Introduction

Edison is your new robot buddy who will teach you about electronics, programing and robotics in a fun and engaging way.

He's equipped with all the sensors, outputs and motors needed to introduce you to the amazing world of robotics.

That's great, but what is robotics? Well that's not an easy question to answer. Edison's creator, Brenton O'Brien says *"a robot is a machine that can behave autonomously"* . This means that a robot can think or make decisions on its own and act on those decisions. Many other people have different definitions, but we like this one as it's nice, simple and applies to what you're about to learn.

Edison the LEGO compatible robot

Robotics wouldn't be possible without electronics, so Edison has his own electronics and you can see it all through his transparent top. There are resistors, capacitors, transistors, motors and more, but the most important electronic part is Edison's microcontroller.

Edison's microcontroller

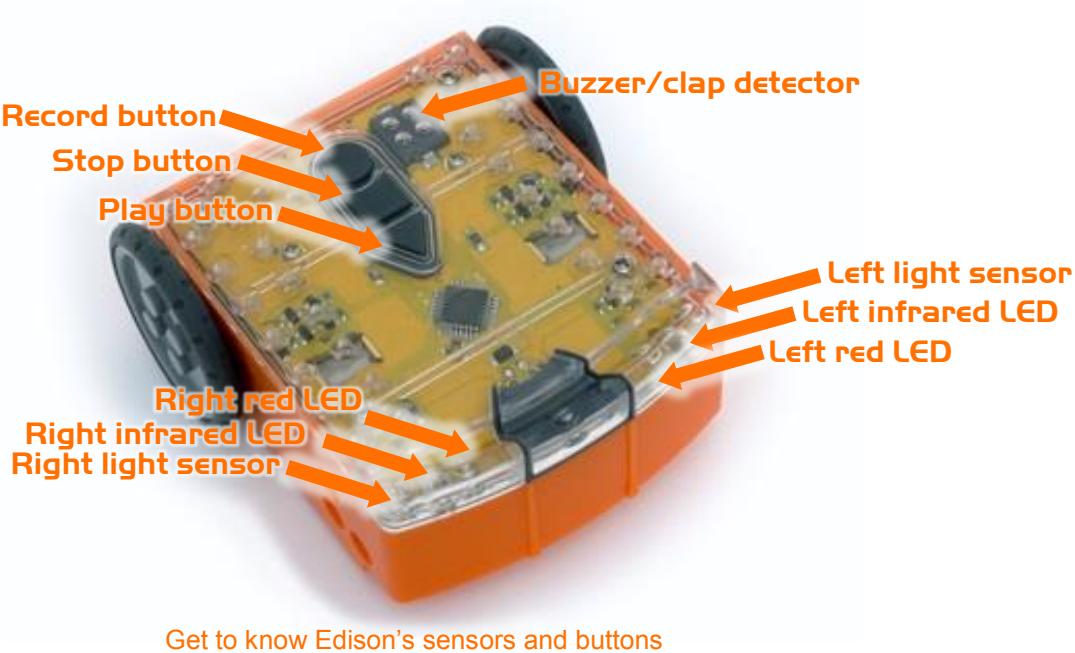
The microcontroller is like Edison's brain. It's where all his '*thinking*' happens. Edison's microcontroller is very similar to the processor chip inside a computer, only much smaller. And just like a processor chip in a computer, Edison's microcontroller has programs. The programs allow Edison to make decisions and '*think*' for himself.

Edison comes with pre-loaded programs that are activated by driving over special barcodes. Here is a sample barcode that activates Edison's line tracking program.

A barcode that activates Edison's line tracking program

Get to know Edison

To use Edison you're going to need to know where all his sensors are and what his three buttons do. Have a look at the images below. You may need to come back and have another look as we go through the EdVentures.



Get to know Edison's sensors and buttons

Play button – Start program
Stop button – Press to stop a program
Record button – 1 press = download program, 3 presses = read barcode

Edison's power switch and line tracking sensor

Edison's line tracking sensor is made up of two parts a red LED light and a light sensor. The red LED shines light on the ground, if the ground is white and therefore, reflects light then the light sensor will get a high light reading. If the ground is black and therefore, does not reflect light then the light sensor gets a low light reading.

The EdComm cable is used to download programs to Edison. It connects into the headphone socket on your computer or tablet.

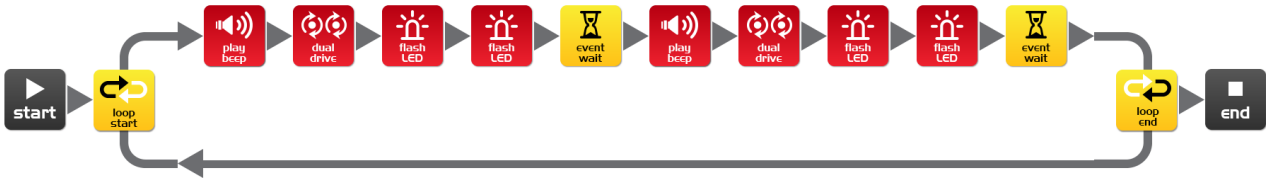
EdComm programming cable

Installing EdWare

The EdWare programming software is available for Windows, Mac, Linux, iOS, Android and Raspberry Pi. Point your internet browser to meetedison.com/downloads to obtain the installation files and instructions on how to install EdWare for your operating system.

