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# **EV3 MakeCode**

***Release 2020***

**Apr 05, 2020**



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Learn to program the LEGO EV3 MINDSTORMS robot by assembling graphical control blocks.



# CHAPTER 1

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## Introduction

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This tutorial is an introduction on how to program the **LEGO MINDSTORMS EV3** robot with **Microsoft MakeCode**.

The language MakeCode is a **graphical language** where you assemble blocks to tell the robot what to do. All the programming is done online **inside a navigator** window (Chrome, Safari, Edge, Firefox) and does not need any installation of software.

To program the EV3 go to the following site: <https://makecode.mindstorms.com/#editor>

MakeCode also has a **simulator** which allows you to see the result of your program immediately, even without downloading it to the EV3 brick.

## 1.1 Hello world

It is a tradition for most tutorials to start with a program which displays **Hello world** on the screen. Here it is.

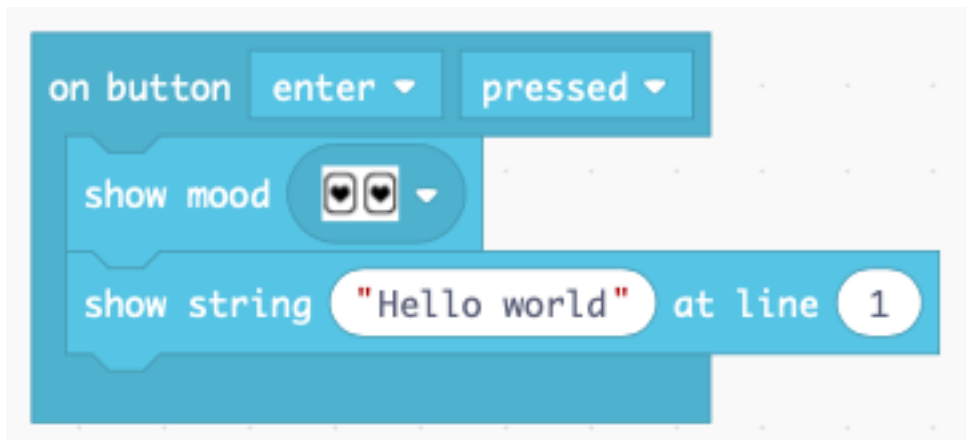


The program displays a line of text on the line you specify. Here we display it on line number 1, but you have up to 12 lines. When you run it, the simulator displays this.



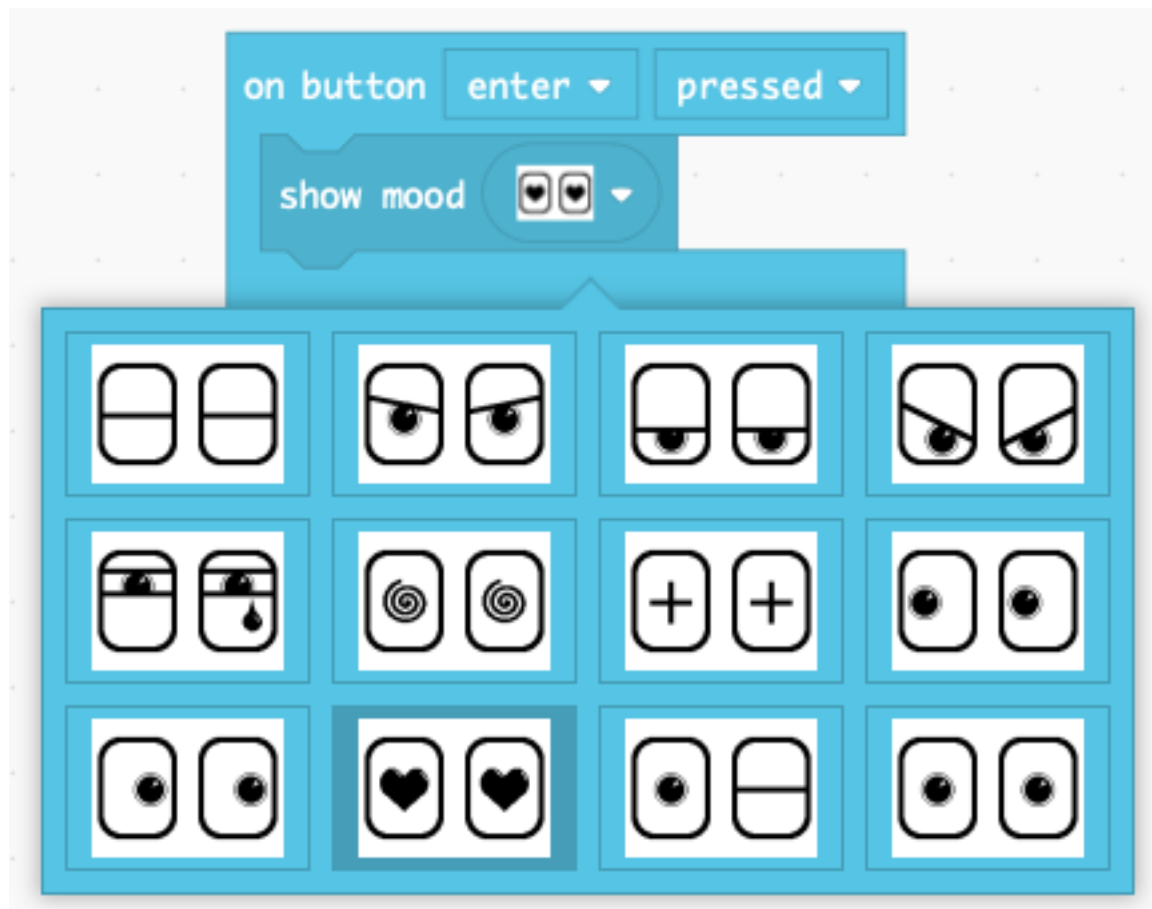
## 1.2 Show the mood

Now let's use the center button to display the mood of the robot.



To express a mood you choose from among 12 images showing different types of eyes. Each image has a different sound associated with it. Choose a mood and test it.





When you press the center button, the robot will display this image.



## 1.3 On start and forever

When you create a new project, you have already two blocks on the canvas:

- the **on start** block,
- the **forever** block.



The **on start** block executes all blocks inside exactly once, when the program starts.

The **forever** block is an infinite loop and repeats all the blocks inside until you stop the program.

The following program plays a deep tone (Middle C) at the start, and then a higher toone (Tenor C) repeatedly every 1 second.



## 1.4 Download a program

So far, you could observe the result of your programs in the simulator. But it's more fun to download them to your robot. Once you connect the EV3 via a USB cable to your computer, it appears as a hard-disk.



In order to download a program to the brick, click on the **Download** button. If you have a project called **intro** this will download a file called **intro.uf2** to your download folder. To run the file on the EV3 you must transfer the file inside the EV3 disk icon.



Inside the preferences of your navigator you can specify to which folder the files are downloaded. You can either

- automatically save to the **EV3** drive,
- ask each time for the destination.

## 1.5 Upgrade the firmware

If the EV3 icon does not appear on your desktop, you must probably upgrade the firmware (FW) of your brick. You can check the firmware on the brick under

- **Settings** top menu (all to the right)
- **Brick info** sub-menu
- **Brick FW:** V1.09H (H=Home, E=Education)

You need to have V1.10E or more.

Go to the online EV3 Device manager at the following adresse: <https://ev3manager.education.lego.com>

The message shows the outdated firmware and allows you to update.

EV3



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## Memory



 1.5 MB used     4.5 MB available

Brick version: V1.09H



Click the button below to update your firmware.

**Update Firmware**

A second message appears

## Update available

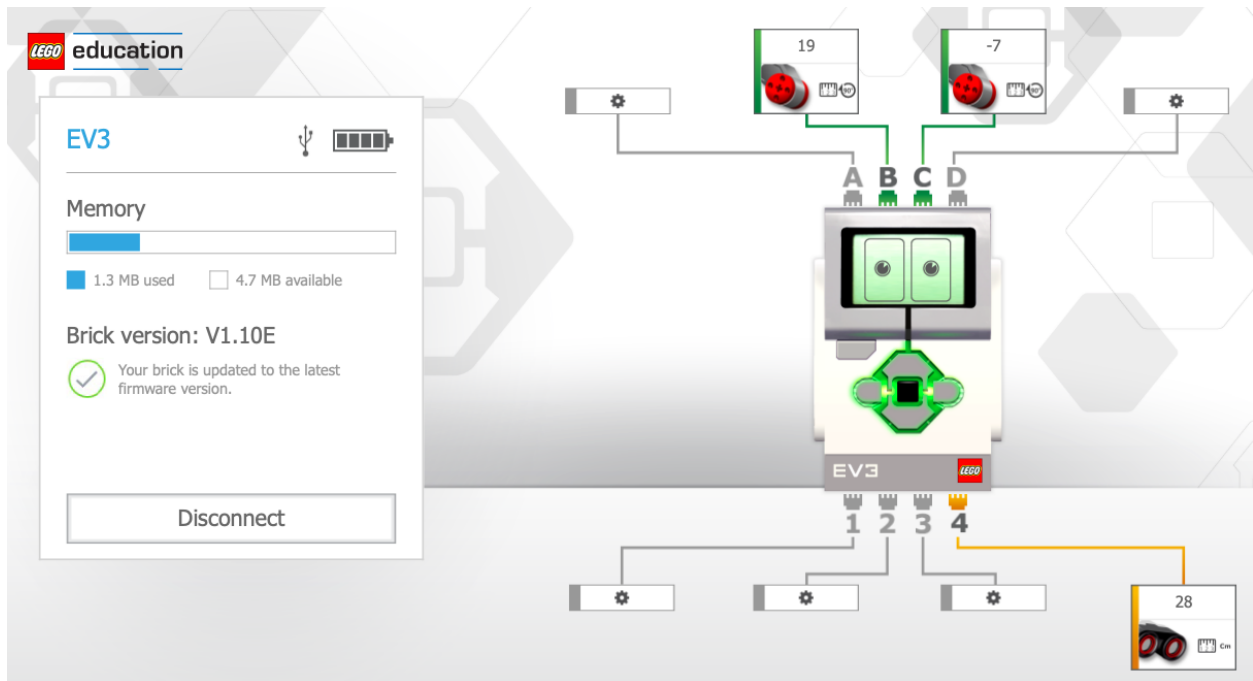


Update the brick now to improve stability and performance.



Please make sure you have at least two bars of power on the brick before updating.

Go ahead with the update and follow the instructions. Once the upgrade is finished, you will get this screen.



