

# Lego Mindstorms Instructions

The aim is to create a robot that can:

- Follow a line
- Stop when it hits on object
- Pick up a ball
- Identify the colour of the ball
- Return to the start
- Release the ball

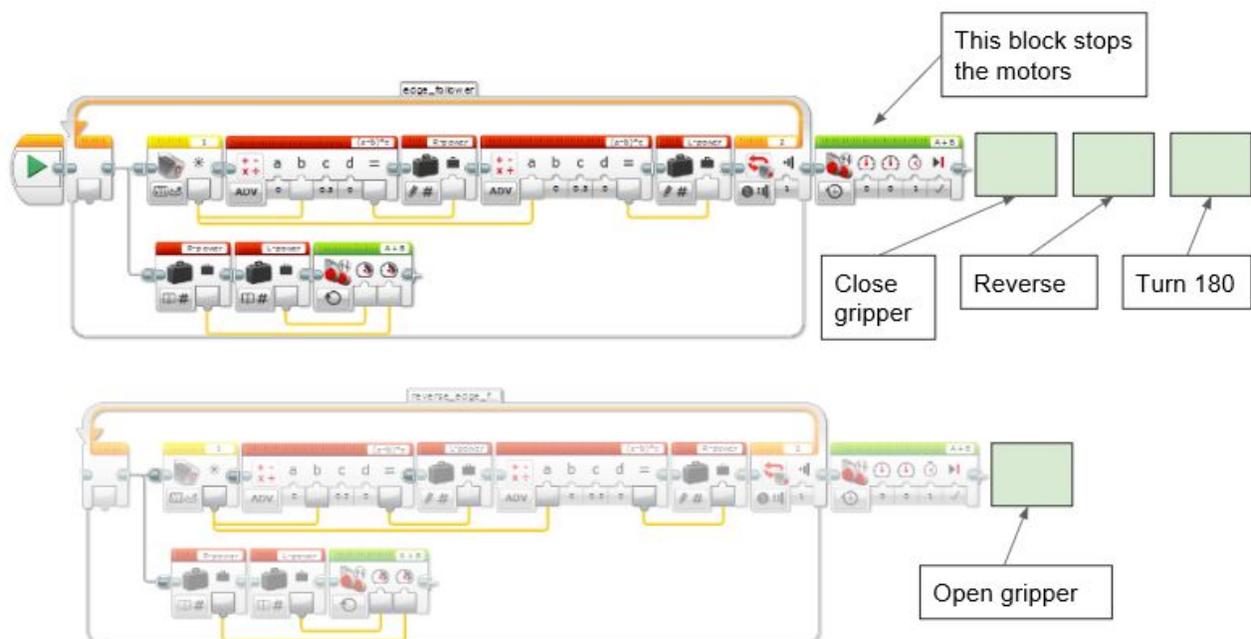
There'll be a competition at the end of the session, where your robot will get 1 point for each activity it completes.

The instructions below will guide you through making the software, but the hardware design is up to you! You'll need to make a gripper to pick up the ball, and a bumper to go on the touch sensor to detect when you're at the ball.

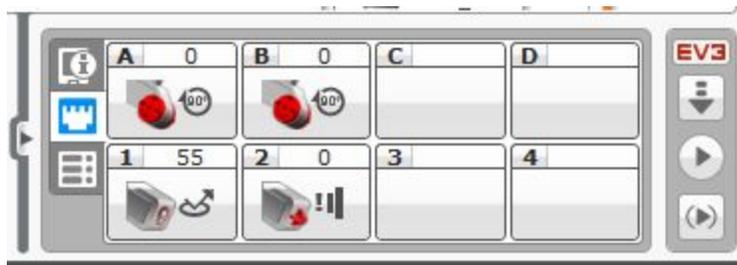
Remember, the best way to see if something works is to test it! Don't be afraid to experiment: you're really unlikely to do any permanent damage to the kit.

## **First Stage: Edge following**

Open the file named *dyson\_skeleton*. You should see something like the screen below. We've also labelled the blocks you'll need to add. Each of the sections is explained below in more detail. Make sure you follow through in this order: it's much easier to develop in stages and remove problems after each stage than to do it at once and hope it works!



Use the Port View of the brick at the bottom left of your screen to measure the light sensor output when it is over a white surface and write this down. Repeat for a black surface.

