

## Workshop 1: Introductory Session

### 1 Getting Started

Make sure you have everything you need to complete this lab. To get started you will need the following:

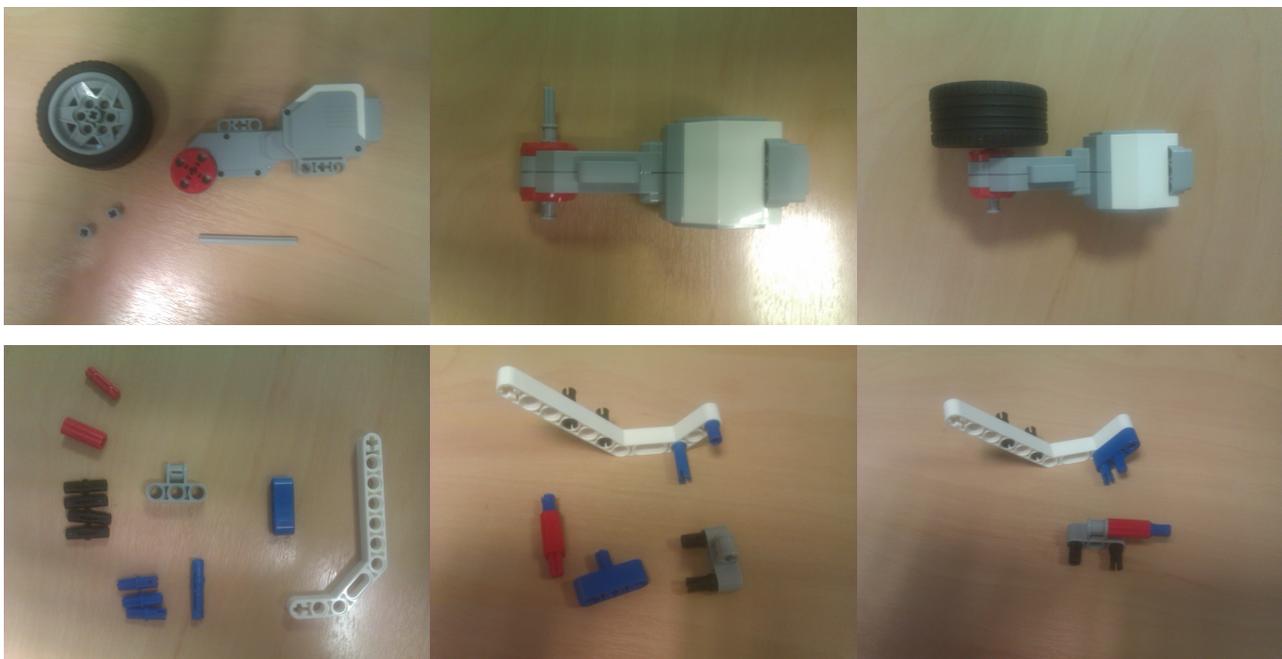
- A LEGO Mindstorms EV3 robot kit.
- A computer with LEGO Mindstorms EV3 software application installed.
- A USB cable that connects the robot to your computer.

