THE HONG KONG UNIVERSITY OF SCIENCE AND TECHNOLOGY
Department of Electronic and Computer Engineering
ELEC 1100

Laboratory 5: Sensors & MCU (5%)

A) Objectives:

- To get familiar with the Arduino coding environment.
- To construct circuit with the Arduino Uno board.

B) Hardware and Software:

- Photoresistor, Motor
- Arduino Uno board, Tinkercad

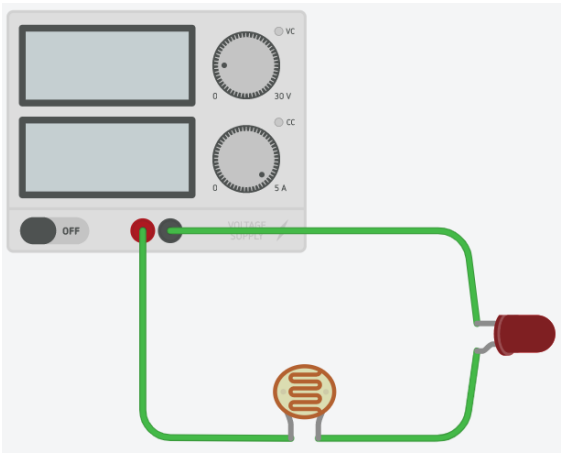
C) Experimental Procedures:

Simulation 1: Line sensor characteristics [Lab#05_S1]

In this experiment, we will use a photoresistor circuit to do simulation of the light sensor performance.

Step 1: Create a new circuit in **Tinkercad** and change the circuit name.

Step 2: Find “photoresistor” in the instrument list and construct the circuit below.



Step 3: Start simulation. Click on the photoresistor to adjust its lightening condition.

Photoresistor is one kind of sensor whose resistance changes based on the amount of light it senses. A different voltage will appear across the photoresistor for different levels of light.

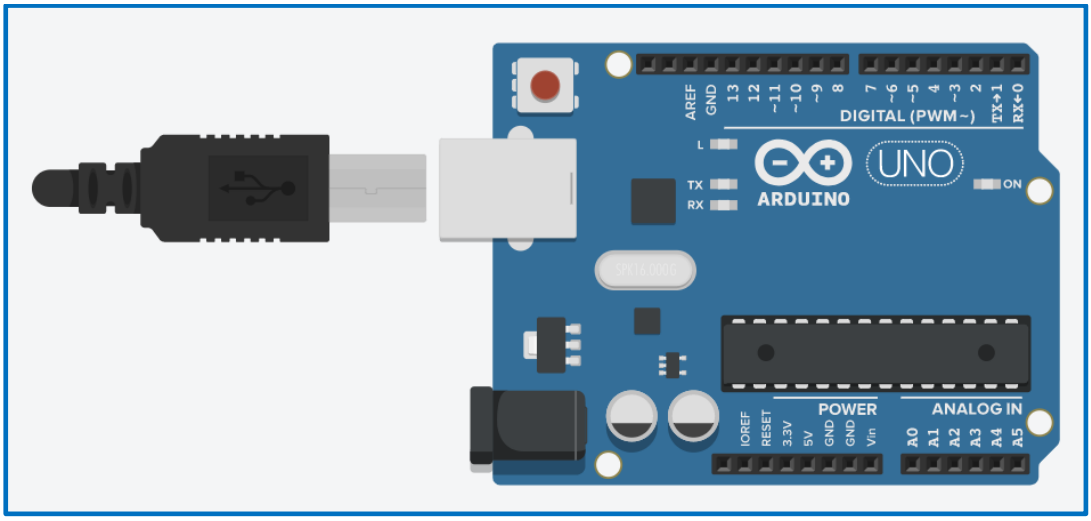
****** TA Check 1: Show demo to your TA that the LED brightness changes according to the changes on lightening condition*****

Simulation 2: Make your Arduino Uno board blinks [Lab#05_S2]

