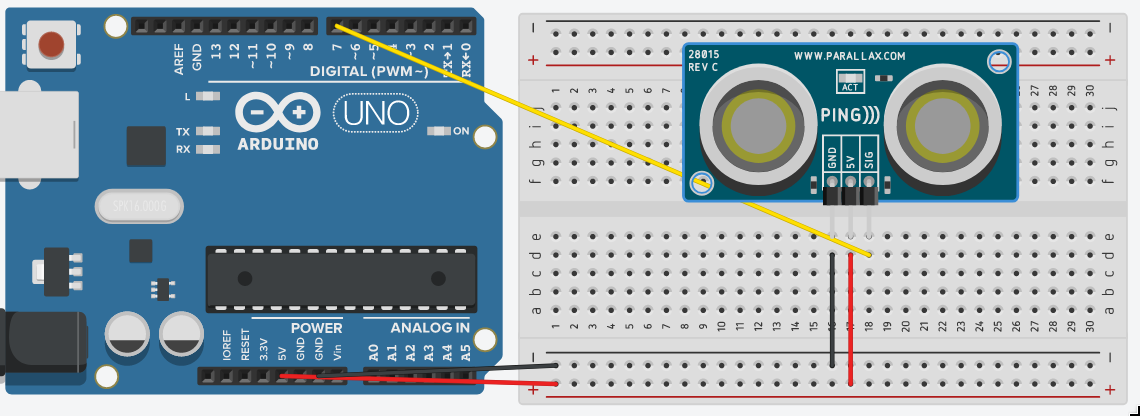


* 1. On Windows, the **ZIP** file will be downloaded to the “**Downloads**” folder: *“****C:\Users\iCREATstudent\Downloads****”*
  2. Uncompress the ZIP file containing the library (i.e. “[**NewPing\_v1.7.zip**](https://bitbucket.org/teckel12/arduino-new-ping/downloads/NewPing_v1.7.zip)”)
  3. Drag the **NewPing** library (move) from your Downloads folder to your Arduino library folder. Under Windows, it will likely be called "***My Documents\Arduino\libraries***". For Mac users, it will likely be called "***Documents/Arduino/libraries***". On Linux, it will be the "***libraries***" folder in your sketchbook. Your folder must look like this after you are done:

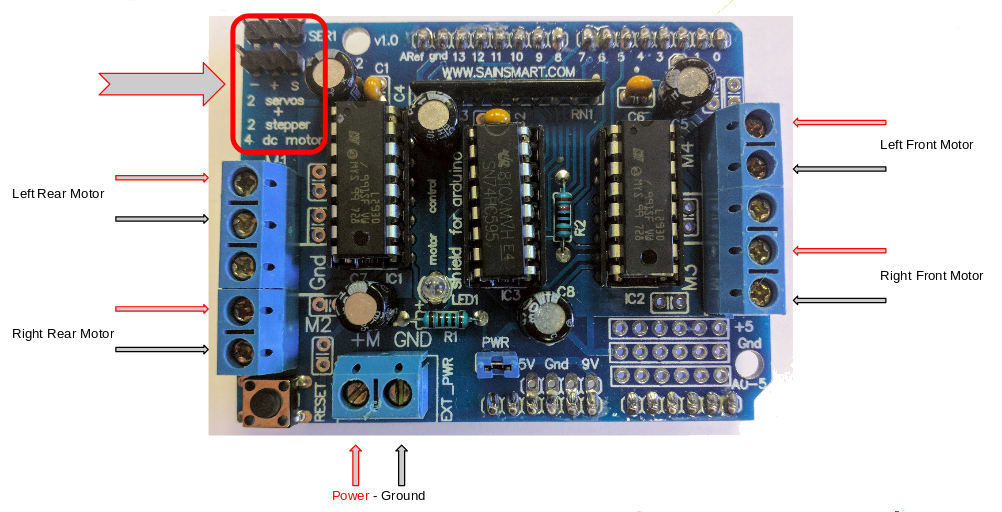


* 1. Restart the Arduino IDE. Make sure the new library appears in the “***Sketch->Include Library”*** menu item of the software. That's it! You've installed a library!

1. **Refer** to the “iCREAT I-Module 5-LAB-Arduino Ultrasonic Sensor” lab, and “[Complete Guide for Ultrasonic Sensor HC-SR04](http://randomnerdtutorials.com/complete-guide-for-ultrasonic-sensor-hc-sr04/)” in order to test your ultrasonic distance sensor.
2. The ultrasonic distance sensor **(**[**HC-SR04**](http://randomnerdtutorials.com/complete-guide-for-ultrasonic-sensor-hc-sr04/)) you will be using for the final project requires 4 pins to be connected to the Arduino (**Pins:** 1) **VCC**: +5VDC, 2) **Trig** : Trigger (INPUT), 3) **Echo**: Echo (OUTPUT), and 4) **GND**: GND). However, there is a very easy way (hack) for you to use only 3 Arduino pins to connect an [**HC-SR04**](http://randomnerdtutorials.com/complete-guide-for-ultrasonic-sensor-hc-sr04/) ultrasonic sensor (4 pins), by using the **Trig** pin (INPUT), and the **Echo** pin (OUTPUT) connected to the same Arduino pin. This simple [Instructable](http://www.instructables.com/) shows you how to create a simple test ([**Hack an HC SR04 to a 3 pin sensor**](http://www.instructables.com/id/Hack-an-HC-SR04-to-a-3-pin-sensor/?ALLSTEPS)**)**. The following diagram shows you how to do it on an Arduino:



1. When you are using the motor shield, you could use the servo pins (9 or 10) to connect the ultrasonic distance sensor, as shown on the figure below:



1. **Look through the sample code provided** in the [NewPing library](http://playground.arduino.cc/Code/NewPing#Example). Sample sketches can be accessed on the [Arduino IDE](https://www.arduino.cc/en/Guide/Environment) by clicking on:
   1. ***File>Examples->SketchBook->NewPing->\****
   2. ***File->SketchBook->iCREAT-motor-sensor-test***
2. In order for you to test your Micromouse, you will be using the chassis provided. Read and understand the code, and make sure you perform the proper adjustment (motor, servos, output lines, etc).
3. **Have fun and experiment** with your code.
4. **Show us your** working test programs before you move to the next section.

* Tutorials, Examples and help at <https://www.arduino.cc/en/Tutorial/BuiltInExamples>
* This tutorial is partially based on the book titled “[***Make an Arduino-Controlled Robot***](https://www.amazon.com/Make-Arduino-Controlled-Robot-Projects/dp/1449344372)” by [Michael Margolis](https://youtu.be/UubLEOP-C8s) (O’Reilly). Copyright 2013 Michael Margolis, ISBN (978-1-4493-4437-5)
* IMPORTANT: Need to have more functionality in your robot? Here is a problem that we discovered that affects functionality - In some cases, using the buzzer causes the motors to shut down.
  + More information and resolution - <http://forum.arduino.cc/index.php?topic=302988.0>
  + TLDR: The "Tone()" function uses pins 1 and 3 in the background even when they're not really used to transmit information to a device. This is a huge problem because the Motor Shield makes constant use of these pins to control the DC motors. The following page provides alternate function library "NewTone" which gets around this problem <http://forum.arduino.cc/index.php?topic=143940.0>