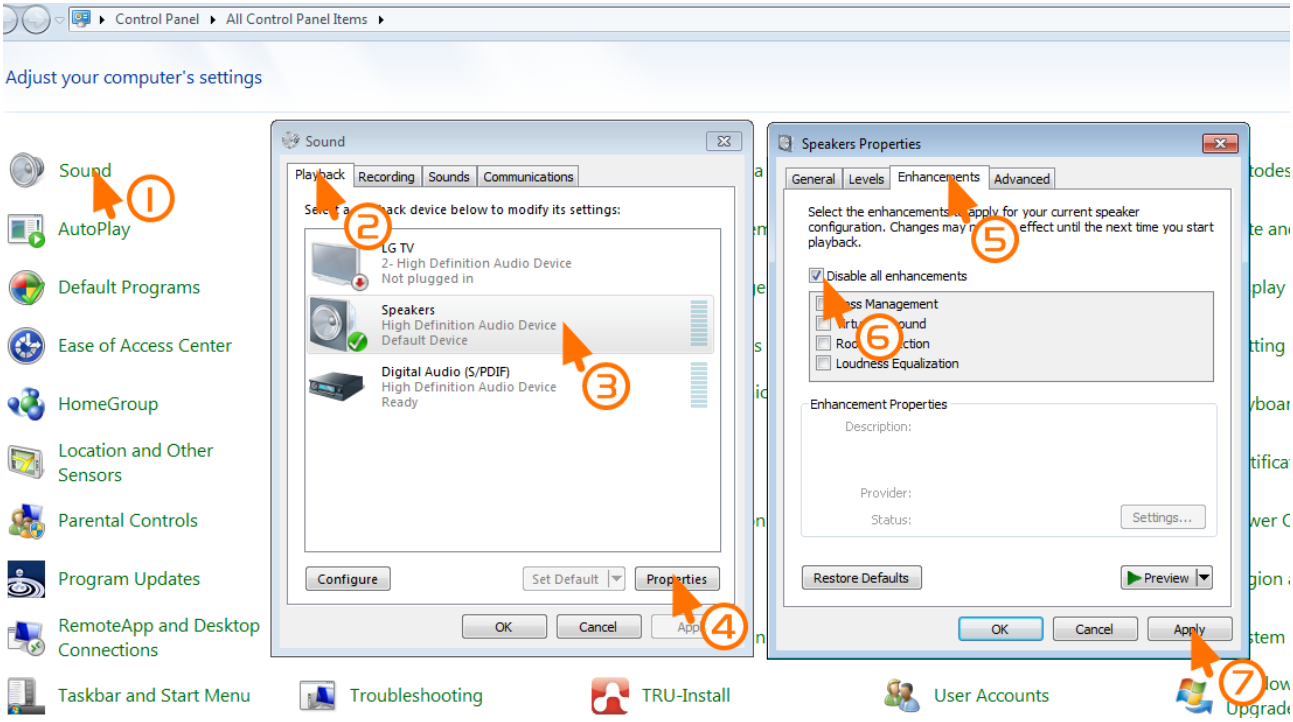
Downloading a program

Once you have installed EdWare on your computer or tablet open the 'TestProgram.edw' file (File>open: EdWare/My Programs). A program that looks like the one below should appear.



Test program

Connect the EdComm cable to the headphone socket on your device and turn up the volume to full. If you are using Windows check that audio enhancements are disabled. To do this go into Control Panel and follow the illustrated steps below.



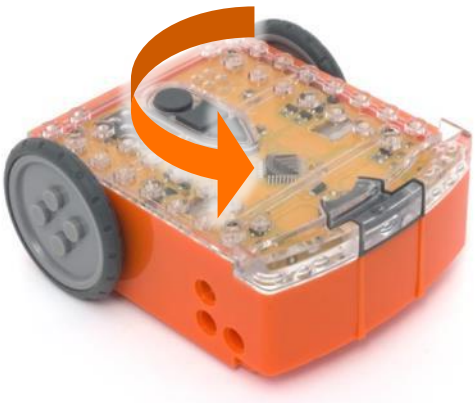
How to disable all enhancements in Windows 7

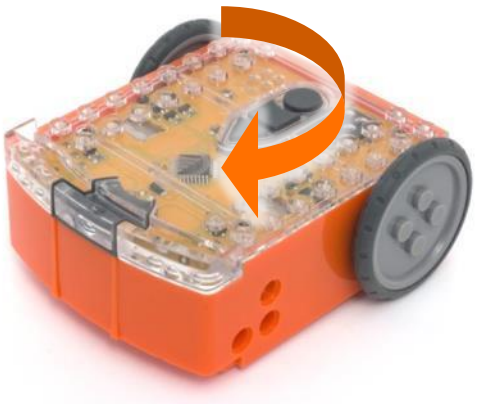
Plug the other end of the EdComm cable into Edison as shown.

To download the test program follow these steps:

1. Press Edison's record (round) button once
2. In EdWare press the 'Program Edison' button and then 'Start Download'
3. Press Edison's play (triangle) button to start the program

Edison will now run the test program and spin left and right, flashing his lights and beeping.

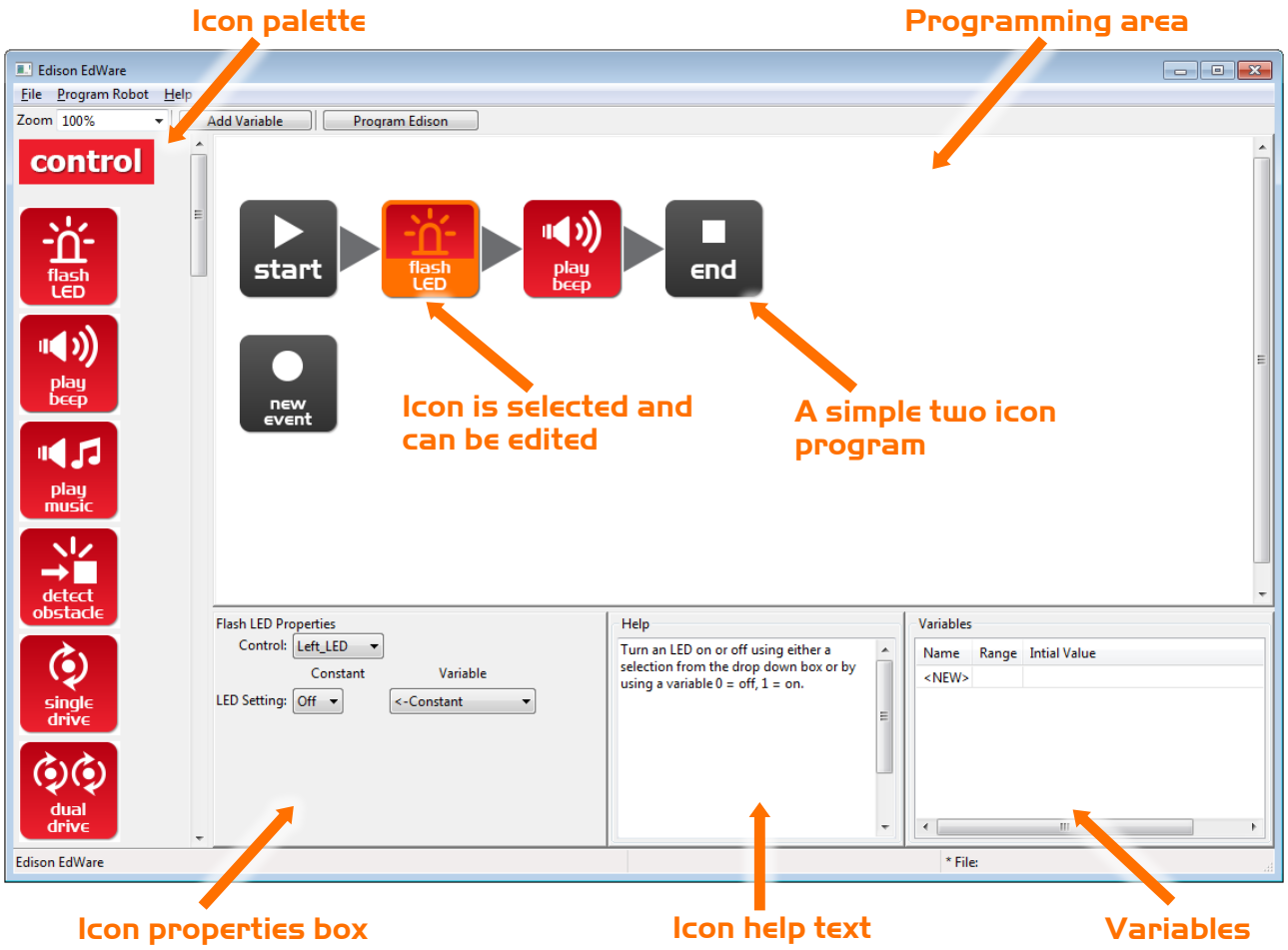




Meet EdWare

Before we get into the EdVentures, let's take a quick tour of EdWare.

Here is what EdWare for Windows looks like. EdWare for the other operating systems looks very similar.



To start programming, grab icons from the palette on the left and drag them onto the programming area. Place the icons between the 'start' and 'end' icons.