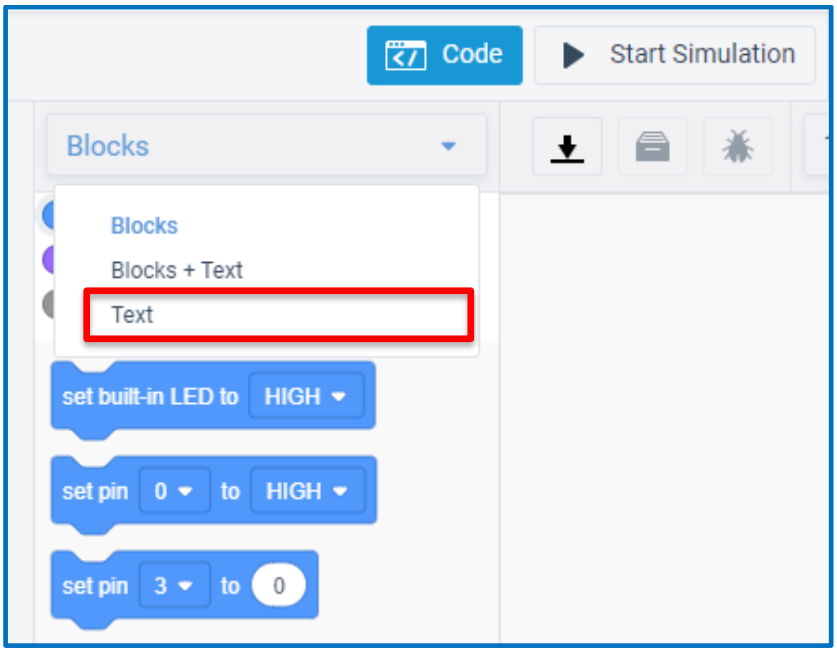
In this experiment, you will start to program and run the Arduino Uno board in Tinkercad.

Step 1: Create a new circuit in **Tinkercad** and change the circuit name.

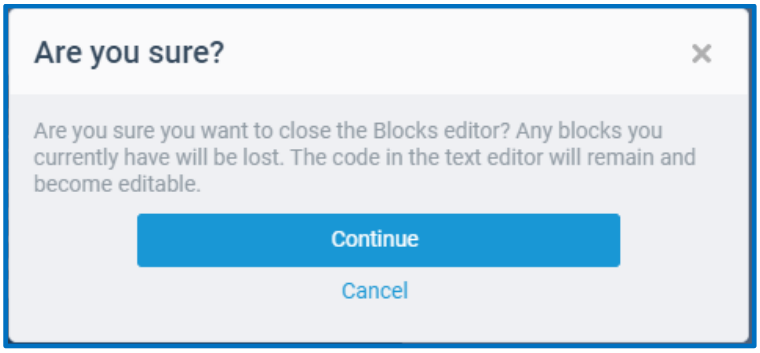
Step 2: Find “Arduino Uno R3” board in the instrument list.

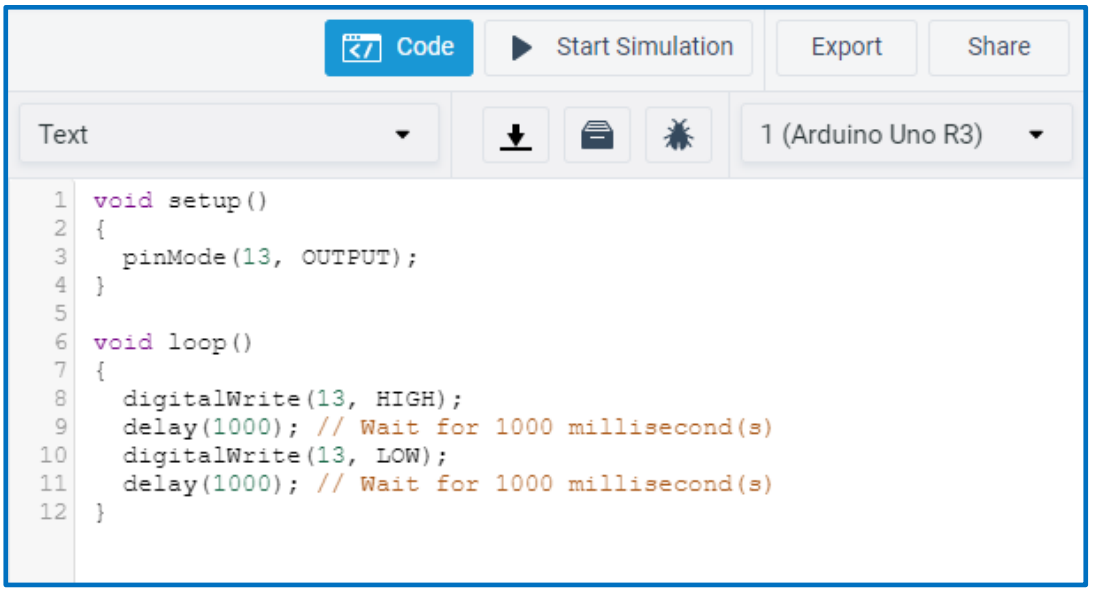


Step 3: Click on  function and switch to use coding “text” to write programs.