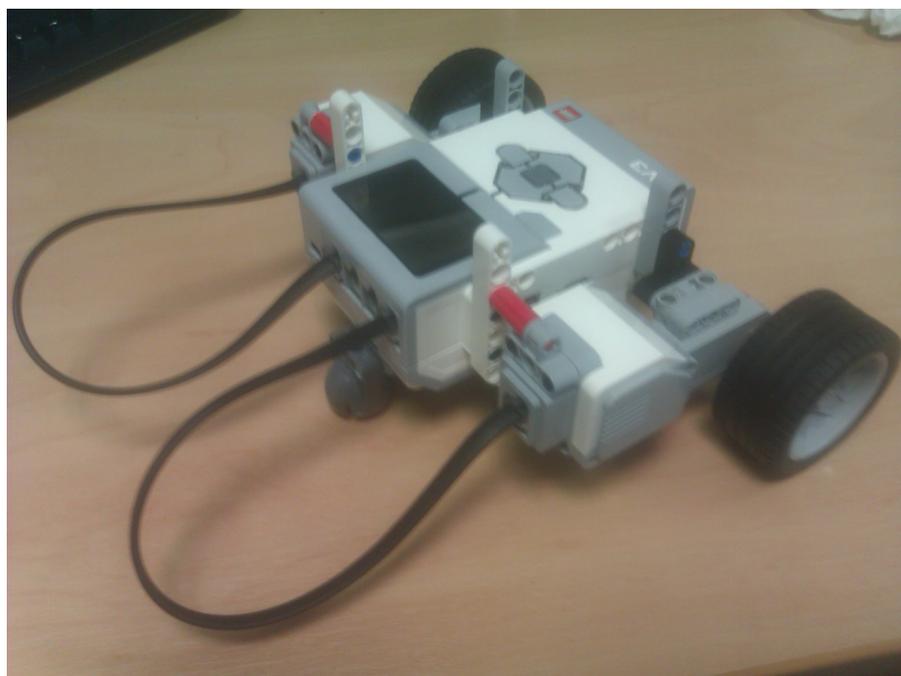
To complete the exercises:

- A marker pen.
- 4 pieces of A4-paper or 2 A3-size.
- Tape.

### 2 Build the 5-minute Bot

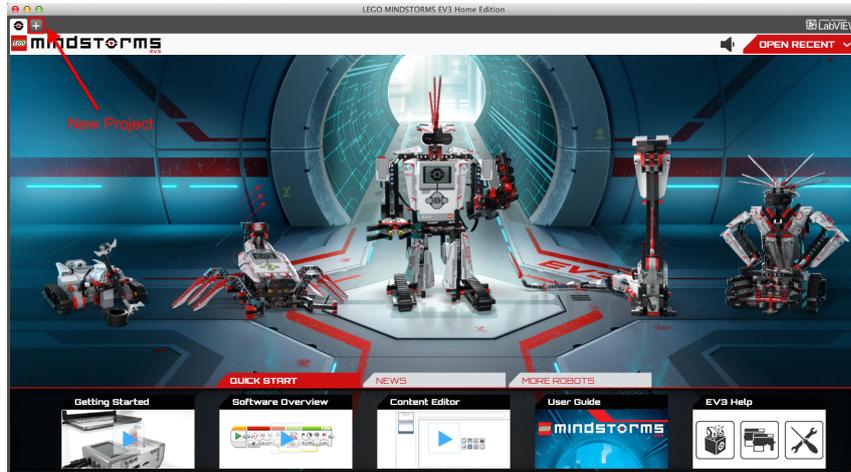
Follow the steps below:



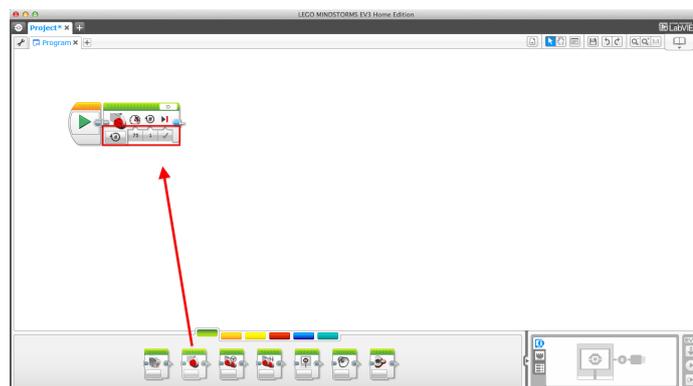


### 3 Write a basic navigation program

1. Start up the LEGO Mindstorms EV3 software application by clicking on the EV3 icon on your computer desktop. Your computer screen should look like this (without the red annotations):



2. Select + from the menu near to the upper left corner.
  3. After this, you should see a blank project with various types of commands on the bottom of the EV3 application window.
  4. Your basic navigation program should be able to do the following:
    - Go straight forward.
    - Go straight backward.
    - Pivot turn (wheels turning opposite directions).
    - One-wheel turn (one wheel turning, the other is stopped).
- (a) To get started, first click on the **Action** category and drag a **Large Motor** block into the starting point. Your screen should look like this:



The **Large Motor** command options panel are highlighted in red.