Select an icon and adjust the settings in the icon property box to control how Edison responds to that icon.

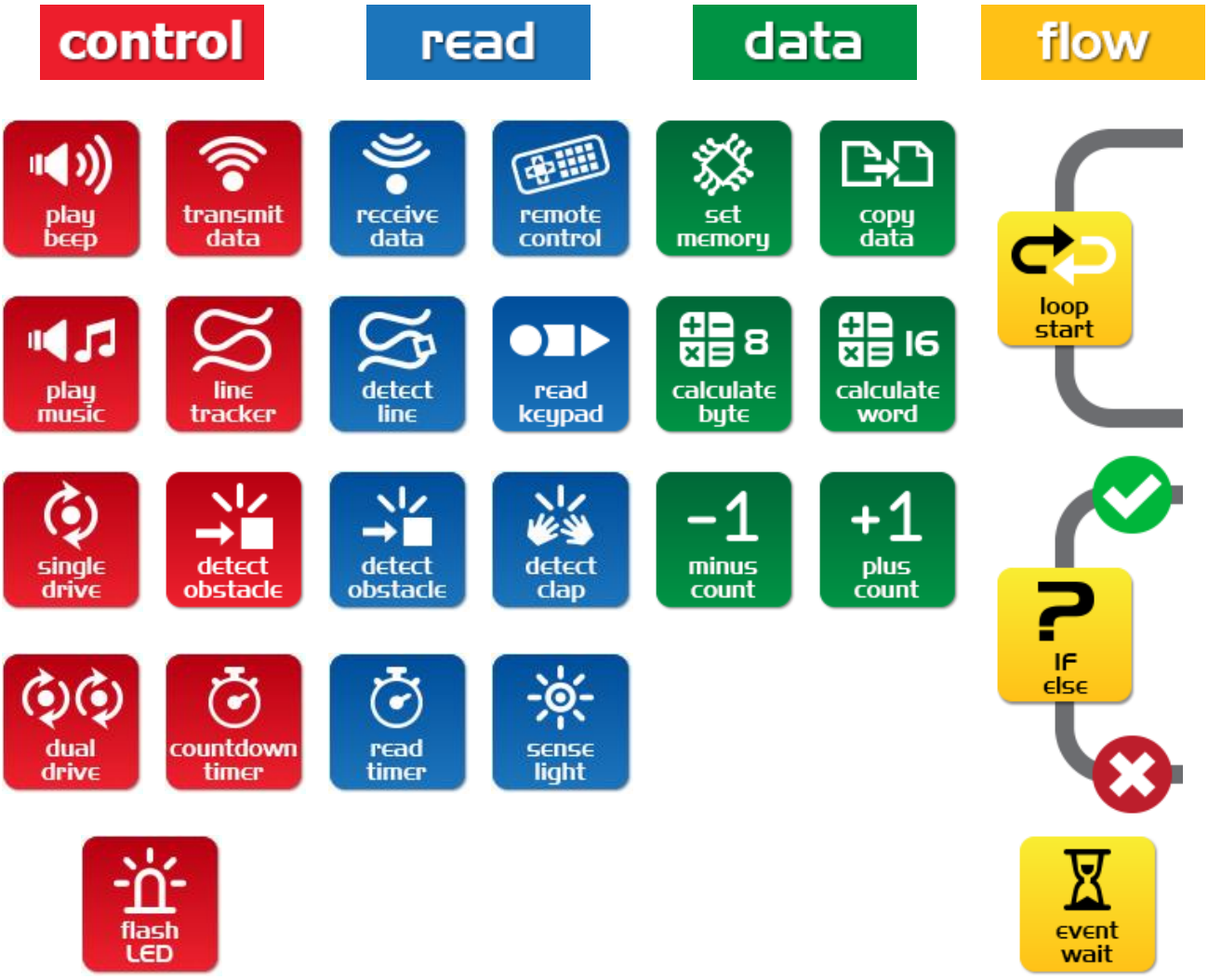
Use the help text as a guide while programming. Everything you need to know about an icon can be found here.

The variables section is where you can create and view little pieces of Edison's memory. More on this later!

EdWare icons

There are four main types of icons used in EdWare. These are control icons (red), read icons (blue), data icons (green) and flow icons (yellow).

Throughout this EdBook we will use almost every icon at least once. Some of the more advanced icons, such as the read icons will be covered in future EdBooks. For more information about all of the icons see the EdWare programming manual [due February 2015].



EdVenture 1 – Clap controlled driving

Edison is equipped with a sound sensor and can detect loud sounds like clapping.

This barcode activates Edison's '*Clap controlled driving*' program. The program *listens* for a loud sound like a clap and Edison responds by turning to his right. If you clap twice he drives forward and stops.

Reading the barcode

1. Place Edison facing the barcode on the right side
2. Press the record (round) button 3 times
3. Edison will drive forward and scan the barcode

Barcode - Clap controlled driving

What to do

Place Edison down on a flat surface and press the play (triangle) button.

Now clap your hands close to Edison. He will turn to his right. Now clap your hands twice and Edison will drive forward about 30cm.

Also, try tapping Edison with your finger, once and then twice.

EdFact

Sound sensors just like the one in your Edison are used in modern cars to detect when the engine fires each cylinder. This information is fed to the car's computer to ensure that the firing is occurring at just the right time. If the engine is firing too late it can cause damage to the engine. Ensuring that the firing is happening at just the right time also ensures the most economical fuel consumption.

EdVenture 2 – Avoid obstacles

Edison can see in the 'dark' using invisible light to detect obstacles and avoid collisions.

This barcode activates Edison's 'Avoid obstacles' program. The program drives Edison forward, when an obstacle is detected he reverses and then turns on the spot away from the obstacle, then continues to drive.

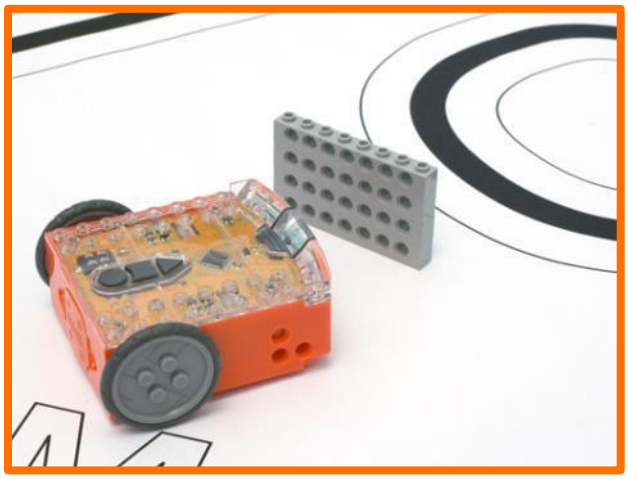
Reading the barcode

1. Place Edison facing the barcode on the right side
2. Press the record (round) button 3 times
3. Edison will drive forward and scan the barcode

Barcode – Avoid obstacles

What to do

Assemble some obstacles for Edison to avoid, such as walls made from LEGO. The obstacles need to be at least the same height as Edison (3.5cm/1.5in).



You could even build a maze for him to escape from.

Press the play (triangle) button and watch Edison approach an obstacle and then turn away to avoid colliding with it.