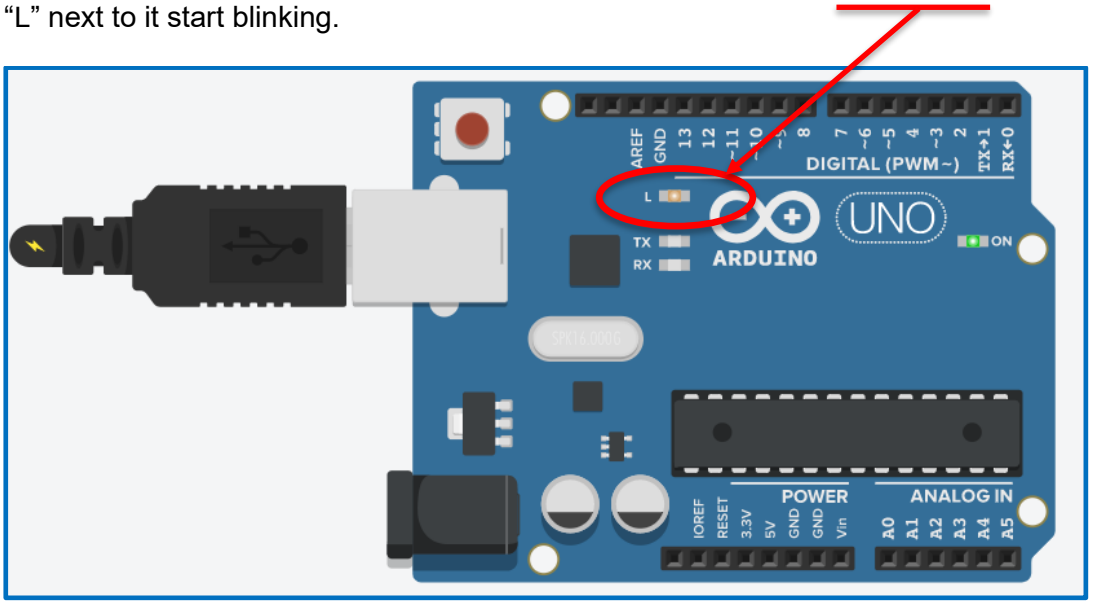


Step 4: You should see a new window poped-up, click on “Continue” to open the LED blink example sketch.





Step 5: Start Simulation and you should then see on your Uno board the built-in LED with an “L” next to it start blinking.



Step 6: Change the delay time to 100. Start simulation again. You should see the time difference in blinking.

****** TA Check 2: Demo to your TA that the blinking time changes according to the differenct delay time ******

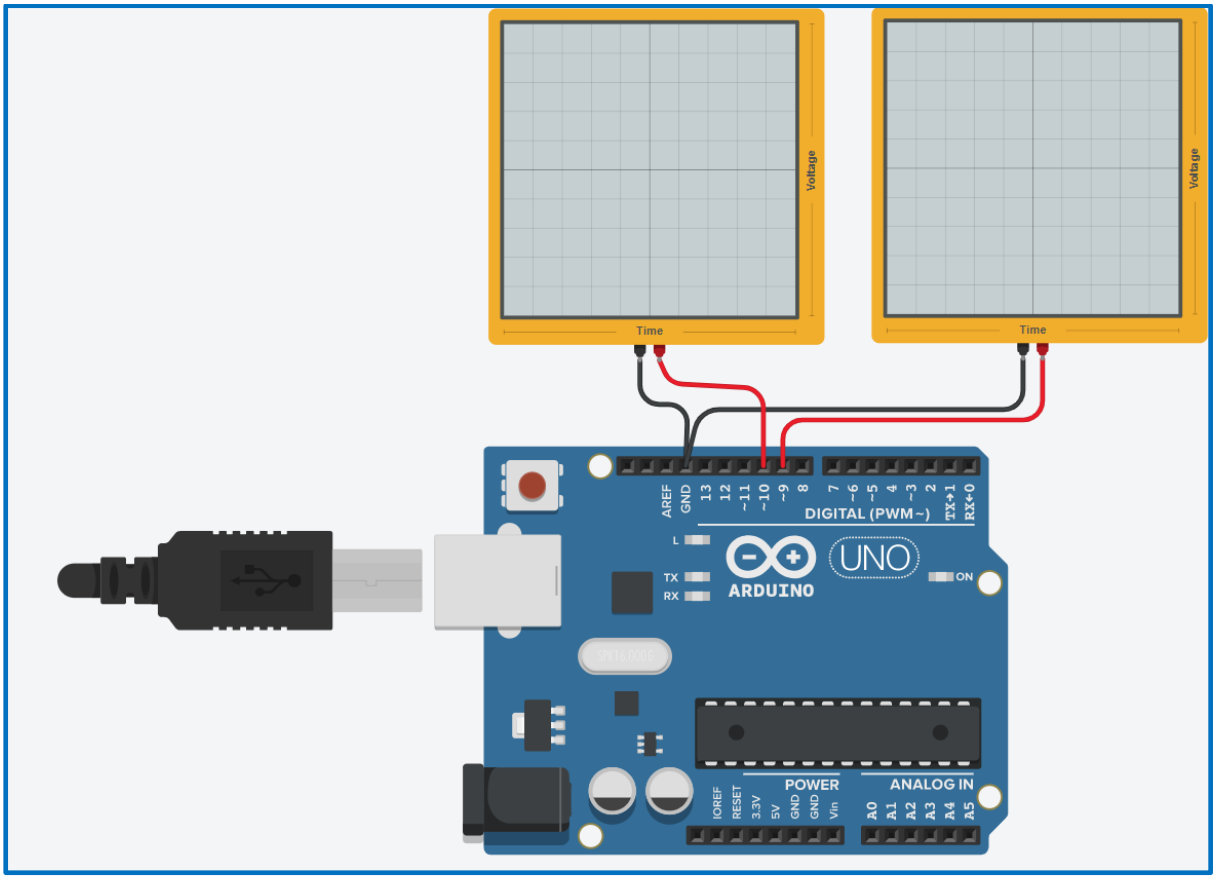
Simulation 3: Use Uno board to generate PWM signal [Lab#05_S3]

