Merchant Venturers School of Engineering

Outreach Programme

Micro:bit Space Invaders

Block Editor - 2 Hours

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Notes to Teachers & Helpers

- This workshop is intended to last 2 hours.
- This workshop is intended for ages 9^+ (years 5^+).
- The content is intended to be learnt through self-directed, individual work, using this worksheet as a guide.
- The learning platform is the BBC Micro:bit (and the online Block Editor - very similar to Scratch).
- Students can use their own Micro:bit or we can provide a Micro:bit for the session.
- Students should be comfortable using the computer, including knowing how to click/drag blocks in the editor to join them together.
- This workshop teaches the following skills:

  Items marked with an asterisk are directly relatable to the National Curriculum.

  - Basic operations: Turning on/off LEDs, showing numbers
  - Use of sensors/input: Buttons, Tilt-sensor
  * Conditional blocks (if/else-if/else)
  * Basic logic: AND, OR, Greater-than, Less-than, Equal-to
  * Basic mathematical programming: Addition, Subtraction, Max/Min
  * Basic game programming: Events, Control Logic

1 What is Space Invaders?

The classic game, Space Invaders!

Space Invaders is a classic game - one of the earliest ever made.

The invaders come down from the top and the green defender at the bottom has to move left and right, shooting the inavders.

If the invaders reach the bottom of the screen, the defender loses a life. Three lives only! The aim is to survive as many levels as possible.

2 What's in this worksheet?

Hi! In this short workshop we're going to try to introduce some of the concepts that Computer Scientists use every day to design everything from your games on your mobile to controllers for self driving cars.

Let's get started. Each section is made up of four parts:

Actions Stuff for you to do. They are highlighted in blue.

Notes Notes about important stuff you need to be aware of (and possibly remember!). They are highlighted in red.

Questions Questions you should try to answer. Sometimes you'll need to write things down; other times you'll need to build something in the game. They are highlighted in yellow.

Ask a helper or the teacher to check your answers.

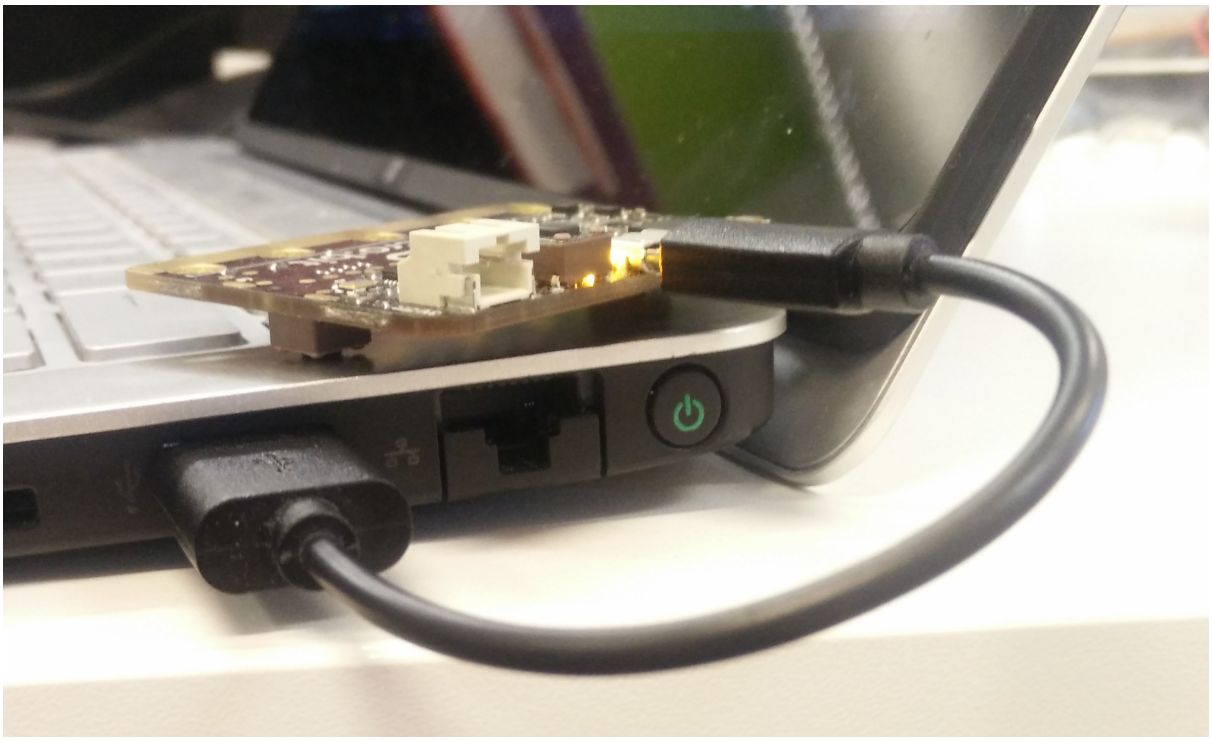
Goals Stuff you should have completed at the end of each section. They are highlighted in green.