EdFact

Edison's obstacle detection system uses the same invisible light that your remote control uses to tell the TV to change channel. This light is called 'infrared' or 'IR' and is invisible because it has a longer wavelength than the human eye can see.

Edison emits IR from two light emitting diodes (LEDs), one on the left and one on the right. In between the two LEDs is an IR sensor. The sensor detects when IR is reflected from an obstacle. If the IR is reflected from the left LED then the obstacle is on the left. If the IR is reflected from the right LED, then the obstacle is on the right.

Is Edison not behaving? Does he bump into obstacles or does he jump at shadows? Go to page 14 to see how to calibrate his obstacle detection system.

EdVenture 3 – Follow torch

Edison loves light! He will drive towards the brightest light source even if it means falling off the table. *Such is love!*

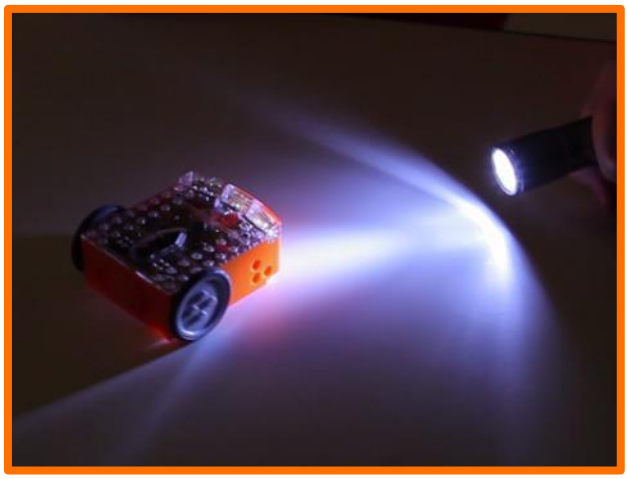
This barcode activates Edison's light following program. The program uses Edison's light sensors and motors to follow a torch (*American English: flashlight*).

Reading the barcode

1. Place Edison facing the barcode on the right side
2. Press the record (round) button 3 times
3. Edison will drive forward and scan the barcode

Barcode – Follow torch

What to do



You will need a torch/flashlight and a flat surface away from any really bright light, such as sun light.

Press the play (triangle) button and aim the torch at Edison. Once he '*sees*' the bright source of light he will drive towards it.

By moving the torch you can control where Edison drives to. *Does this behaviour remind you of anything?*

EdFact

This is one of Edison's most interesting programs, because it mimics the behaviour we see in some flying insect. I'm sure you've seen moths on a hot summer night swarming around a bright light. This type of robotic behaviour is called 'phototropism' and is normally found in plants that grow towards the sun.

This program is also very interesting, because Edison is behaving autonomously. This means that he is thinking for himself and responding to changes in his environment.

Is he alive?

EdVenture 4 – Line tracking

Meet the *holy grail* of enthusiast robotics; line tracking. Line tracking is a very popular robotics activity as it's fun to watch the robot go around and around a track. See how many people ask you *"Is that line magnetic?"*

This barcode activates Edison's line tracking program. The program uses Edison's line tracking sensor and motors to follow the edge of a black line.

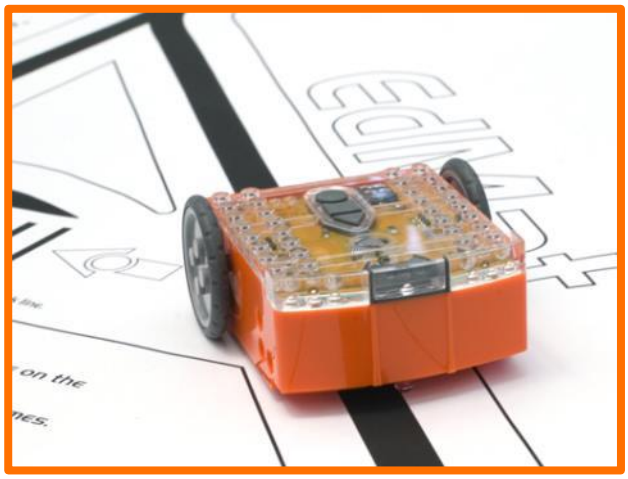
Reading the barcode

1. Place Edison facing the barcode on the right side
2. Press the record (round) button 3 times
3. Edison will drive forward and scan the barcode

Barcode – Line tracking

What to do

The first thing you need is a line. You can print the small track on the next page, print the large A1 (84cm x 59cm) EdMat from meetedison.com/downloads or make your own using black electrical tape on a white table (the line must be 1.5cm/0.6in thick).



Place Edison to one side of your line, so that the line tracking sensor is on white. Now press the play (triangle) button and watch Edison follow the line.

EdFact

Edison's line tracking sensor shines light on the surface and then measures the amount of light that is reflected back. White reflects a lot of light, giving a high light reading and black reflects very little, giving a low light reading.

To track the line Edison is in a constant state of dissatisfaction. When he is off the line, he turns right to get on the line. But when he's on the line, he turns left to get off the line. This results in him waddling on the edge of the line.

EdVenture 5 – Bounce in borders

Ever heard of Dromophobia? Well, it's a fear of crossing the street and we're going to give a version of it to Edison! Cue evil laugh…*Muwhahaha!!!*

This barcode activates Edison's bounce in borders program. The program uses Edison's line tracking sensor and motors to stop him from crossing a black line.

Reading the barcode

1. Place Edison facing the barcode on the right side
2. Press the record (round) button 3 times
3. Edison will drive forward and scan the barcode

Barcode – Bounce in borders

What to do

You can use the oval track on the previous page, or use the large A1 (84cm x 59cm) EdMat from meetedison.com/downloads or create your own (the line must be 1.5cm/0.6in thick).

Place Edison inside the borders and press play (triangle) button.

Edison will drive forward until the line tracking sensor detects the line, then reverse back, turn and continue driving.

EdFact

Line tracking and bounce in borders are fun programs, but there's a serious side. Warehouses that use robots to move items around, use lines or markers on the ground to guide the robots to their destination. These robots use barcode markings on the floor to navigate in Amazon's warehouse.

EdVenture 6 – Sumo wrestle

Bring on the robot wars!

This barcode activates Edison's Sumo wrestle program. The program brings together bounce in borders to stay with in the ring and obstacle detection to hunt and find the opponent.

Reading the barcode

1. Place Edison facing the barcode on the right side
2. Press the record (round) button 3 times
3. Edison will drive forward and scan the barcode

Barcode – Sumo wrestle

What to do

Create your own sumo wrestle ring using black electrical tape on a white surface. The ring should be around 40cm/16in in diameter.

Place two Edisons inside the ring and press play on both at the same time.

Each Edison is now slowly driving forward, staying inside the ring and '*looking*' for the opponent. If the opponent is detected Edison charges forward at full speed until the edge of the ring is detected. He then reverse back victorious and continues to look for another opponent.