Now we use the Uno board to generate PWM signals.

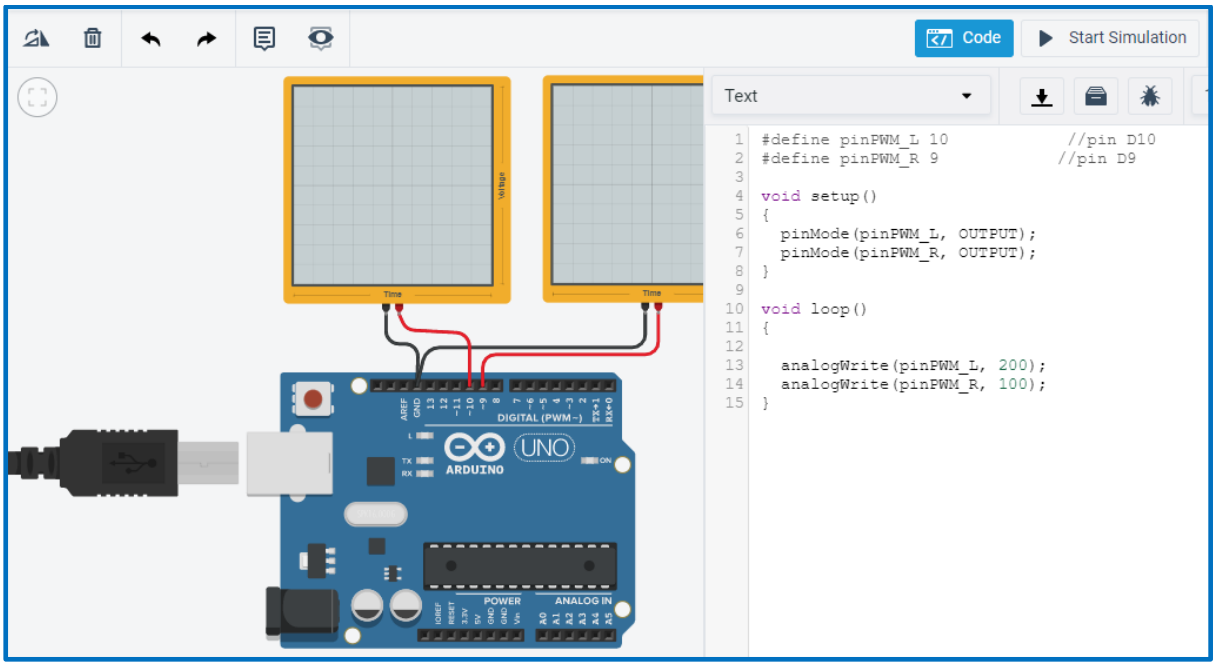
Step 1: Create a new circuit in **Tinkercad** and change the circuit name.