## 1.6 Bluetooth

It is possible to download programs to your EV3 via Bluetooth. This is an experimental feature and works on the Google Chrome and the Microsoft Edge navigator, version 77 or higher.

You need to enable this feature by going to this address:

- <chrome://flags/#enable-experimental-web-platform-features>
- <edge://flags/#enable-experimental-web-platform-features>

Then you have to link the EV3 with your computer via Bluetooth.

Once everything installed, click on the **Download** button. This window will open.

## Download to your EV3



## First time here?

You must have version 1.10E or above of the firmware



[Check your firmware version here and update if needed](#)



**1** Connect the EV3 to your computer with a USB cable

Use the miniUSB port on the top of the EV3 Brick



**2** Move the .uf2 file to the EV3 Brick

Locate the downloaded .uf2 file and drag it to the EV3 USB drive

**Bluetooth**

lego-test.uf2

**I got it**

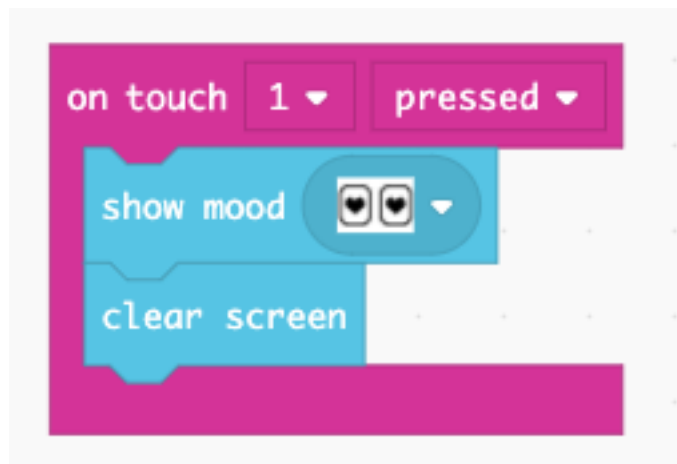
Then click on the blue **Bluetooth** button then select the select indicated serial port. You must stop any running program on the EV3 before you can download via Bluetooth.

The EV3 has multiple sensors such as:

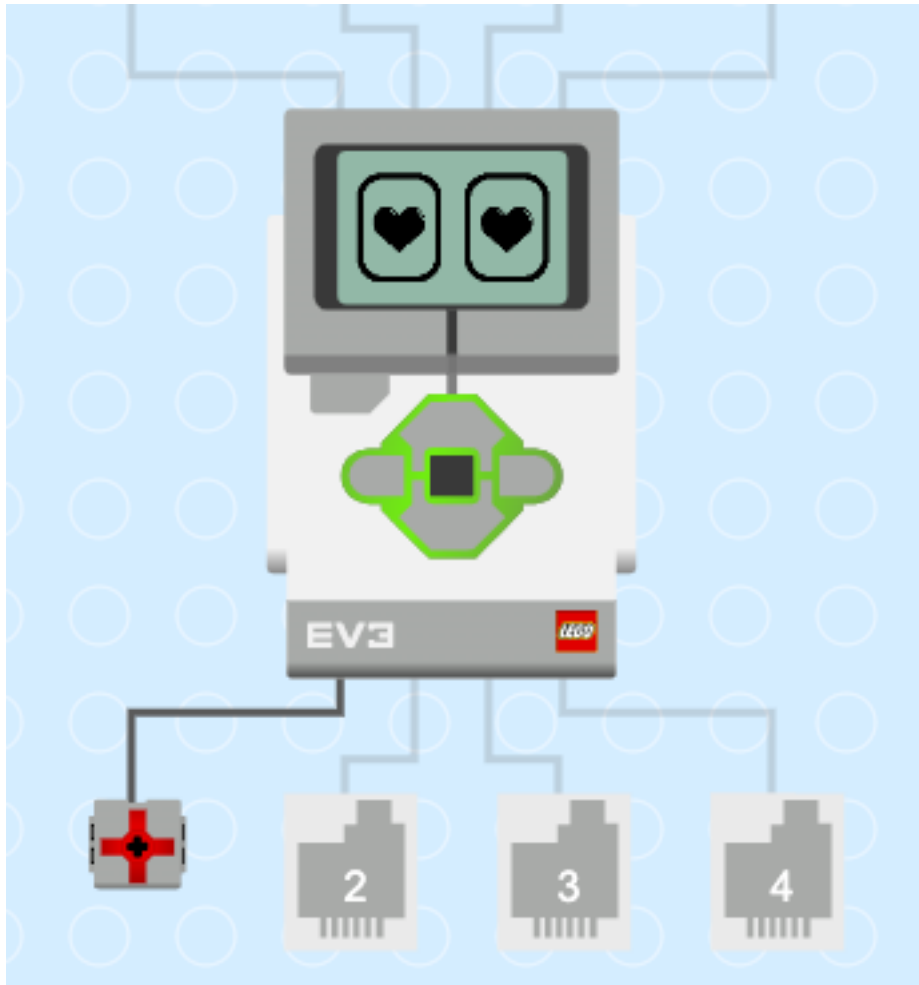
- touch sensor
- color sensor
- light sensor
- gyro sensor
- ultrasonic sensor

### 2.1 Touch sensor

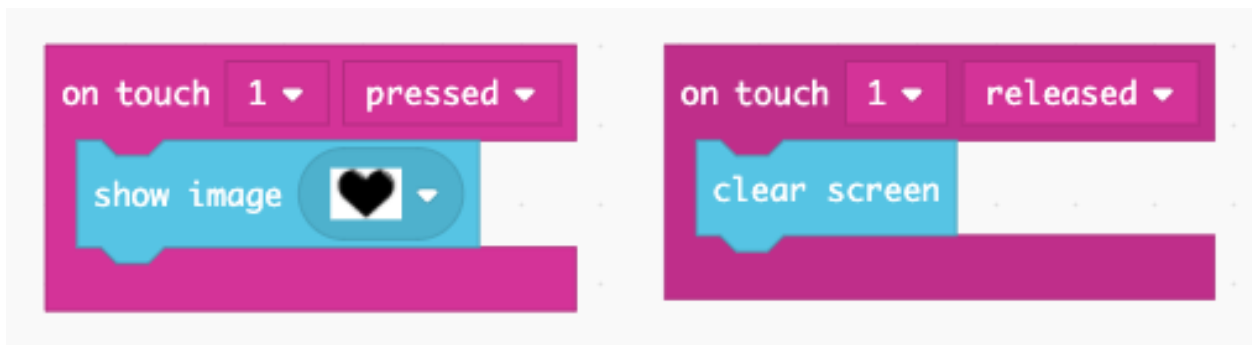
Each time you press the touch sensor, the eyes with the hearts appear and a sound is played.



You can test this inside the simulator. When you click with the mouse on the touch sensor icon, the image and the sound appear.



Connect the touch sensor to port 1. When you press the touch sensor, a heart is displayed. When you release the touch sensor, the screen is cleared.



## 2.2 Colour sensor

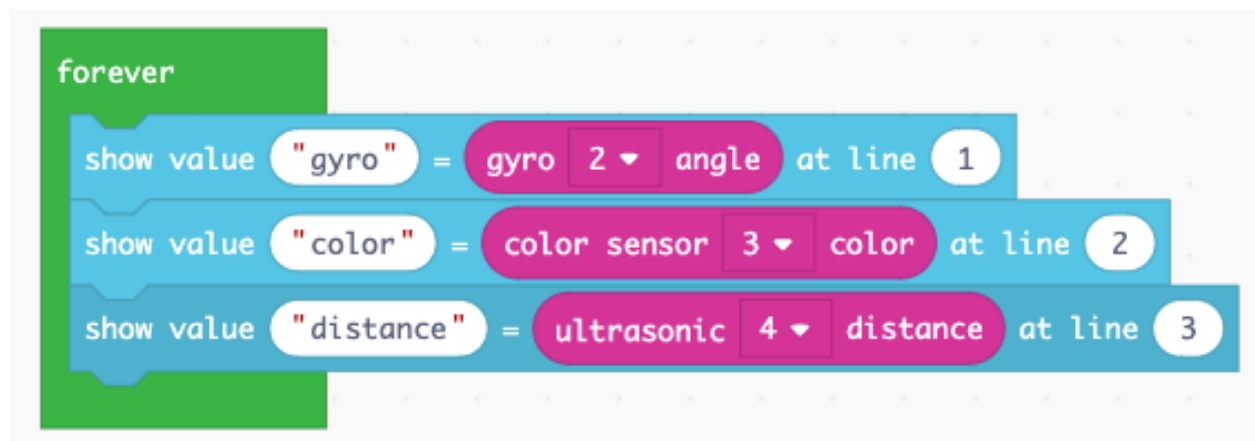
Connect the color sensor to port 3. When you place a blue LEGO brick in front of the sensor, it says *blue*. When you place a red LEGO brick in front of the sensor, it says *red*.



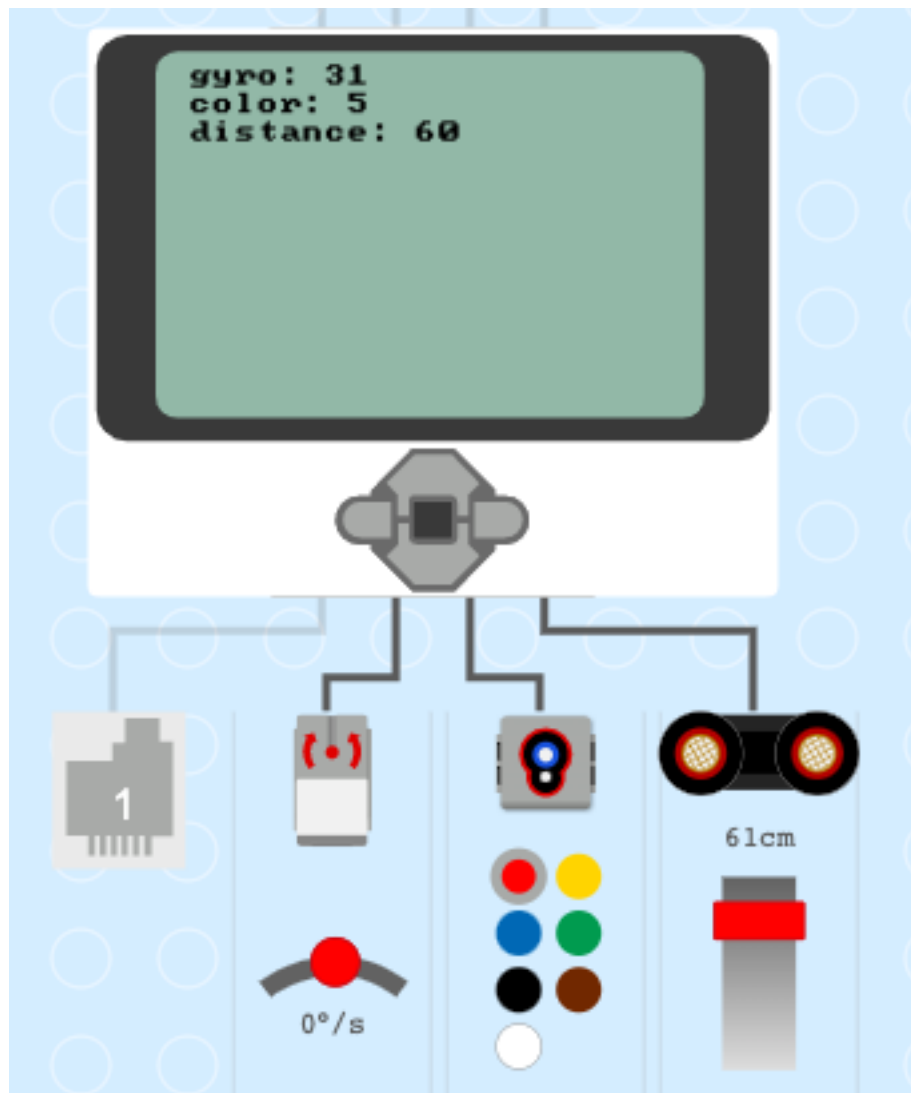


## 2.3 Show values on the screen

You can use a **forever** loop to write the sensor values to the screen.