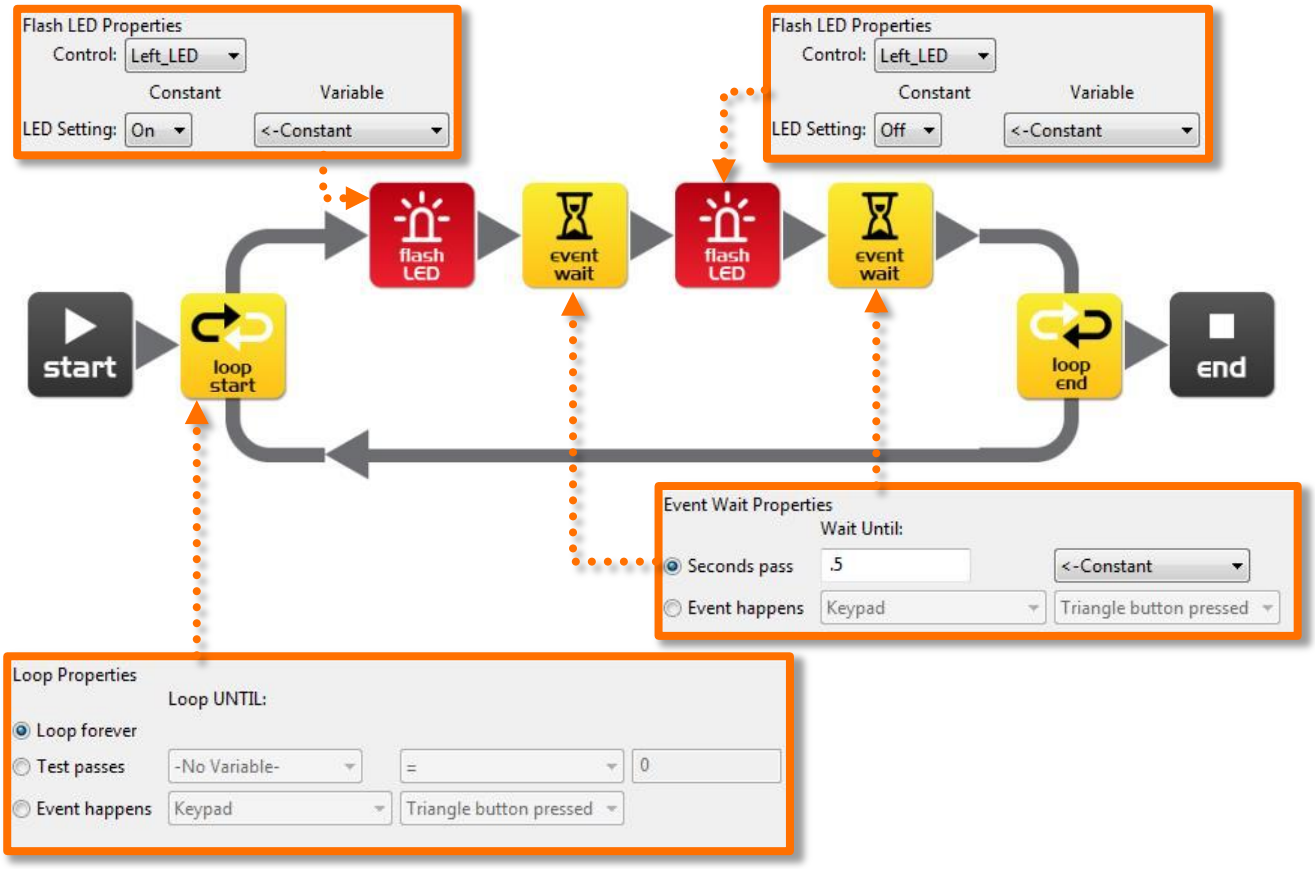
Battles don't always go to plan, as there are so many variables, such as the angle of the opponent, the proximity of the edge of the ring or just plain bad luck.

EdVenture 1 - Flash a LED

Simple loop program to make the left LED flash

The traditional first program to write is to make a LED light flash. This is a very simple program and as the name suggests turns on and off the left LED light.

Drag across the icons to form the program below, then click on each icon and set the properties box as shown.



How the program works

Edison's microcontroller (brain) follows each icon as a step and the arrows show the direction of the steps. Let's follow the steps in the program above.

Step 1: the program begins at the start icon

Step 2: the program follows the arrow out of the top of the loop icon

Step 3: the LED is set to on by the flash LED icon

Step 4: the program waits for 0.5 seconds by the event wait icon (keep the LED on)

Step 5: the LED is set to off by the flash LED icon

Step 6: the program waits for 0.5 seconds by the event wait icon (keep the LED off)

Step 7: what happens here is very important! Rather than following the arrow to the right of the loop end icon, the program moves out of the bottom of the icon and goes back to the loop start icon. This happens because the loop icon is set to 'Loop forever'. The program therefore once again goes to the first flash LED icon and turns on the LED and then follows the same sequence outlined above. This will continue *forever* or at least until the batteries go flat!

Download and play

Connect the EdComm cable between Edison and the headphone jack on your computer/tablet. Click the Program Edison button, then the record (round) button once on Edison. Now click Start Download.

Press the play (triangle) button and the left LED will flash on and off.

Congratulations! You have written and downloaded your first Edison program.

Experiment

Try adjusting the event wait times and adding more flash LED icons to control the right LED. Can you make a cool flashing light display?

EdFact

L.E.D. stands for Light Emitting Diode.

Unlike the original light bulb invented by Thomas Edison (no direct relation to your Edison robot) a LED has no filament or special wire that produces light when electricity passes through it. Instead, LEDs use advanced semiconductor material, just like that found inside computer chips.

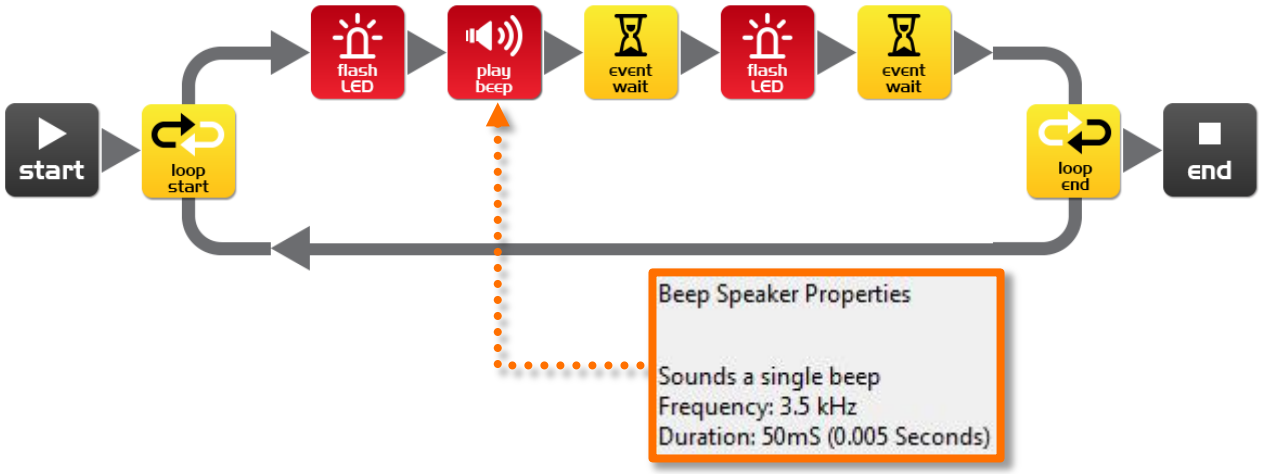
LEDs are superior to traditional light bulbs as they last longer, are more robust and use much less power.

So next time you have a great idea don't think of a light bulb coming on. Think of an LED coming on!