Step 2: Find “Arduino Uno R3” board and construct the circuit shown below.

You need two Oscilloscopes. Use Oscilloscope 1 to measure Pin 10 of your Uno board and Oscilloscope 2 to measure Pin 9 of your Uno board.



Step 3: Download the “lab_05_s3” Arduino sketch program from your Canvas lab page. Open the Arduino ino file using window notepad and copy & paste into your Uno board coding “text” section in Tinkercad as shown below.



Step 4: Start simulation and observe the difference between the waveforms generated at Pin 10 & 9 of your Uno board.

Notice:

1. There are two motors on your robot car, you need to generate two PWM signals for controlling each of the two motors.

2. In the coding text above, we use pin 10 of your Uno board to generate PWM signal for your **Left motor** (Pin 10: PWM_L) and pin 9 to generate PWM signal for your **Right motor** (Pin 9: PWM_R).

3. We use **“analogWrite”** function to assign the values of duty cycle to each PWM signal, notice the difference between PWM_L & PWM_R with different values (PWM_L with 200 while PWM_R with 100). You may play with changing the value in function **“analogWrite”** and see how it effects on the generated waveform at Pin 10 or 9 of your Uno board.

****This simulation is for your own practice, no need to show demo to your TA.

Simulation 4: Use sensor voltages to control motor rotation [Lab#05_S4]

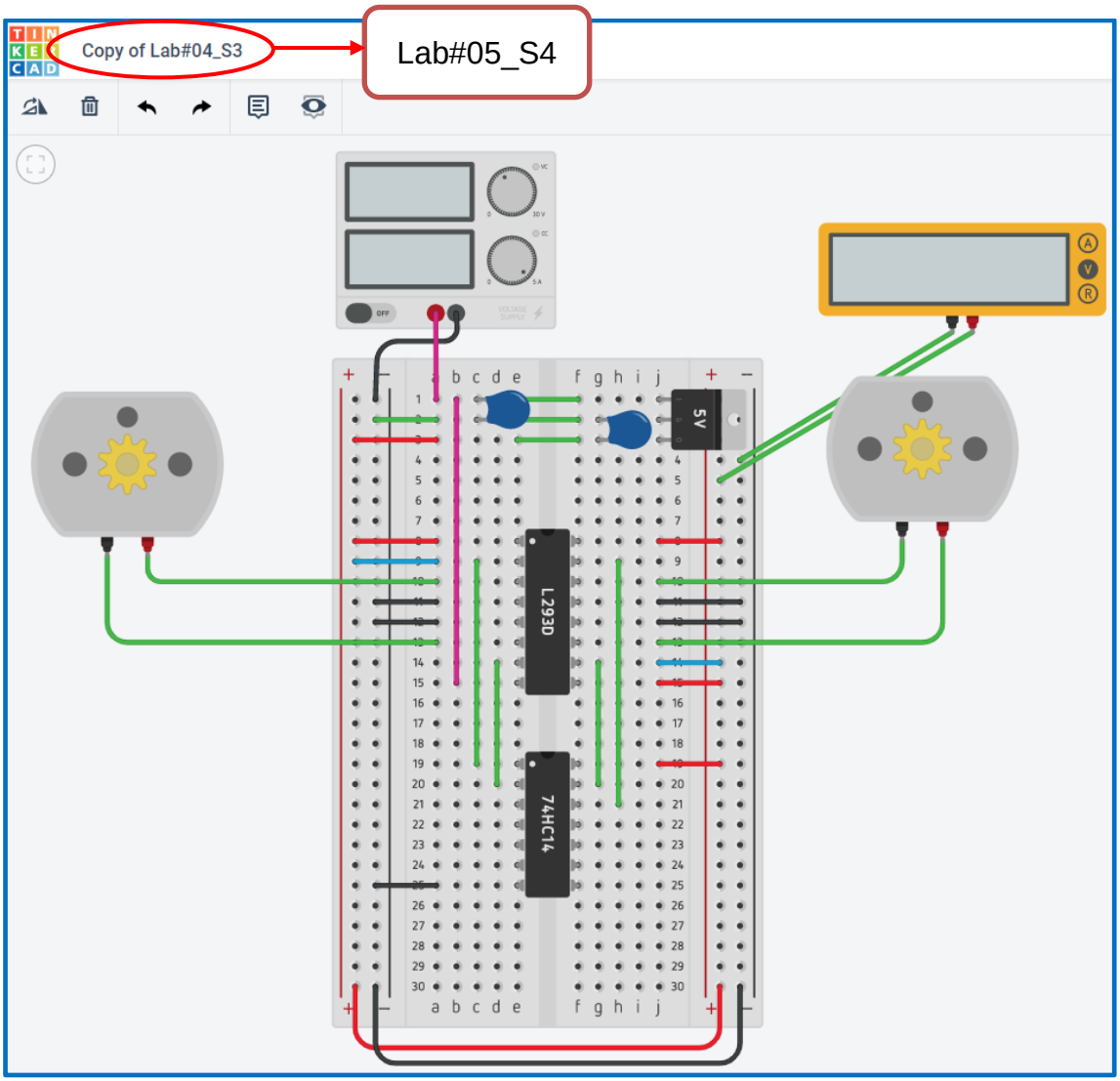
In Lab#04_S3, the motor rotating direction can be changed by changing the input voltage (0V to 5V, or vice versa) to **L_DIR** signal (pin 2 of L293). Similar situation for **R_DIR** signal (pin 10 of L293).