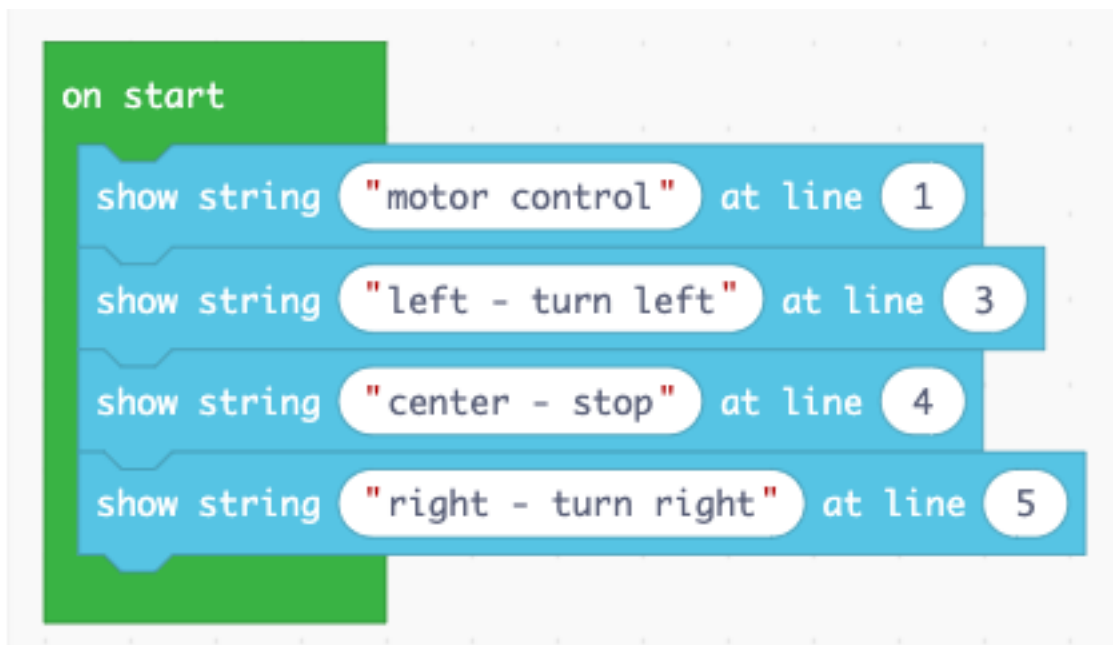
In the simulation in the navigator window you can set different values for the sensor and display the values on the first three lines of the screen.



Motors let you move your robot.

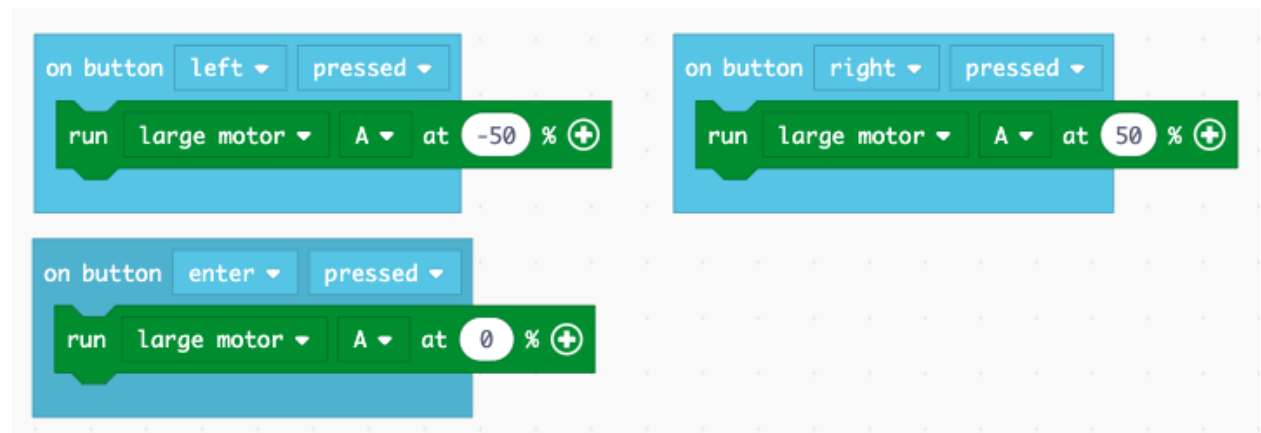
### 3.1 Display a welcome screen

Let's write some explanations to the display. It is always good to give the user some hints about what the program is doing. Let's explain how to use the 3 buttons to control the large motor on port A.

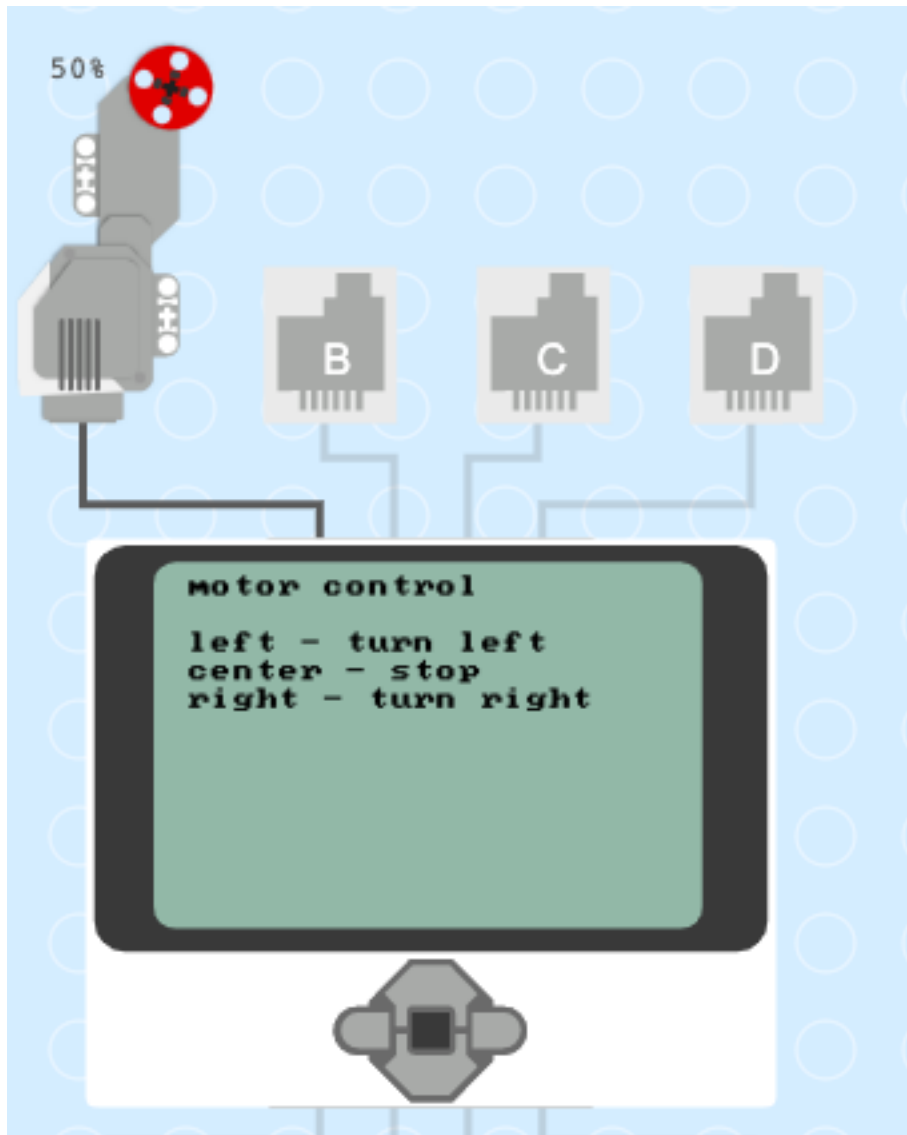


## 3.2 Move a motor

Now let's use the buttons to make the motor move.