EdVenture 2 – Beep!!... Beep!!...

Add sound to the above program

Drag across the play beep icon and place it as shown below. Play beep sounds a short 50 millisecond (0.05 second) beep. There are no properties setting for play beep.



How the program works

Just as the previous program goes around and around in a loop repeating every icon, this program is no different, except that when the LED comes on a beep is played.

Experiment

Try adding more play beep icons, changing the event wait periods and adding more flash LED icons. You can now add sound to your cool flashing light display!

EdFact

Speakers make sound by converting electrical signals into tiny backwards and forwards movements. These tiny movements cause small rapid changes in air pressure, which we call sound.

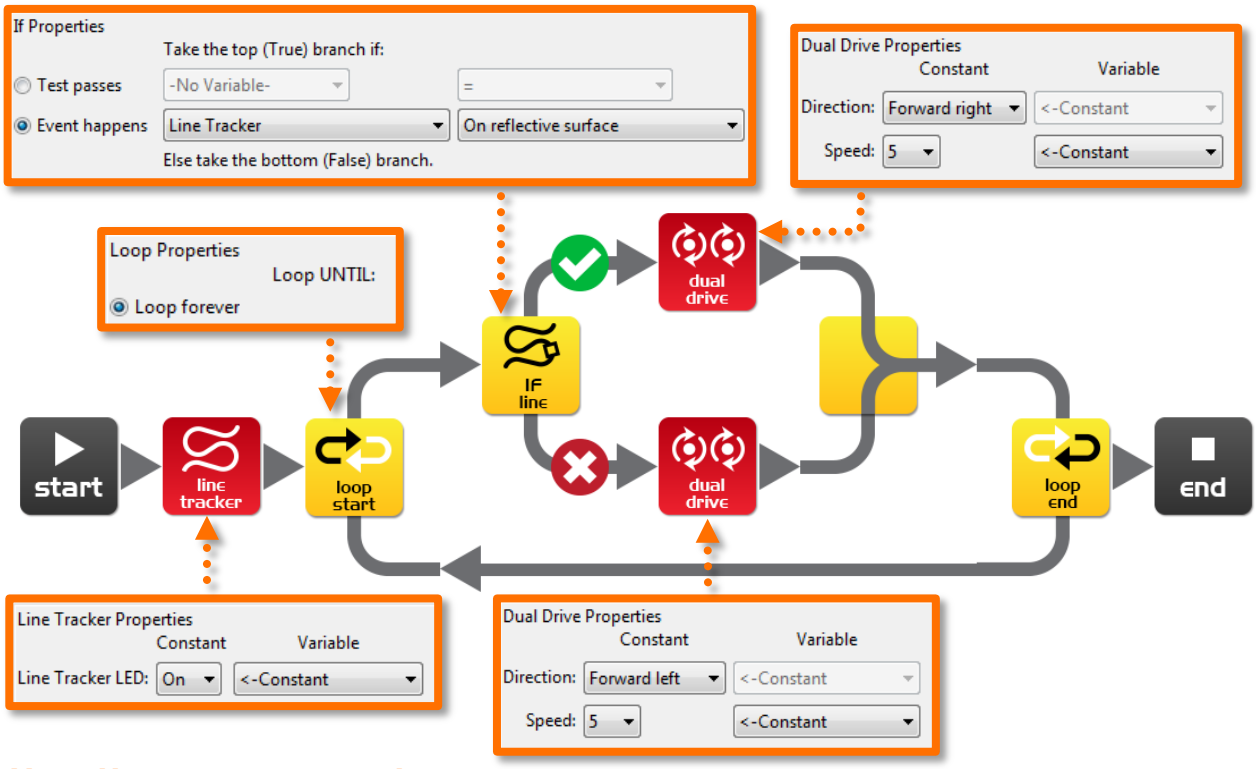
Edison has a slightly different type of speaker than you will find in a typical radio and is called a piezo transducer. The advantage of piezo transducers are that they use very little power, are inexpensive and can easily work in reverse by converting sound into an electrical signal. We'll look at that last point again when we have Edison respond to sound commands.

EdVenture 5 – What IF?

Give Edison the power to make decisions

The introduction said that a robot can think or make decisions on its own and act on those decisions. Well, now were going to see how that happens using the IF icon.

Create the program and download it to Edison. Place him next to a thick black line on a white surface and press the play button. He will follow the line.



How the program works

The first thing the program does is turn on the line tracking LED. Next, the program enters an endless loop. In the loop is the, all important, IF icon. The IF icon asks*: Is the line tracker on a reflective surface (white)?* If the answer is *YES,* then the program follows the tick path out of the top of the IF icon. The dual drive icon turns Edison right. This drives him onto the black line. But, if the answer is *NO*, then the program follows the cross path out of the bottom of the IF icon. This dual drive icon turns Edison left and drives Edison off the line. The program then loops around again, and again, and…

Edison is in a constant battle with himself. When he's on the line, he wants to get off it. When he's off the line he wants to get on it. Frustrated movement by movement he moves forward.

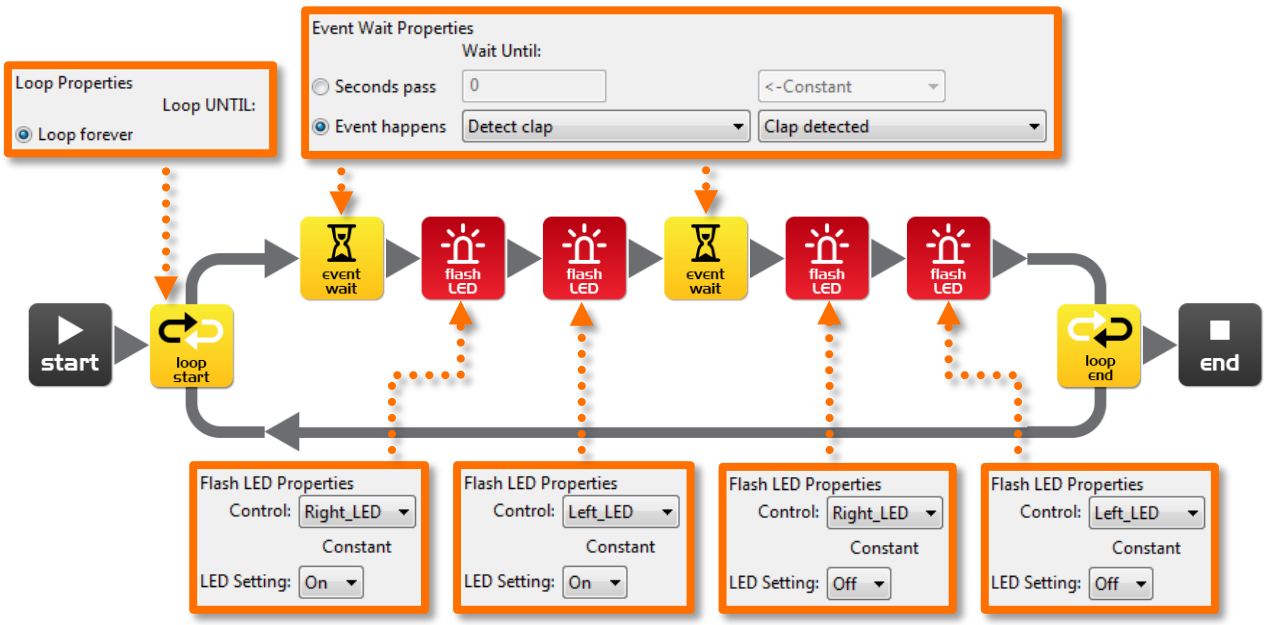
EdFact

This program is very simple, but demonstrates the principal of 'artificial' decision making (intelligence). Scientist still don't fully understand how the human brain works and are now using computer scientists to help make sense of their research. *Do you think your brain is a giant computer?*

EdVenture 6 – What's the hurry? Let's wait!