In real situation (i.e. especially in final project), the change of these DIR signals shall be controlled by an Arduino board which triggered by signals from **line sensors**. A line sensor consists of an IR emitter and a photo-diode. It works by illuminating a surface with the IR emitter, the photo-diode picks up the reflected IR and, based on its intensity, determines the reflectivity of the surface. This allows the sensor to detect a dark line on a pale surface or a pale line on a dark surface.

This is a digital sensor, meaning that its output voltage is either “high” (5V) or “low” (0V).

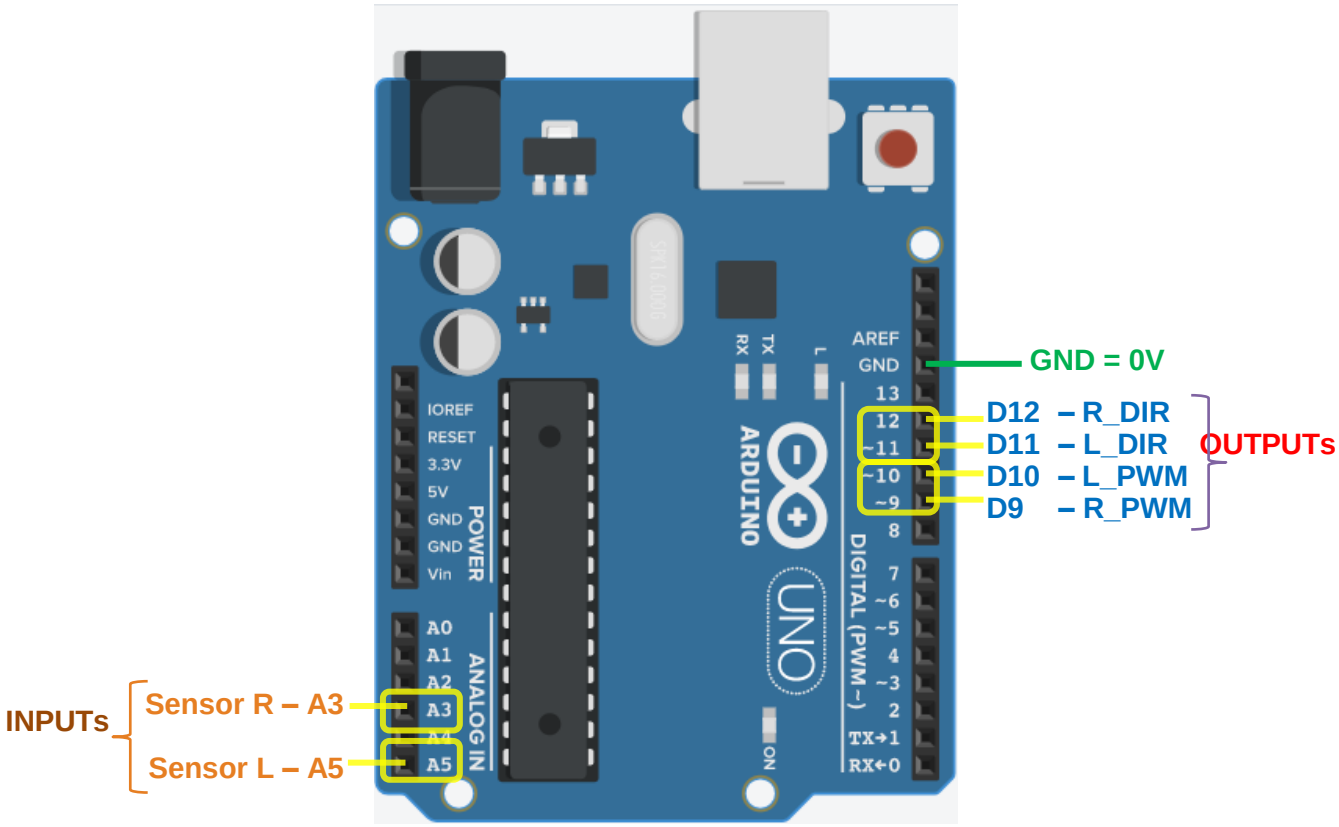
Now we link two sensor voltages **Sensor L** and **Sensor R** (simulated by switches) to the Uno board and use the Uno board outputs to control **L_DIR** & **R_DIR** (motor rotation signals)**,** and **L_PWM** & **R_PWM** signals (motor speed signals).