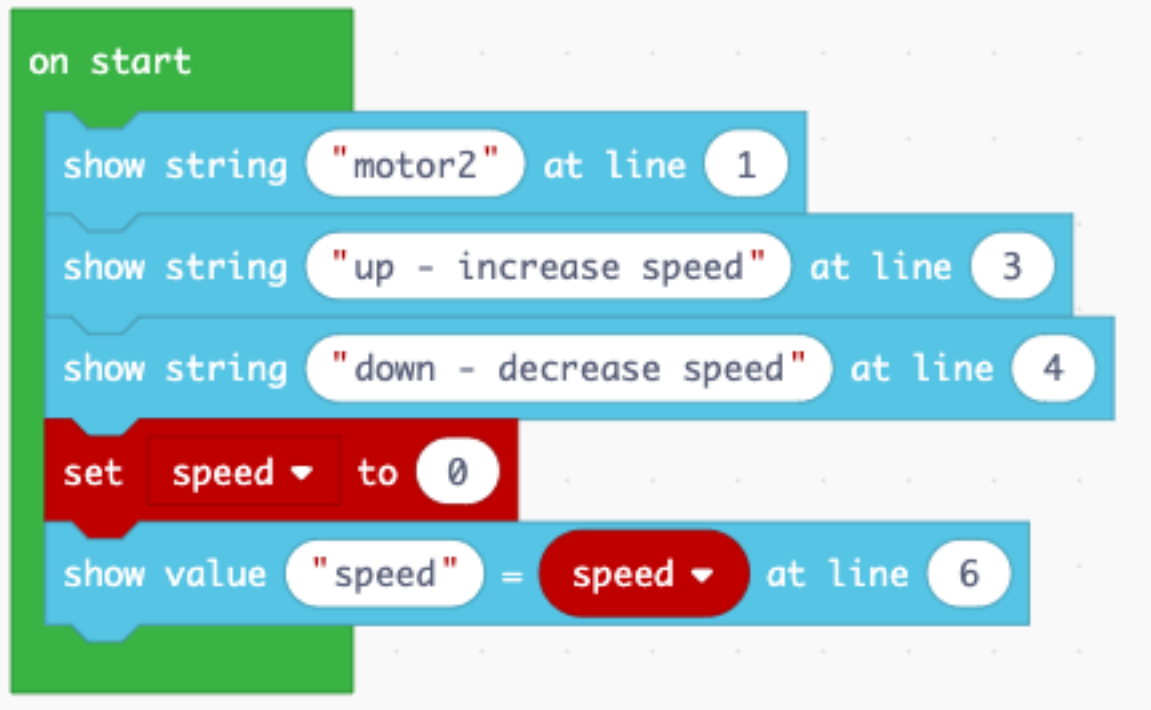
Before downloading the program to the brick, you can test it in the simulation.



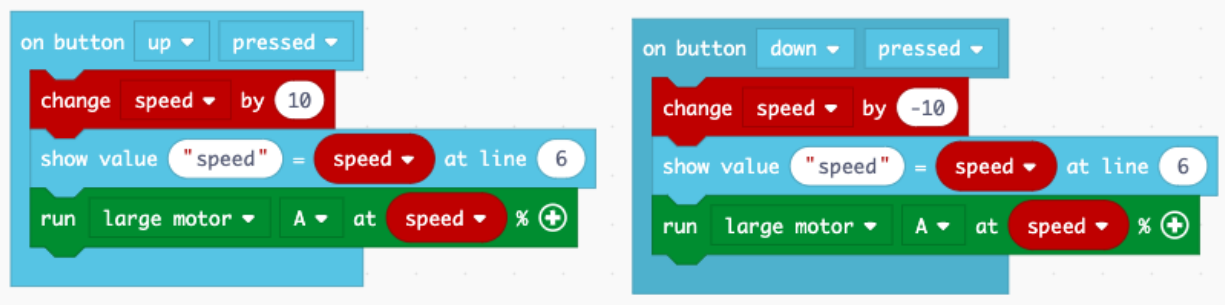
### 3.3 Change the motor speed

Make a new program called **motor2**. This time we will include that name in the welcome screen.

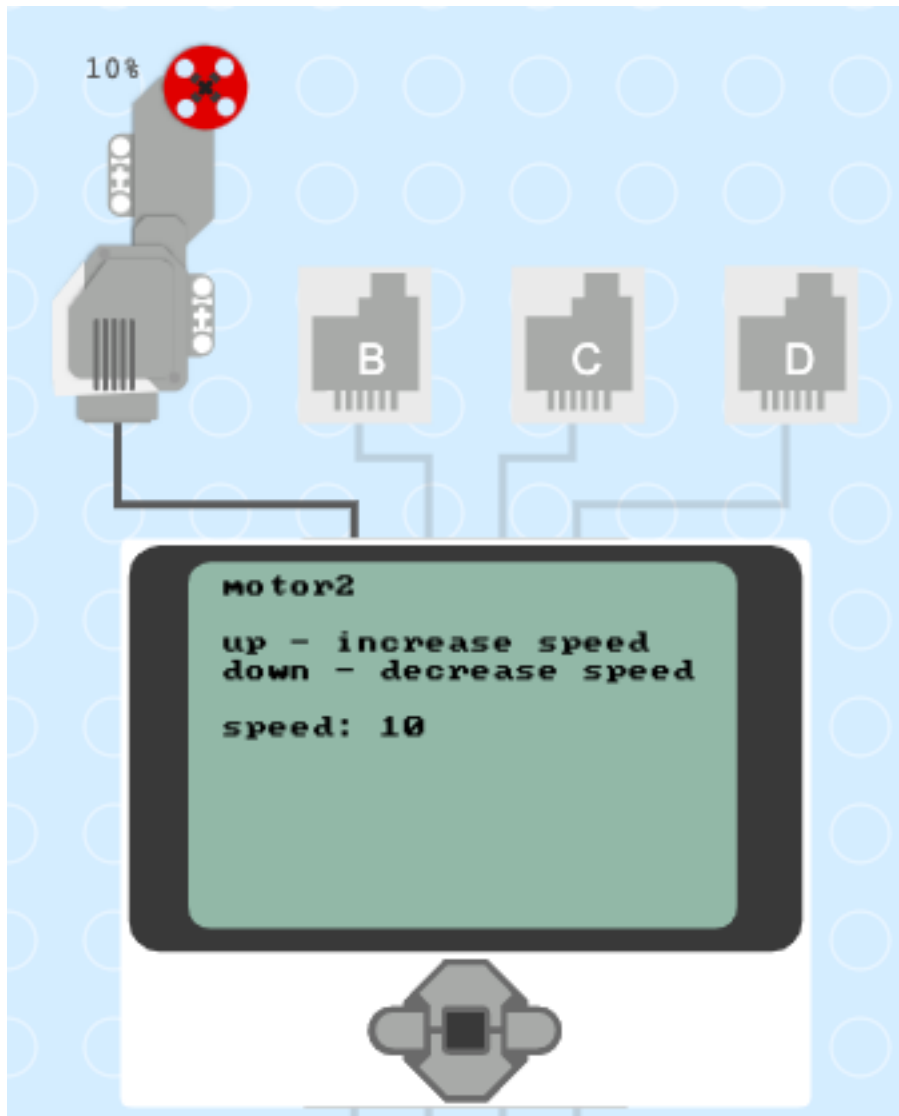
We are going to use the **up/down** button to increase or decrease the speed. For this we will need a variable **speed**.



When pressing the **up** button we increase the **speed** variable by 10. When pressing the **down** button we decrease the **speed** variable by 10.



You can try this program in the simulator before you download it to the brick.



motor2.uf2



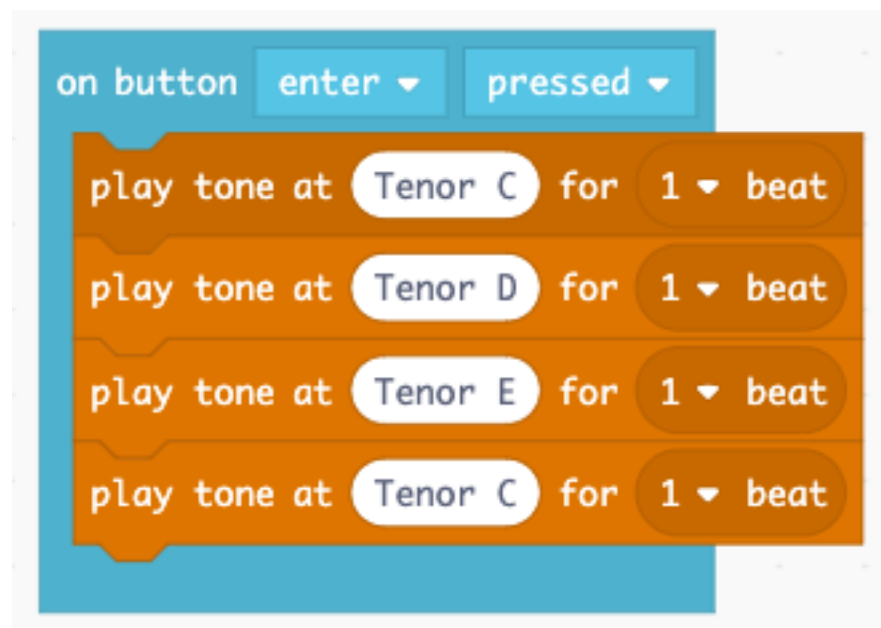


The EV3 brick can produce sounds.

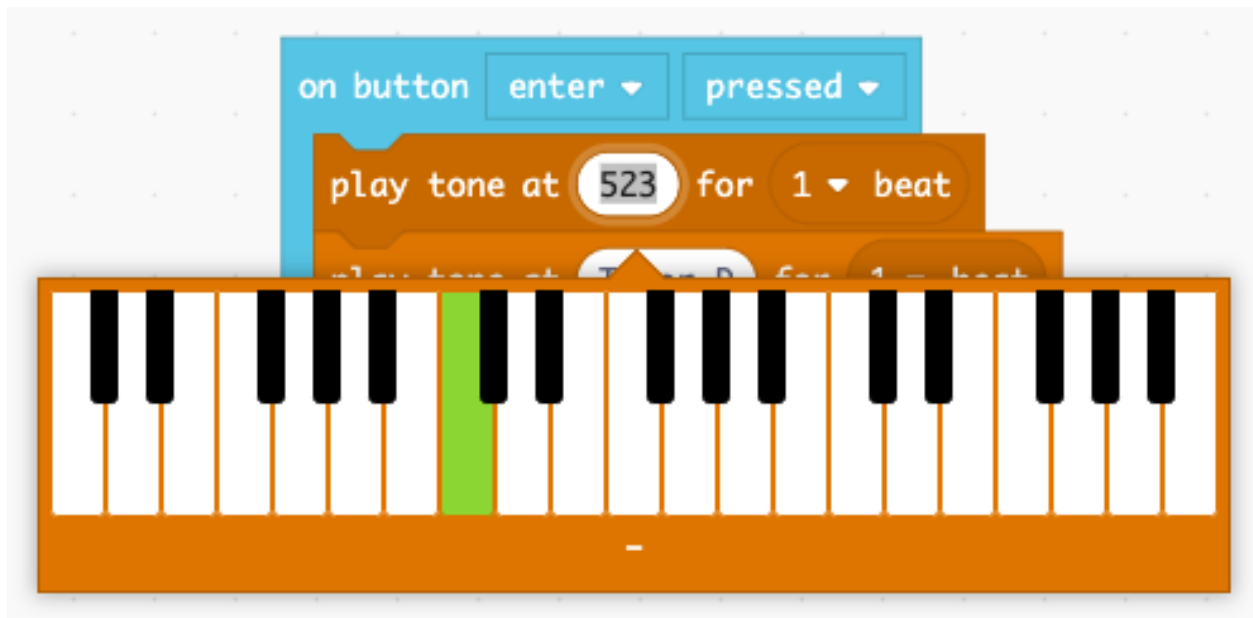
### 4.1 Play a melody

Let's program the musical score of *Frère Jacques*, a popular French song.