Meet the *event* in the event wait icon

Edison can wait for more than just time. He can wait for a specific event to occur before progressing through your program. This program takes advantage of Edison's clap sensor.



How the program works

Once again we have a loop, which you should be familiar with now. The first icon in the loop is the event wait icon and is set to wait until a clap is detected, so the program will wait here until a clap is detected. Once this happens, the program progresses to turn on the right and left LEDs and encounters another event wait icon with the same settings as the first one. When another clap is detected the program progresses to turn off the right and left LEDs, and loops around again.

Important!

The clap detection sensor becomes overwhelmed with noise when the motors are running, so you can't detect for claps while Edison is driving.

EdFact

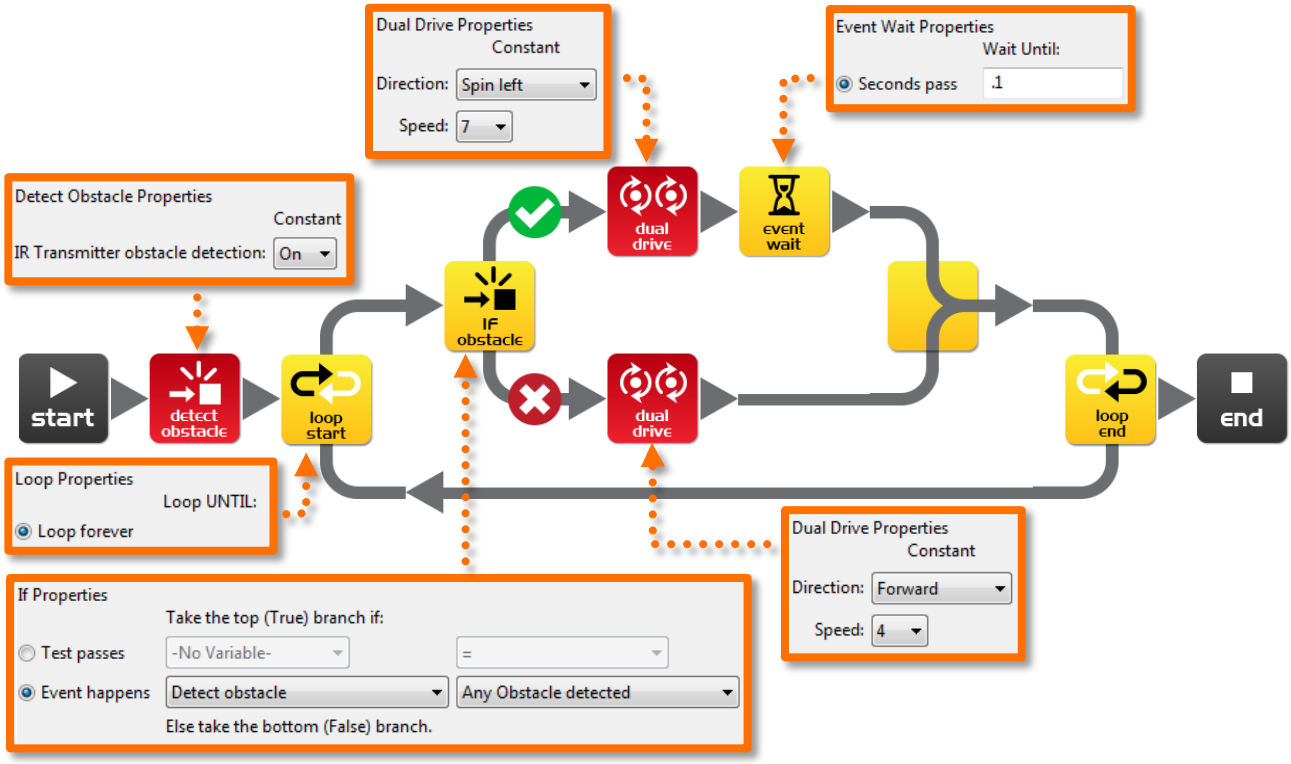
As mentioned earlier Edison uses an electronic component called a piezo transducer to both make sound and detect claps. Piezo transducers have two plates that are separated by a thin layer of ceramic. When an electrical signal is applied to the two plates they move, which produces sound. They also work in reverse, when sound or vibration is applied to the plates they produce an electrical signal.

The name piezo comes from the Greek language meaning press or squeeze and a transducer is anything that converts one form of energy into another (i.e. sound energy into electrical energy and electrical energy into sound energy).

EdVenture 7 – Watch out! There's an obstacle!

Let's do some autonomous driving

Edison is equipped with an obstacle detector, so he can *see* obstacles in his path and avoid them. Here's a simple program that does this.



How the program works

Before entering an endless loop, the program turns on Edison's obstacle detection system. Edison now emits infrared (IR) light from two light emitting diodes (LEDs), one on the left and one on the right. In between the two LEDs is an IR sensor. The sensor detects when IR is reflected from an obstacle. If the IR is reflected from the left LED then the obstacle is on the left. If the IR is reflected from the right LED, then the obstacle is on the right.

The IF icon asks; *'have any obstacles been detected'?* If the answer is no, then the cross path is taken and Edison drives forward. If the answer is yes, then the tick path is taken and Edison spins left for 0.1 of a second (100 milliseconds). See next page for calibration.

Experiment

Try detecting for obstacles on the left and right. See if you can add more IF icons and have Edison spin left to avoid obstacles on the right and spin right to avoid obstacles on the left.

EdFact

I'm sure you've heard of, or even seen, robot vacuum cleaners; well they use the same IR system as Edison to detect obstacles. The 'Roomba' has two of these sensors. One is used just like Edison to detect obstacles, and the other is used as a 'cliff detector' and looks at the ground in front of the robot to ensure it isn't about to dive down a staircase.