Here's an enlarged image of the Command Option Panel:

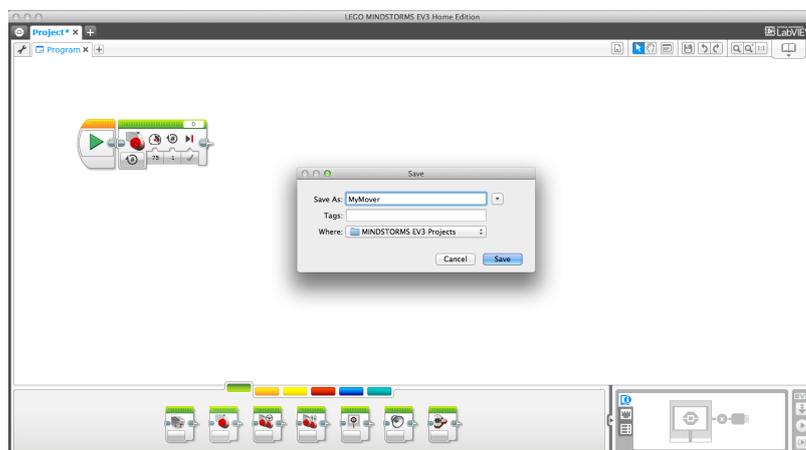


Make sure the ports which are connected to the robot's 'brain' are selected in the **Port option**. If not, look at your robot and trace the wires from ports **B** and **C**; they should end at the robot's motor.

- (b) The direction of the robot depends on the rotation number. If it's a **negative** number, it means it's a backward movement. Otherwise, a positive rotation number, means forward. You may want to change the power (which roughly translates into the robot's speed) and the duration of the movement.

**HINT:** The **Rotation** and **Degrees** option in the **Large Motor** task bar indicates the wheel's rotation (one wheel rotation is equivalent to  $360^\circ$ ).

- (c) Continue dragging more **Large Motor** blocks from the command panel and use different settings in order to complete the exercise.
- (d) Once you have written the basic navigation program, you should save it by selecting **File**→**Save Project** from the menu in the upper left corner. Your screen should look like this:

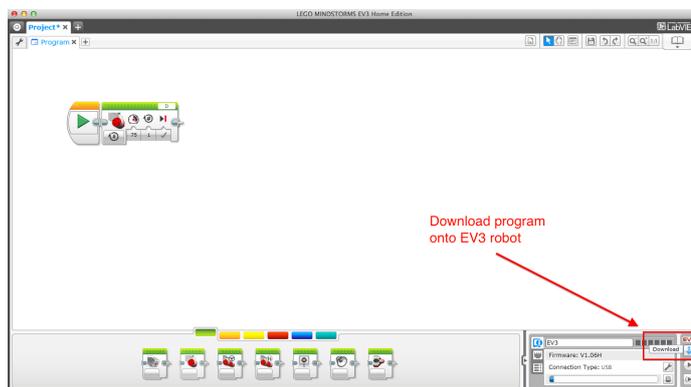


Type in a name for your program, choose a folder to save it in, then click on **Save**. In the example, the program is named 'MyMover'.

- (e) After you have saved the program, you are ready to **download** it onto the robot. Make sure that your robot is plugged in to the USB cable (the other end is plugged into the computer), as indicated by the **red** arrow in the image below:



Make sure the robot is turned on by clicking on the **dark-grey** button on the top of the robot. Then click on the download icon on the lower right corner of the EV3 application window:



The robot will make a beeping noise when the program has finished downloading.