We start playing the first measure when pressing the center button.

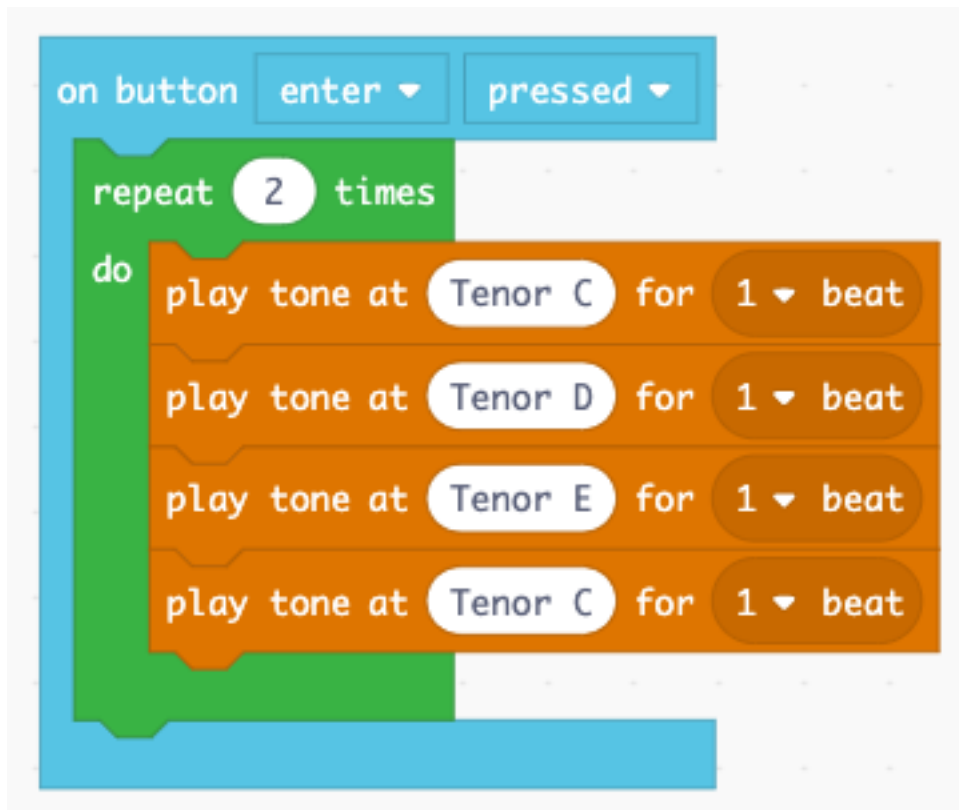


To select the note to play, just click on the name, for example *Middle C*, and select another note on the piano scale keyboard.



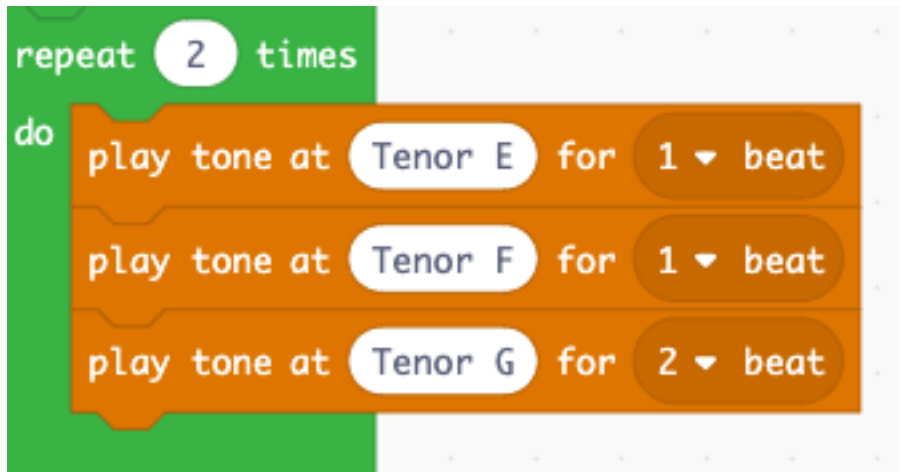
## 4.2 Repeat a melody

To repeat a part of the melody, place it inside a loop. For example the first measure needs to be repeated twice.

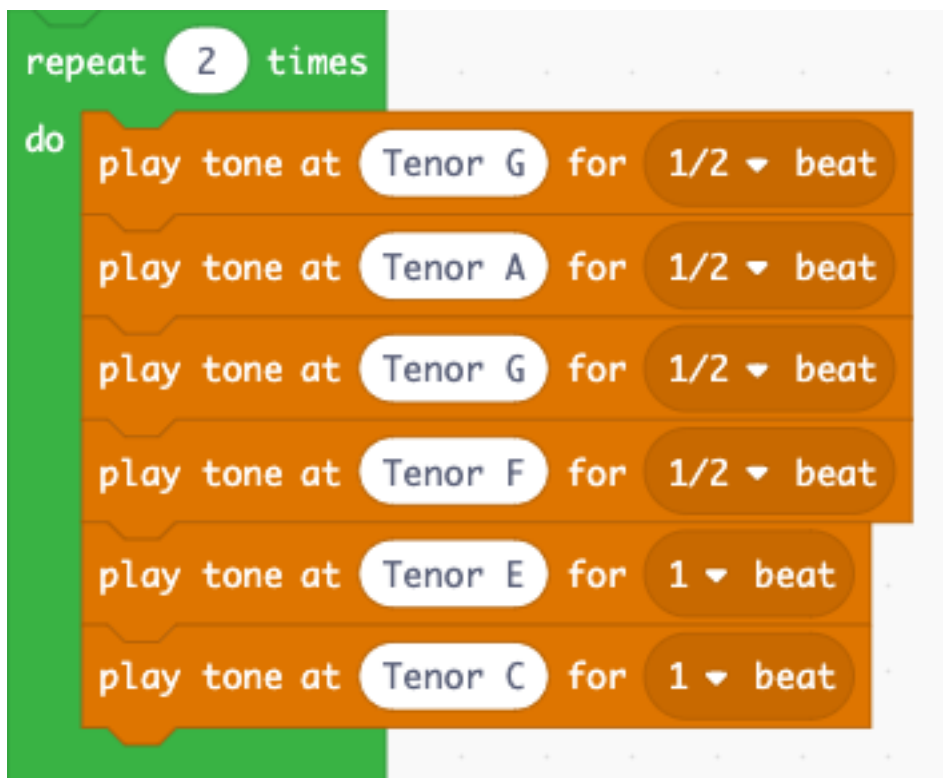


## 4.3 Longer and shorter notes

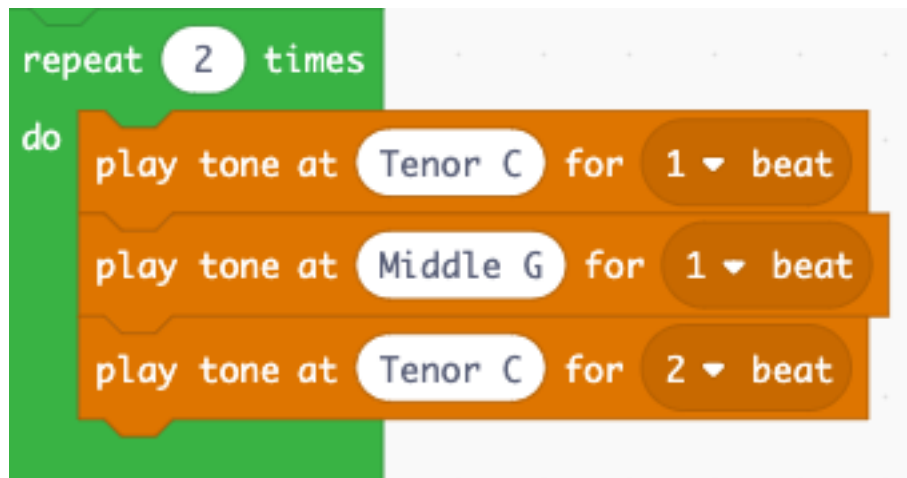
So far our notes had a duration of one beat. We can increase to the duration to two beats, which is required in the second measure.



The next measure has 4 notes with only half a beat.

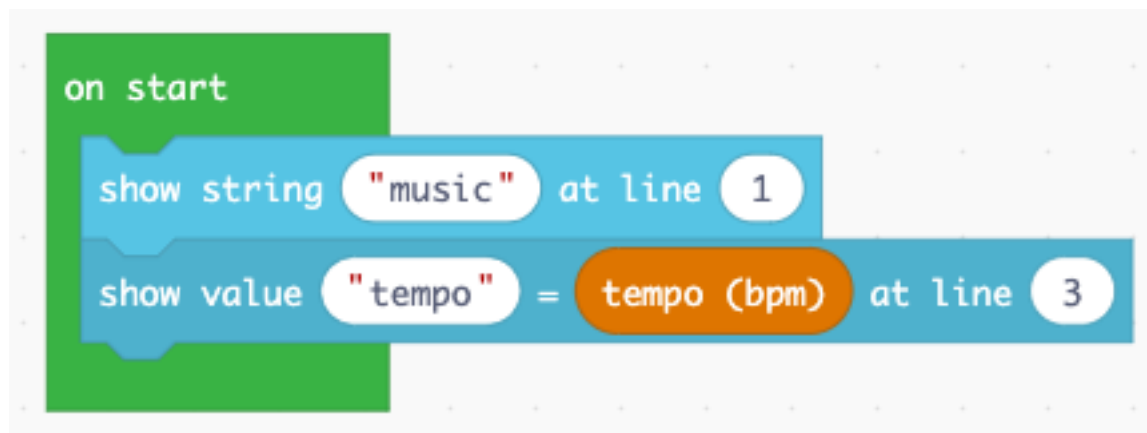


The last measure has long note again.



## 4.4 Change the tempo

The next part allows you to change the tempo. The tempo of the music is measured in **beats per minute** (bpm). Let's make a program to display the initial tempo.