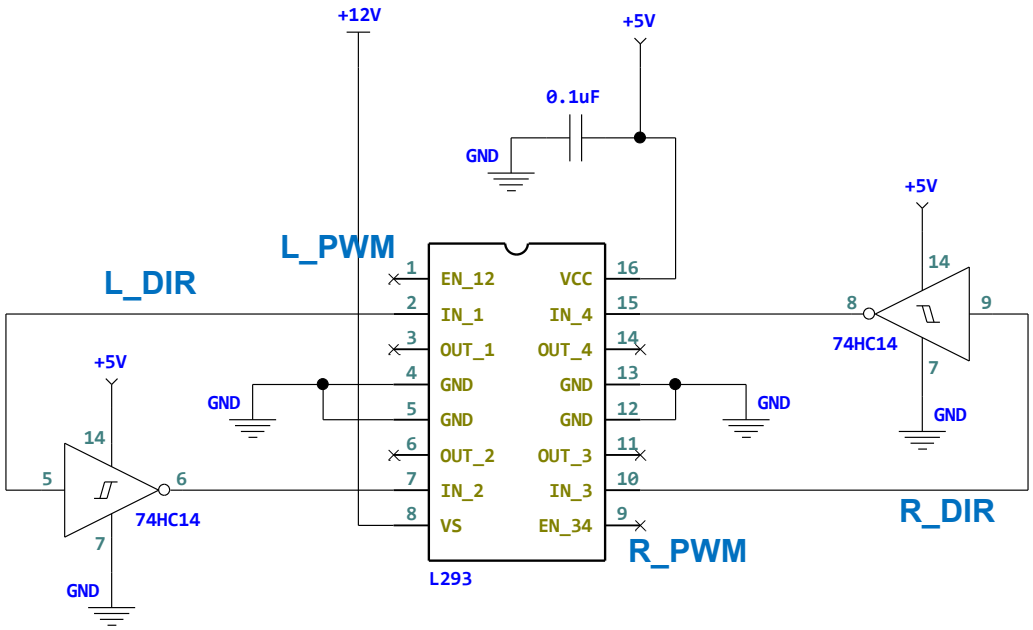
Step 1: As in previous lab, “Duplicate” your L293 H-bridge circuit (“Lab#04_S3”) and change the circuit name to “Lab#05_S4”.



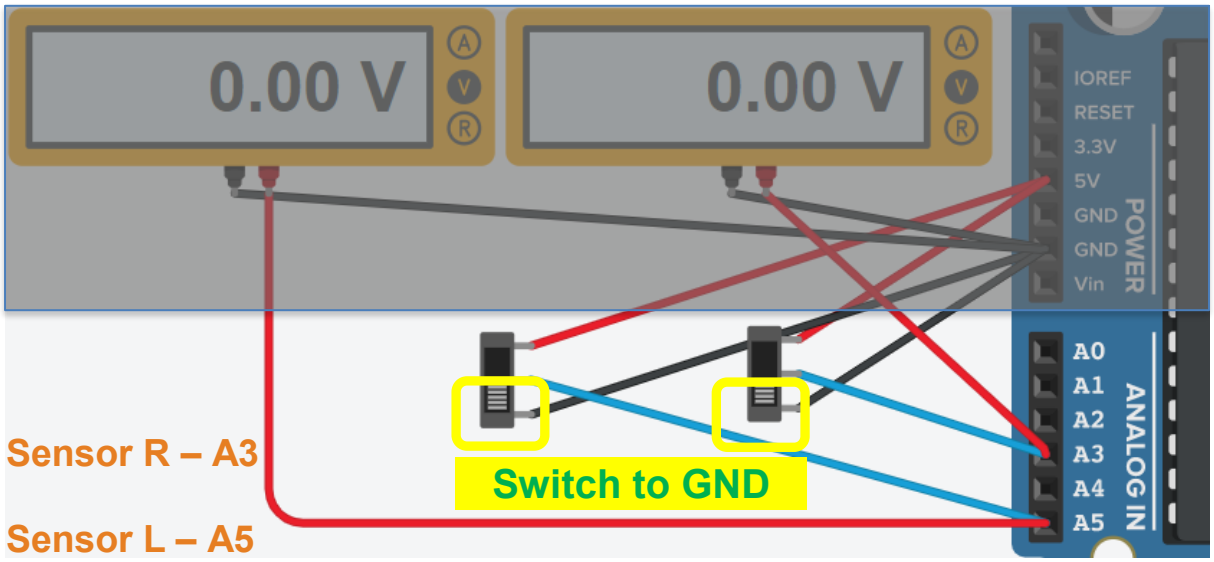
Step 2: Disconnect the **L_DIR** and **R_DIR** signals (pins 2 &10 of the H-bridge) from 5V or 0V (Ground), i.e. remove the two blue wires from breadboard.