- (f) Now you are ready to test the program by **running** it on the robot. Go to the second window by pressing the right arrow on the EV3 brain. Then choose the program you just downloaded. When you get to the **Program** display, as in image (c) below, the robot will start running the next time you press the **dark-grey** button.

**Make sure that the robot is on the floor or in an arena before you start it running.**



- (g) If the robot doesn't do what you want it to do, try to make some changes in your code then download and run it again. **Ask for help if you have any trouble!**

**HINT:** It's a good idea to turn the robot off when you are not using it for a long time. You can do that by sequencing back through the screens shown above. Do that by pressing the **grey** button (the one below the screen) until the robot's display shows the **Turn off** screen, as shown below:

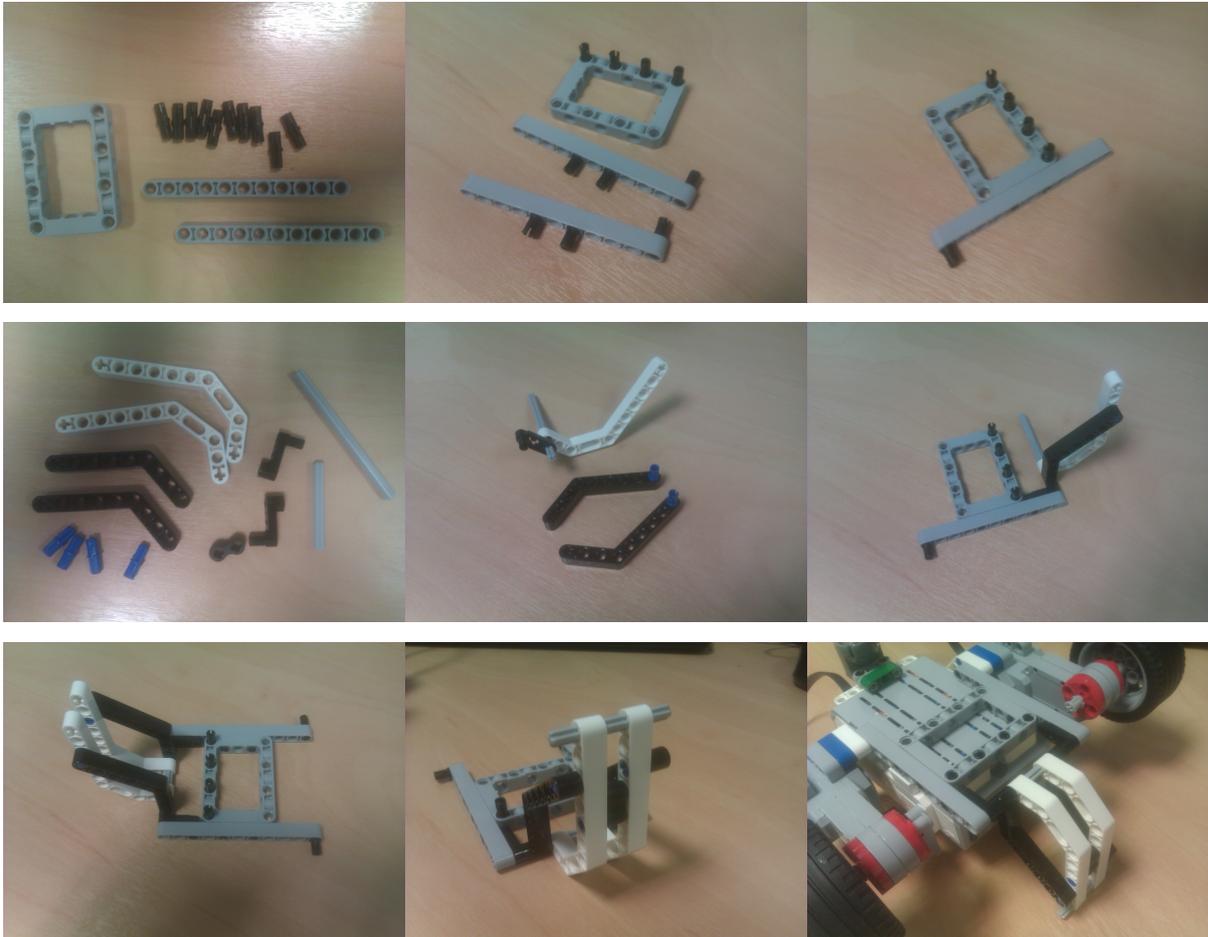


Press the **dark-grey** button when the check-mark is highlighted to turn the robot off. (You can turn it on again by pressing the **dark-grey** button.)