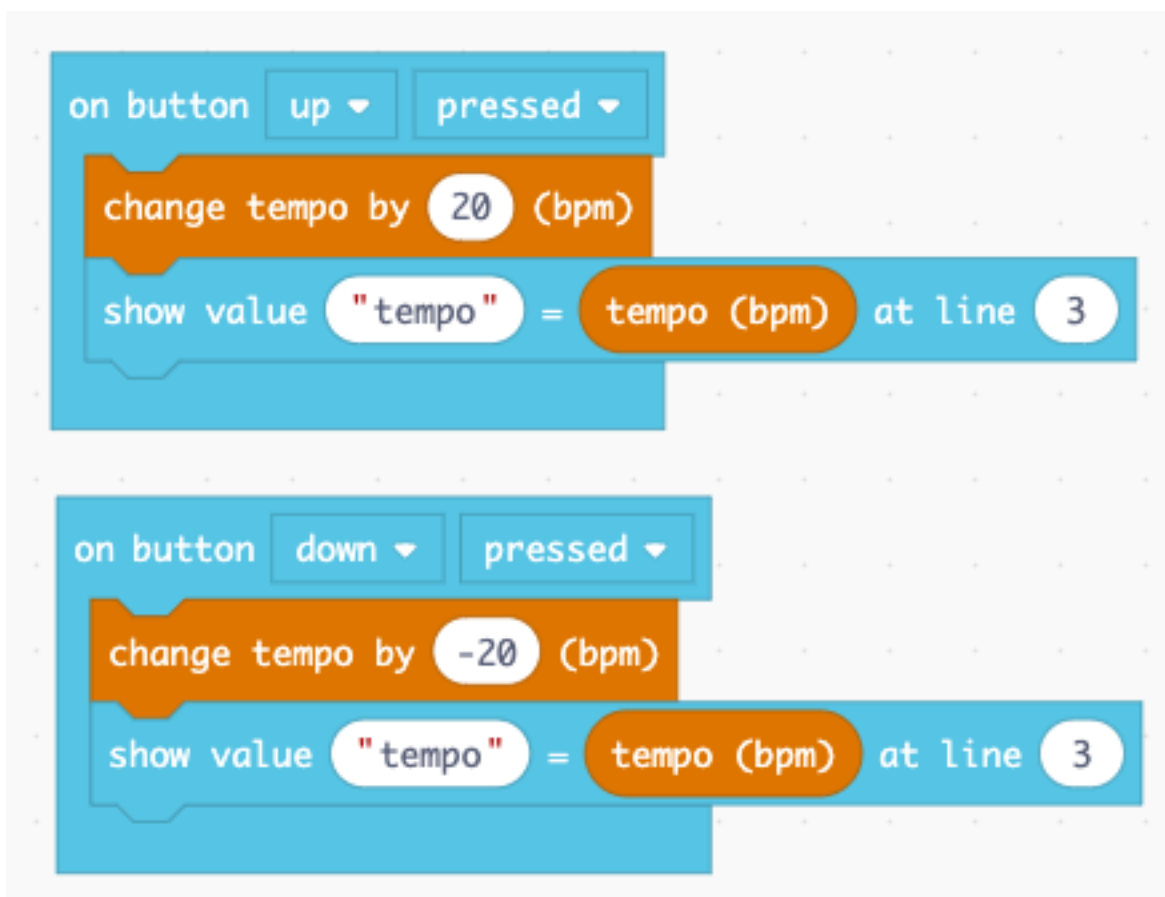


When you run the simulation you see that the temp is 120 bpm.



Now let's program two buttons to increase and decrease the tempo.

- The **up** button makes the tempo faster by 20 bpm (beats per minute).
- The **down** button decreases it by 20 bpm.



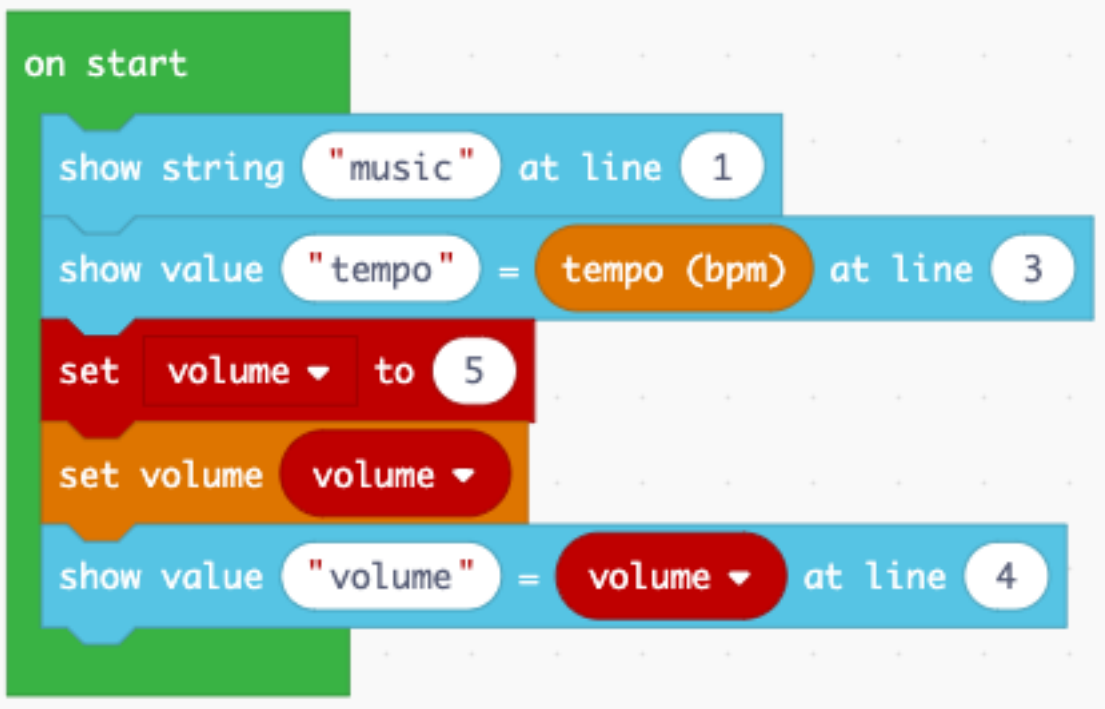
## 4.5 Change the volume

To keep track of the value we need to create a variable.

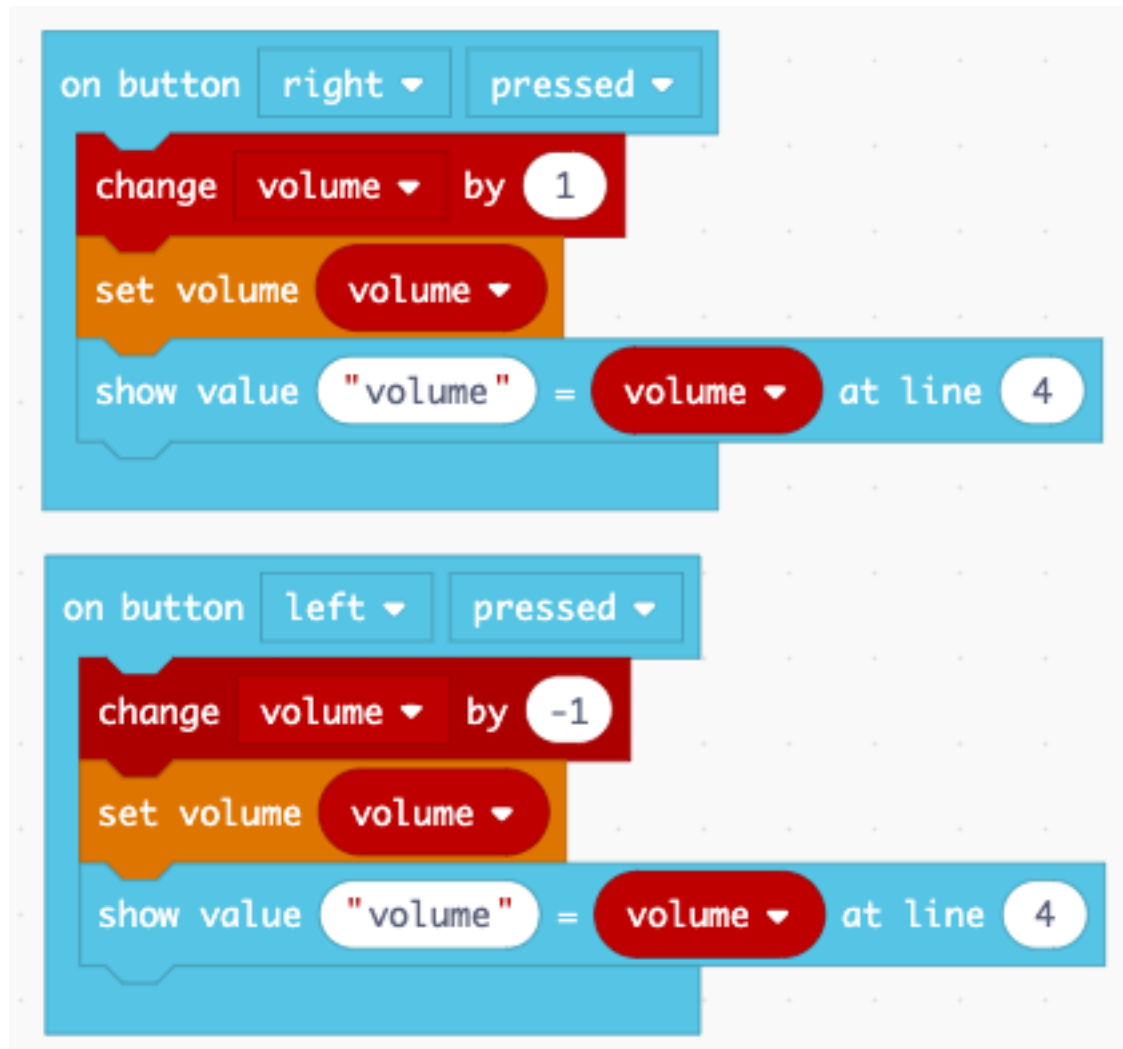
### New variable name:

volume

We can **set this variable** to 5 in the **start** block. Then we set the volume using this variable. And finally we display its value on line number 4.



Finally we program the **left/right** buttons to increase or decrease the volume.