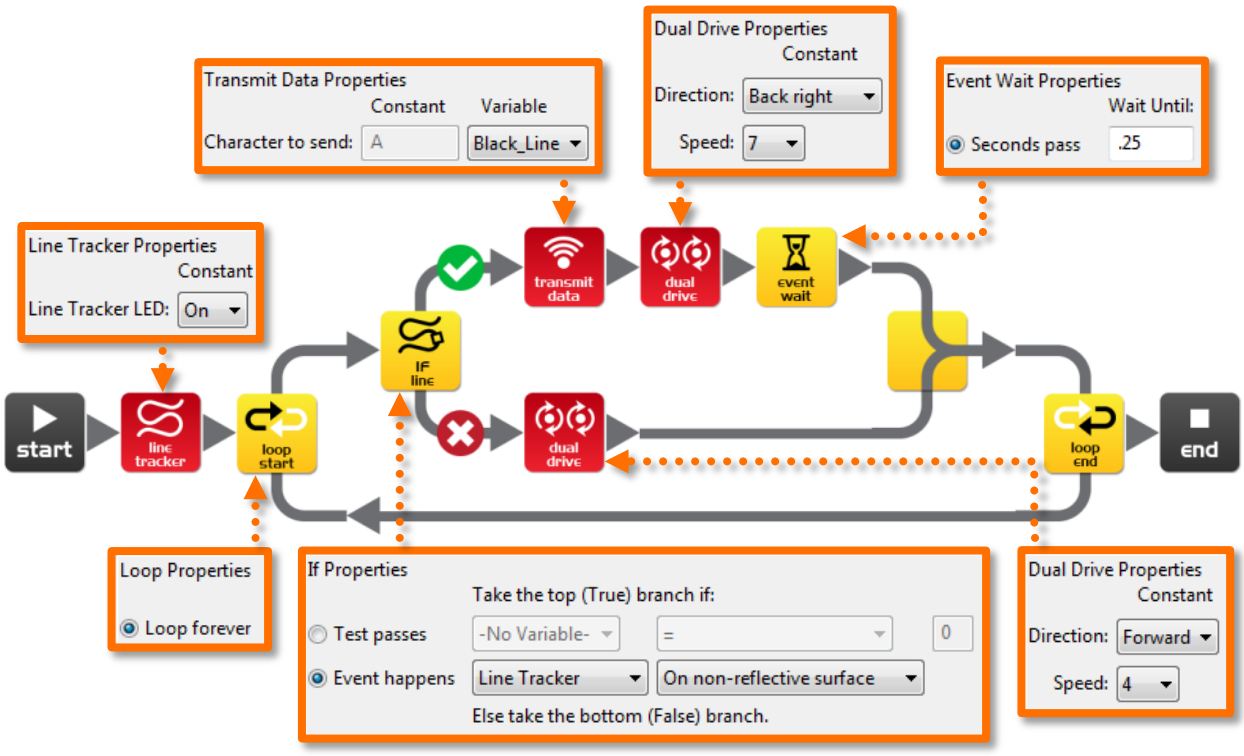
EdVenture 10 – Robot communications

Bounce *without* borders

A robot swarm is when many robots work together to solve a common problem. Generally the robots are small and by themselves aren't very intelligent, but as a swarm they can achieve complex tasks (*think of ants building a complex nest*). The most important part of swarm robotics is communication. Without robot to robot communication a robot swarm is not impossible. Here is an introduction to robot communication.

In this EdVenture you will need at least two Edison robots. The first Edison will bounce within a border and tell the second robot each time a border is encountered. The second robot will use this information to mimic the first robot and will seem to bounce in side an invisible border.

Write the following program for the first Edison (Edison with borders).

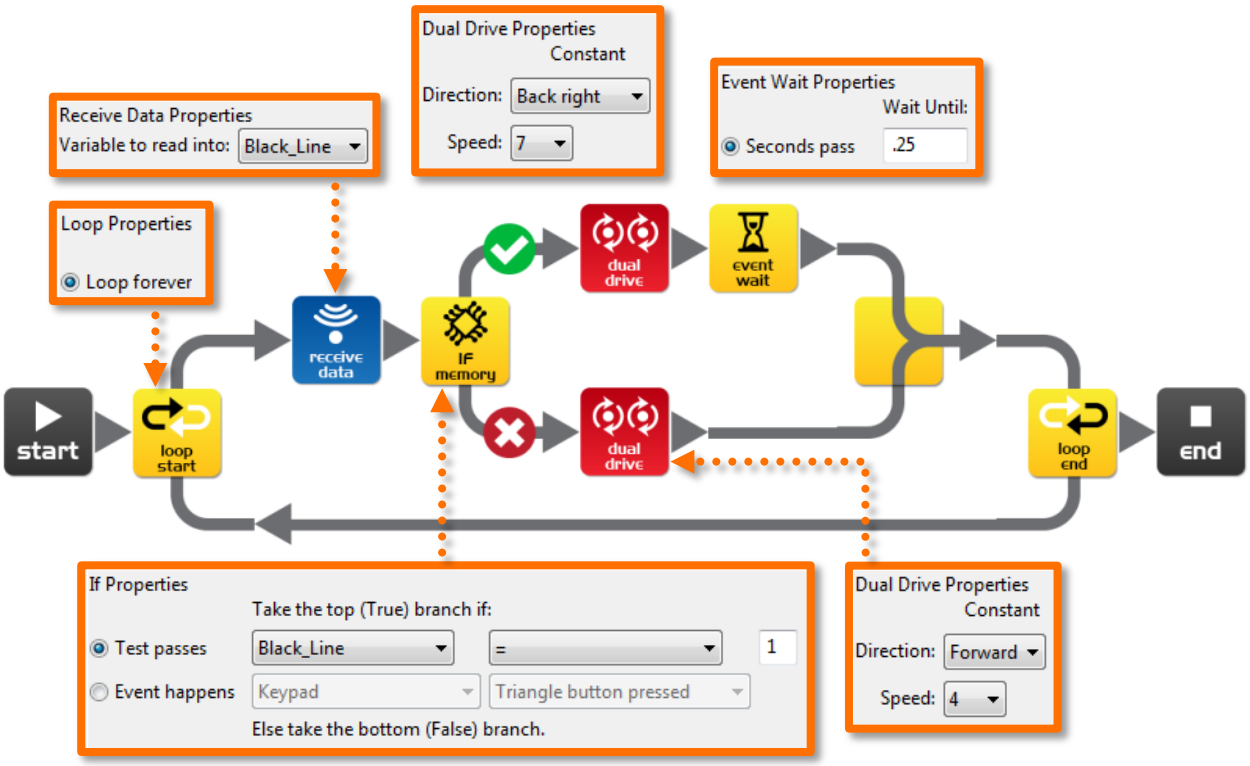


Create an 8 bit variable called 'Black_Line' and set the initial value to 1.

How the program works

The first icon turns on the line tracking sensor LED. The program then enters an endless loop. The IF icon in the loop checks the state of the line tracking sensor, if the surface is white (reflective) then the dual drive icon drives Edison forward at speed 4. If the surface is black (non-reflective) then the contents of the variable 'Black_Line' (1) is transmitted. Edison then reverse-turns for 0.25 seconds and repeats the loop.

Write the following program for the second Edison (Edison without borders).



Create an 8 bit variable called 'Black_Line' and set the initial value to 0.

You can program a third, fourth or fifth Edison with this program for more fun.

How the program works

The program goes straight into an endless loop and reads incoming data using the receive data icon. The receive data icon places the data into the variable 'Black_Line'. The IF icon then checks if the data in the variable is equal to 1. If it isn't (no data from the other Edison) then the dual drive icon drives Edison forward at speed 4. If the data does equal 1 (the other Edison has encountered a line) then the dual drive icon drives Edison in a reverse-turn for 0.25 seconds. The loop is then repeated.

What to do

Print the track on the next page and place the first Edison inside the border. Place the second Edison outside the border and press the play button on both Edisons.

The Edison inside the border will not leave the oval and the second Edison will mimic the firsts every move.

Experiment

This is just an introduction to robot communications. Can you improve on this program and can you achieve two way communications? What if the first Edison couldn't turn until the second Edison confirmed that it had received data?