## 4 Draw, with a pen attached

For this challenge, you will use the basic navigation as you have learnt above, to get the robot to draw on a piece of paper. To get set up:

1. Follow the instructions to build a basic pen holder and attach it to the robot:



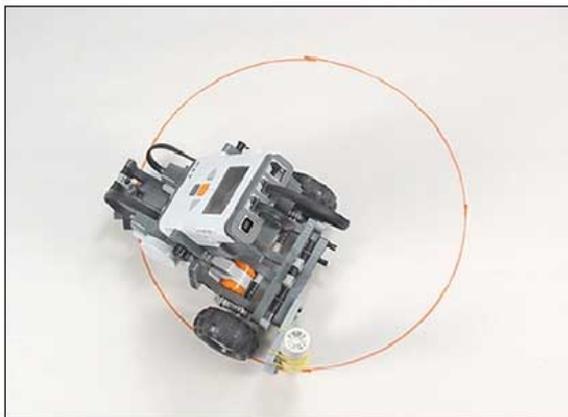
Set the position of the pen carefully, to barely touch the paper. With the pen in it, the holder should look something like this:



- Before you start programming, let's also build an arena for the robot. For this, we'll use a few pieces of paper taped next to each other to give some space for the robot. Use 4× A4-size pieces of paper or 2× A3-size pieces of paper and use the tape to stick them together.

**Make sure the paper is properly taped down before the robot starts moving!**

- Once you've finished the building, open the Lego Mindstorms application and complete the following exercises:
  - First you need to build up the movements for drawing a **circle**. For this, you may want to change the angle of the pen a bit. The drawing should look like this:



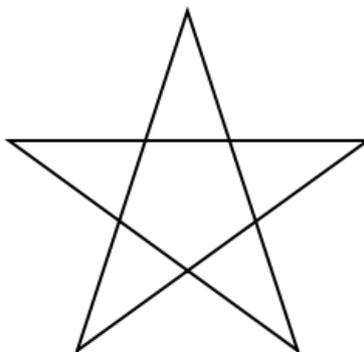
- After you finished with the circle, try a bit more complicated shape. Draw a **rectangle** and a **triangle** with your robot.

**HINT:** You may want to decrease the power of the robot during the drawing. When you finished the programming, try the movements without the pen attached, to make sure it behaves the way you want it to. If not, make some changes in your code and run it again.

**Ask for help if you have any trouble!**

## 5 Challenge: Draw a five-point star

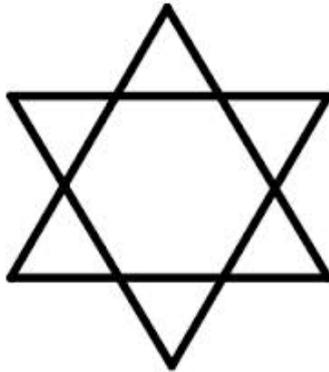
Try to draw a five-point star. Here is a picture of how it should look:



**HINT:** While programming the robot, you may want to try to making the movements with your robot first, without a pen attached, and to see what is happening. Where is the centre of the movement? What is a good position for the pen?

Once you have mastered the 5-star, see what other shapes you can draw.

Can you draw a six-point star?



## 6 Challenge: Write your name

Can you program the robot to write your name?

**HINT:** You may need to think about redesigning the pen-holder to be able to lift the pen from the paper. Can you think of any simple mechanisms to do this?

**Warning:** This challenge is hard!