You can download this file.

lego-music.uf2

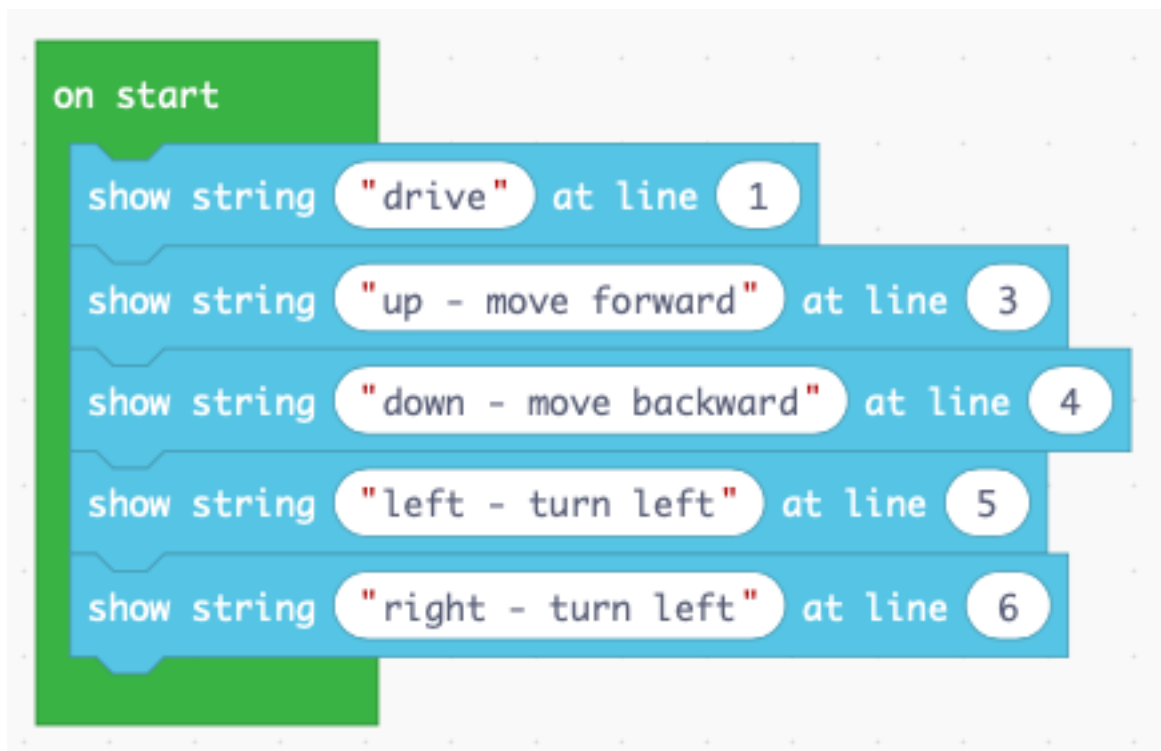




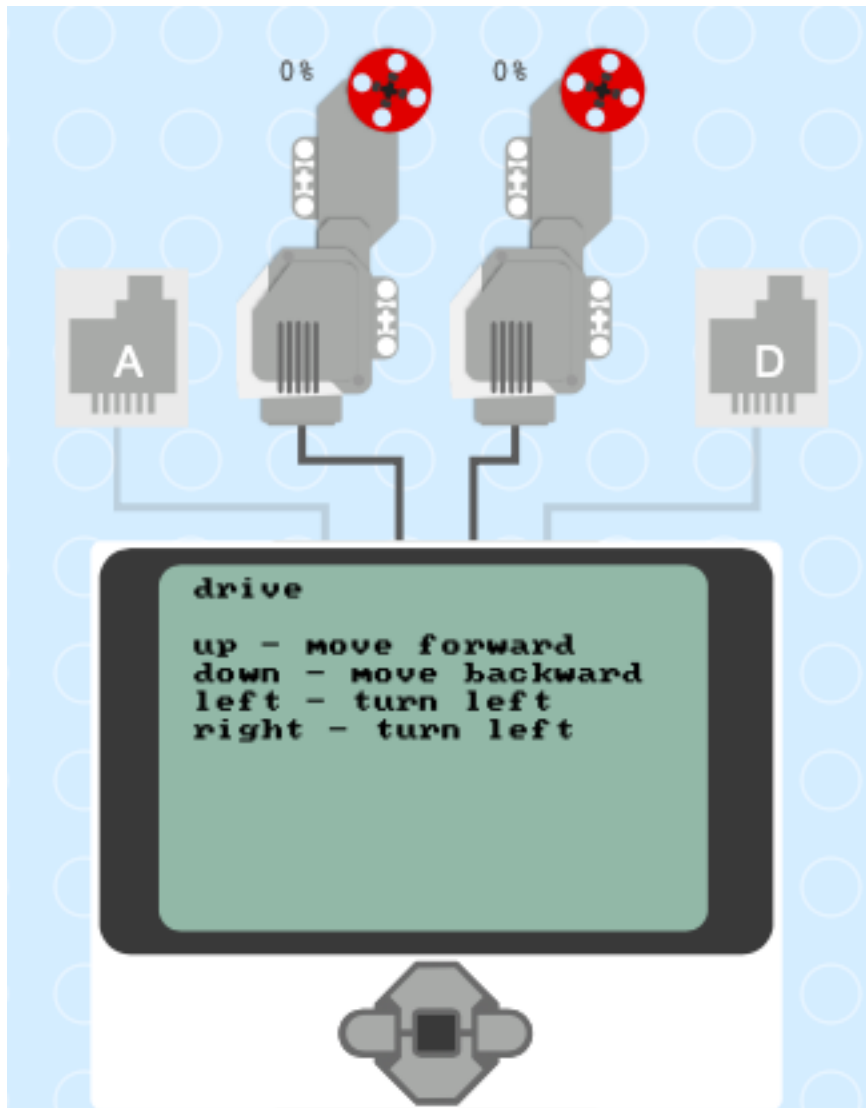
The EV3 has special commands for controlling the two large motors for moving the robot around.

## 5.1 Use the buttons to drive

First we display a small user guide on the EV3 display.

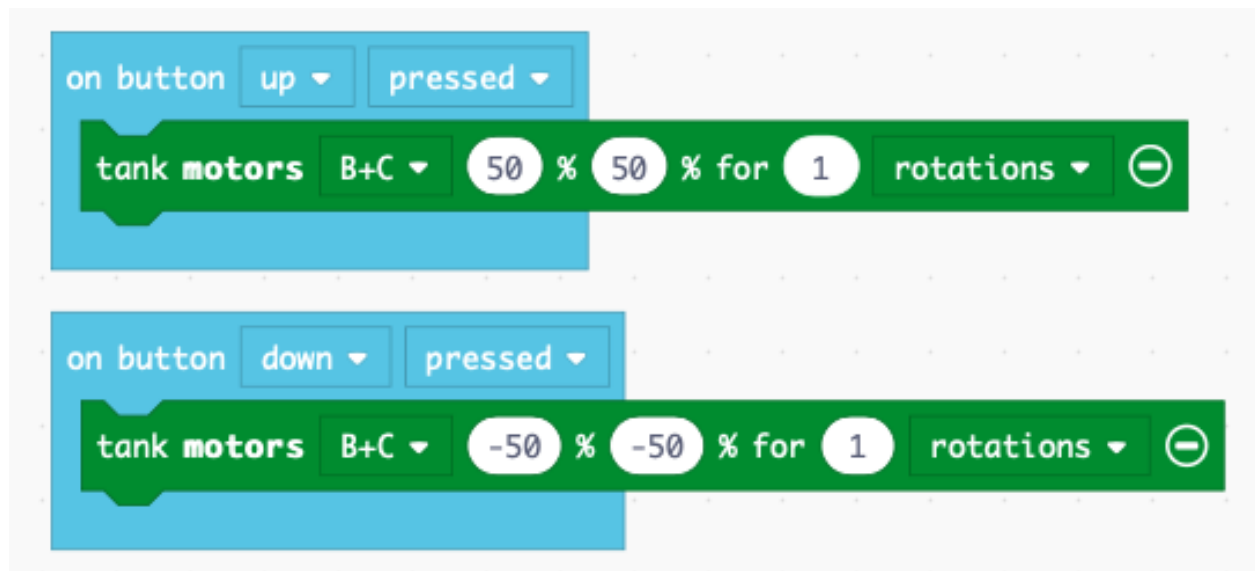


At this point we can test the display and the presence of the two large motors.



## 5.2 Move forward and backward

The robot moves forward if both motors turn forward (50%) at the same speed. The robot moves backward if both motors turn backward (-50%) together.



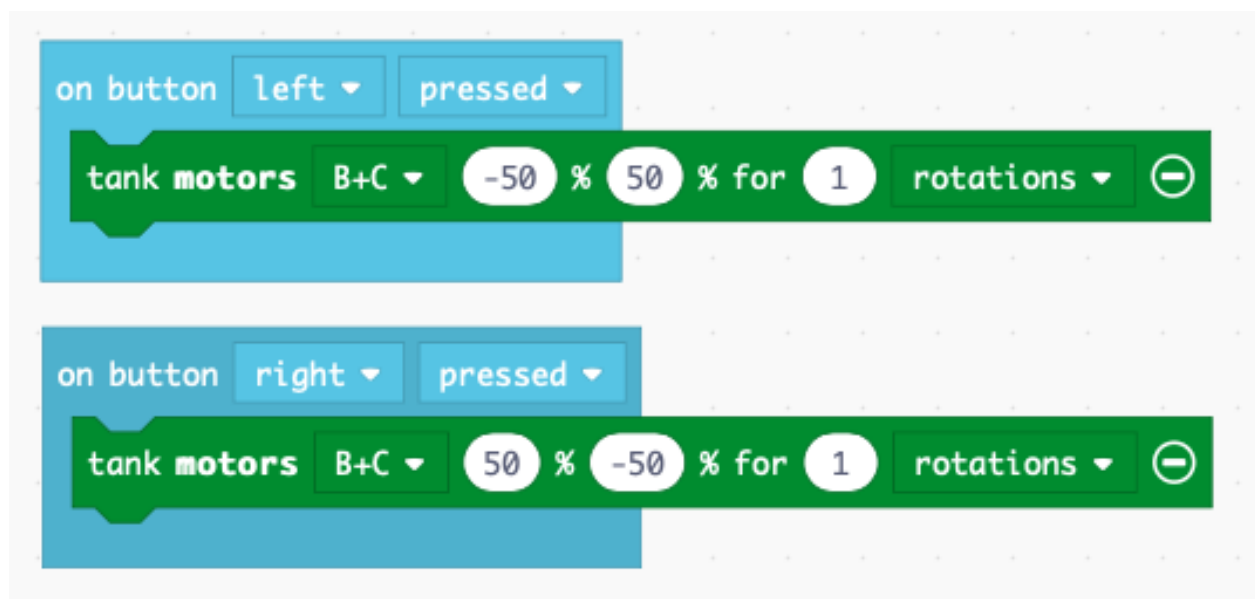
### 5.3 Turn left and right

The robot turns left if

- motor B goes backwards (-50%)
- motor C goes forward (50%)

The robot turns right if

- motor B goes forward (50%)
- motor C goes backward (-50%)