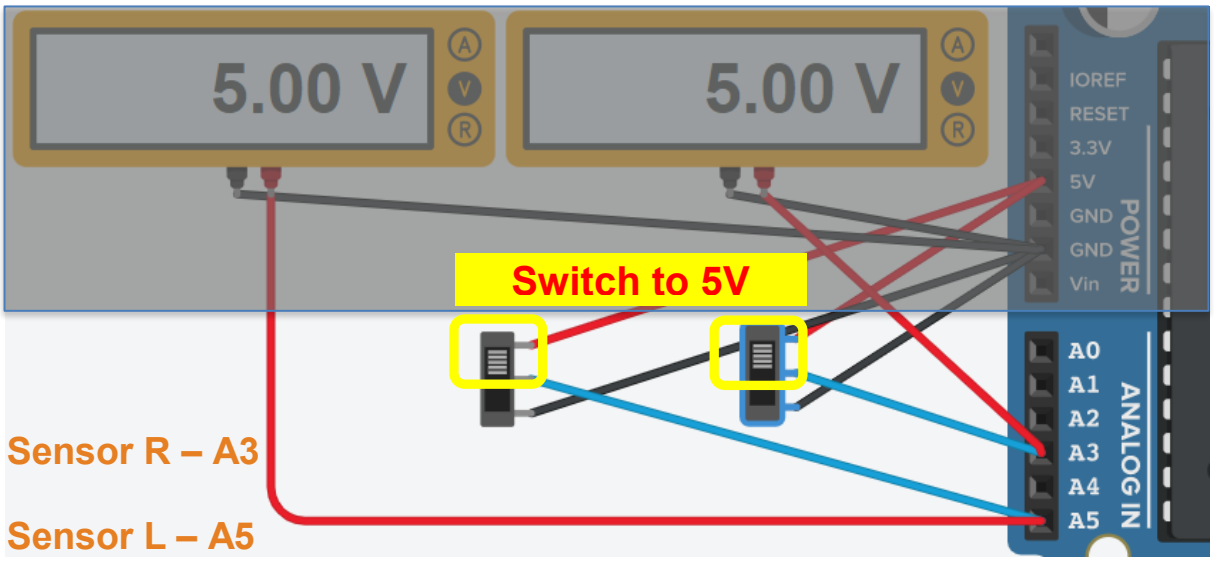
Step 3: Find “Arduino Uno R3” board and connect terminals of **OUTPUTs** and **GND** (as defined below) to your L293 H-bridge circuit accordingly.





Step 4: Find “Slideswitch” in Tinkercad and connect to your Uno board as shown below. you need two slideswitch to simulate Sensor voltages **Sensor L** (left sensor on your car) and **Sensor R** (right sensor on your car), each of them is with output voltage either a 5V or a 0V.





Step 5: Download the “lab_05_s4” Arduino sketch program from your Canvas lab page. Copy & paste into your Uno board coding “text” section in Tinkercad.

Step 6: Switch both **Sensor L** and **Sensor R** to 0V. Start simulation. You should see the two motors turning in one direction with a negative reading speed value of rpm.

Step 7: Switch both **Sensor L** and **Sensor R** from 0V to 5V. You should see the two motors turning in opposite direction with a positive reading of rpm.

****** TA Check 3: Demo to your TA that “Sensor L” voltage can control the rotation of your left motor, and Sensor R voltage can control the rotation of your right motor ******