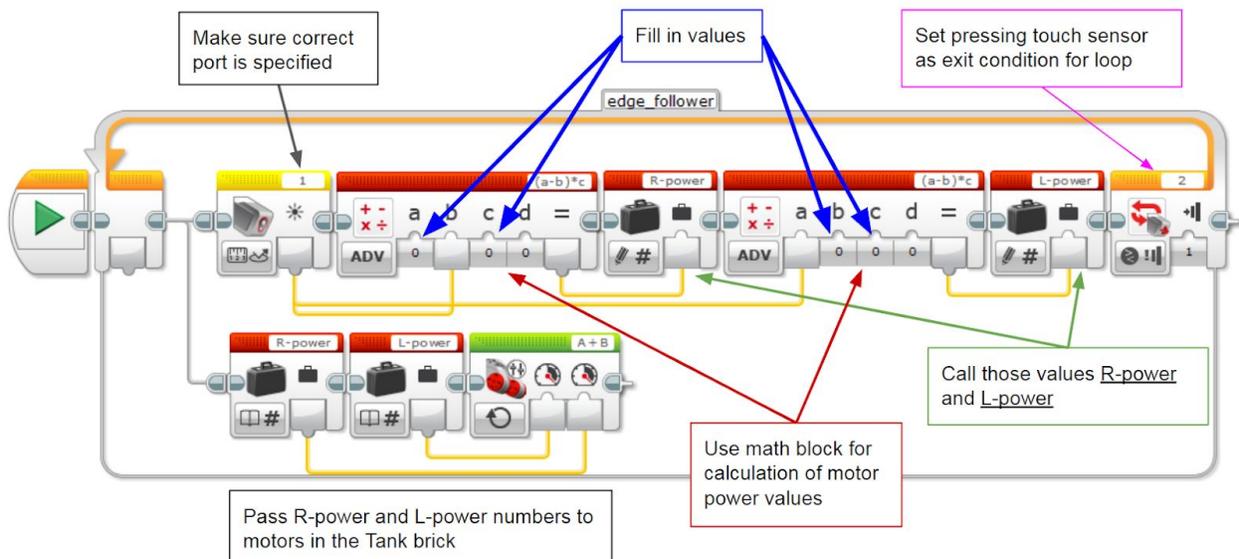


The robot needs to follow the black and white edge from start to end as in the map below:



So the motor needs to turn left when the sensor is on black, and turn right when on white. We can use the difference between the light sensor measurement now and the measurement on black or white to control the motor power.

We already talked through how the edge following works, but here's a reminder just in case:



Right motor power is calculated using:

$$(reading\ on\ white - reading\ now) \times power\ factor = right\ motor\ power$$

Left motor power comes from:

$$(reading\ now - reading\ on\ black) \times power\ factor = left\ motor\ power$$

Put some numbers in to see how this works:

On white, my light sensor reads 89

On black, it reads 12

I used a power factor of 0.4 for smooth running

These numerical answers are rounded a bit because the robot does this.

When the robot is on white:

$$(reading\ on\ white - reading\ now) \times power\ factor = right\ motor\ power$$

$$(89 - 89) \times 0.4 = 0$$

$$(reading\ now - reading\ on\ black) \times power\ factor = left\ motor\ power$$

$$(89 - 12) \times 0.4 = 31$$

The left motor drives the robot into a right turn, which is what we want. ☺

When the robot is on black:

$$(reading\ on\ white - reading\ now) \times power\ factor = right\ motor\ power$$

$$(89 - 12) \times 0.4 = 31$$

$$(reading\ now - reading\ on\ black) \times power\ factor = left\ motor\ power$$

$$(12 - 12) \times 0.4 = 0$$

The right motor drives the robot into a left turn, which is also what we want. ☺

If the sensor is right over the colour boundary that we are trying to follow, it reads about 51.

$$(reading\ on\ white - reading\ now) \times power\ factor = right\ motor\ power$$

$$(89 - 51) \times 0.4 = 15$$

$$(reading\ now - reading\ on\ black) \times power\ factor = left\ motor\ power$$

$$(51 - 12) \times 0.4 = 15$$

Both motors have the same power and the robot moves straight ahead.

Get this working before going any further! Running the code will cause the robot to follow the edge until the touch sensor on the front is pressed.

## **Second Stage: Pick up the Ball**

Your robot should now be able to follow the edge until the front bumper is pressed. Your teammates should have finished building the gripper by this point too. They will have used either a medium or large motor, which you can control with the medium or large motor blocks.



Add one of these blocks after the “stop motors” block to close the gripper and pick up the ball!

## **Third Stage: Turning Around**

Now you’ve collected a ball, your robot will need to turn around and bring it back to the start. Add some movement blocks to make it first reverse until it’s away from the stand, and then to spin around on the spot so it’s facing the other way

## **Fourth Stage: Reverse Edge Following**

Now you’re following the edge in the other direction, you need to swap what way the robot turns when it’s on white or black (think about it!). This has been implemented for you, so you should just need to put in the same values as you used when following the line in the first place.

## **(Optional) Fifth Stage: Identifying the ball**

If your teammates were able to put a sensor on the gripper, you can also try identifying the ball to gain extra points. (*Hint: Use the port view and try and see if there are any differences in light sensor readings for the red and green ball*).

If the ball has been identified, make sure it indicates the ball colour. You should do this by making the brick say the colour name using the sound brick, and/or display the colour using text on the brick display.

We suggest you put these blocks either immediately after picking up the ball, or just before dropping it.

**Test Surface**

Use this page to set the correct levels for your light sensor.