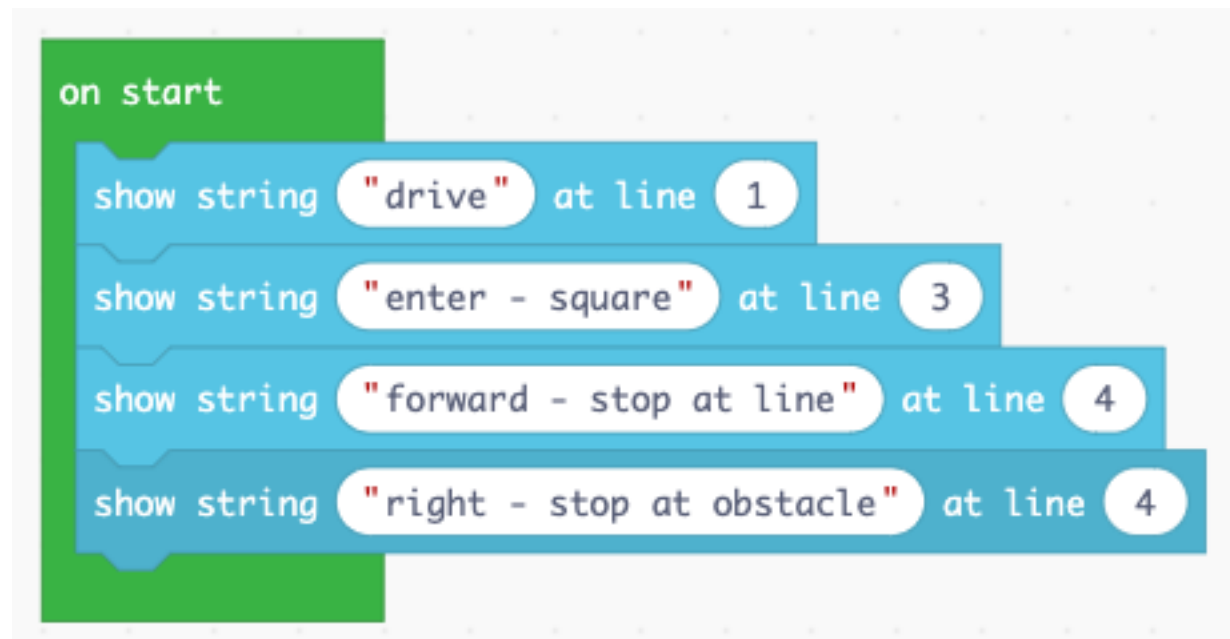


## 5.4 Display a start screen

It's always good practice to display on the screen what the robot is doing. We place that code inside the **on start** block.

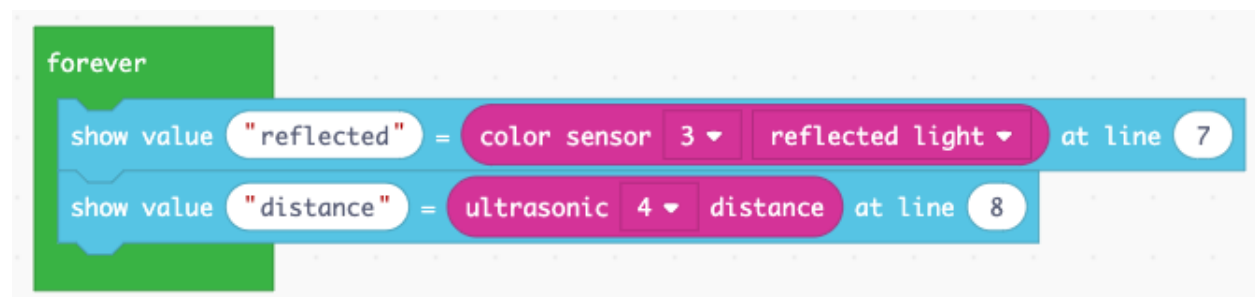
This robot can execute 3 behaviors:

- drive a square
- advance till it reaches a dark line or the border of the table
- advance till the distance sensor detects a nearby object



## 5.5 Display the sensor values

It is useful to display the measured sensor values on the screen. We place this code into the **forever** block, as we want to do these measurements continuously.

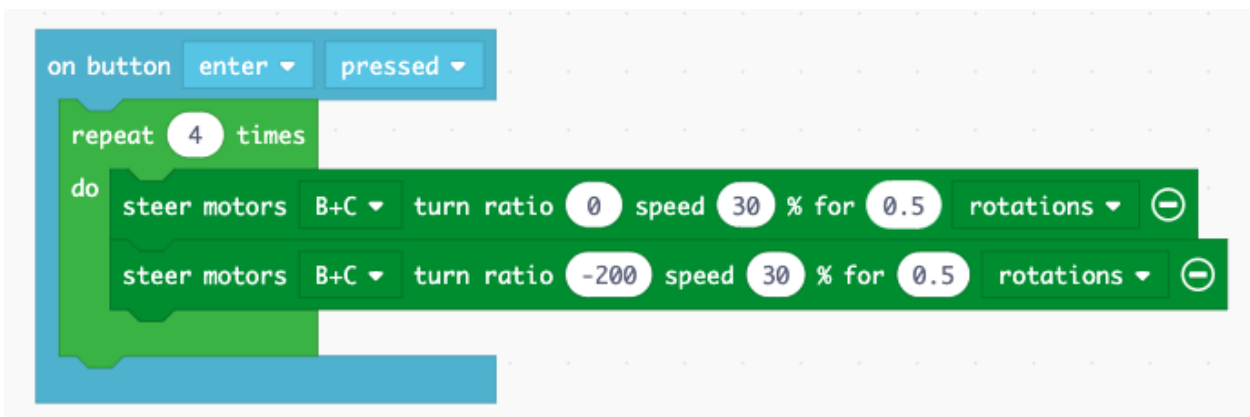


The result on the screen will be this



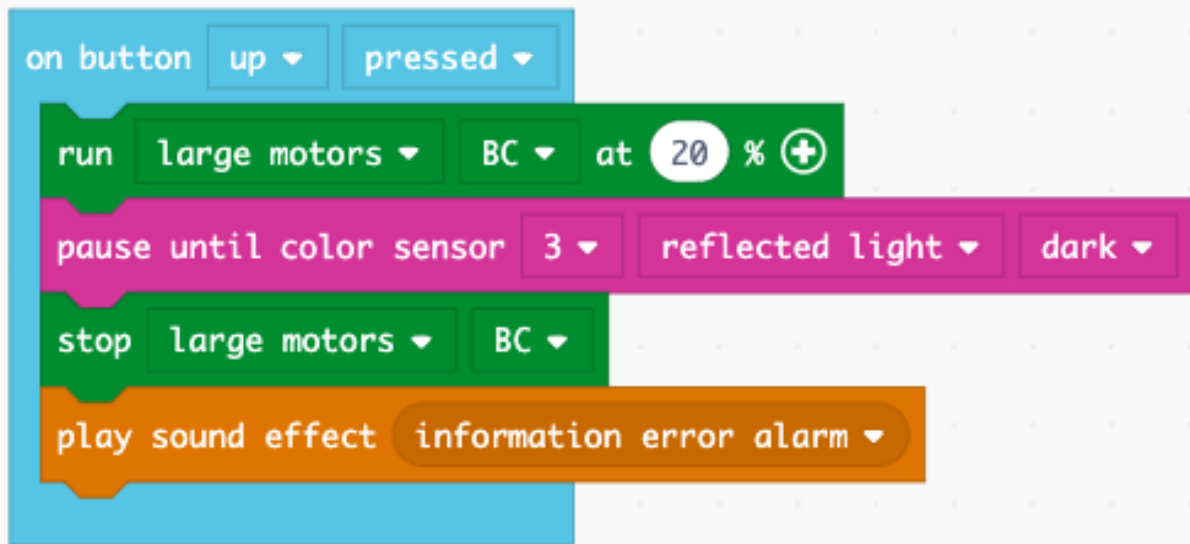
## 5.6 Drive along a square

We repeat 4 times inside a loop a straight segment and a 90-degrees turning segment. The robot will execute a square trajectory.



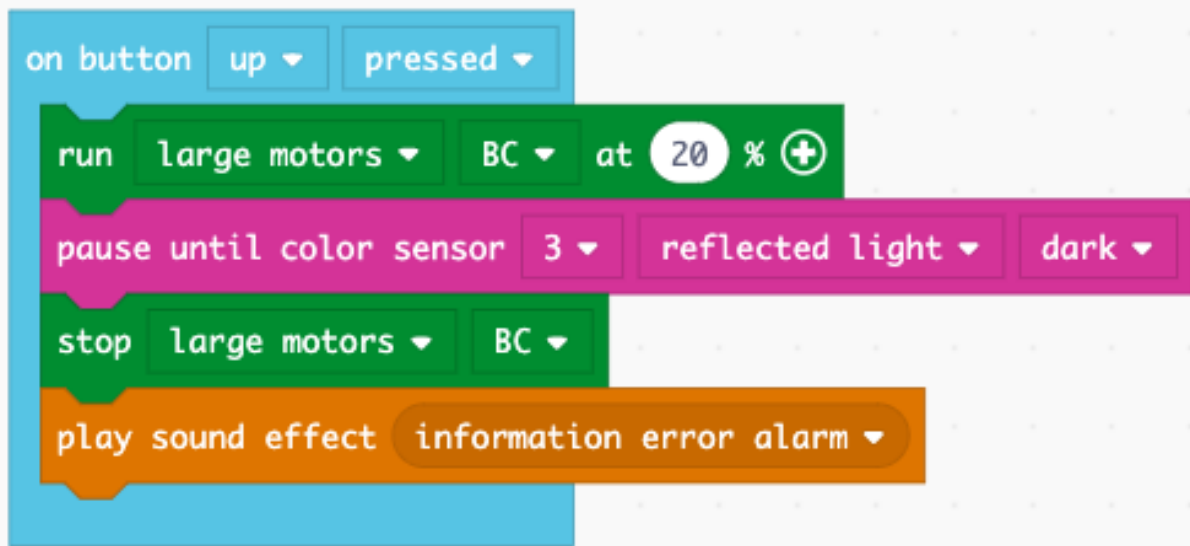
## 5.7 Stop at a line

We program the light sensor to make the robot stop when the light intensity goes down.



## 5.8 Stop at an obstacle

We program the ultrasonic distance sensor to stop the robot when an object is near.



You can download this file and import it into MakeCode.

lego-drive.uf2

## CHAPTER 6

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### Indices and tables

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- `genindex`
- `modindex`
- `search`