We'll also write some information between parts and include plenty of screenshots to help you out.

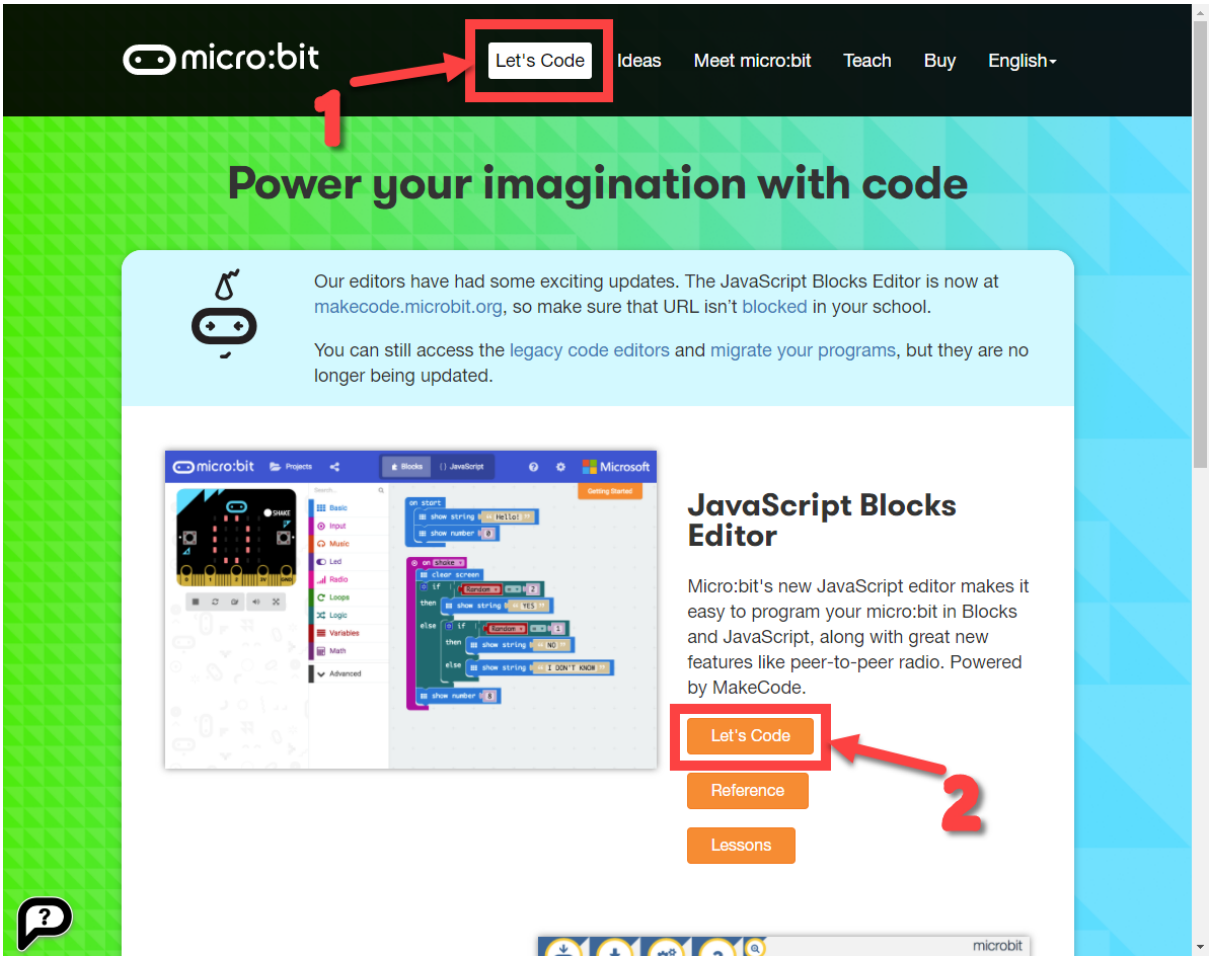
3 Getting Started

Actions

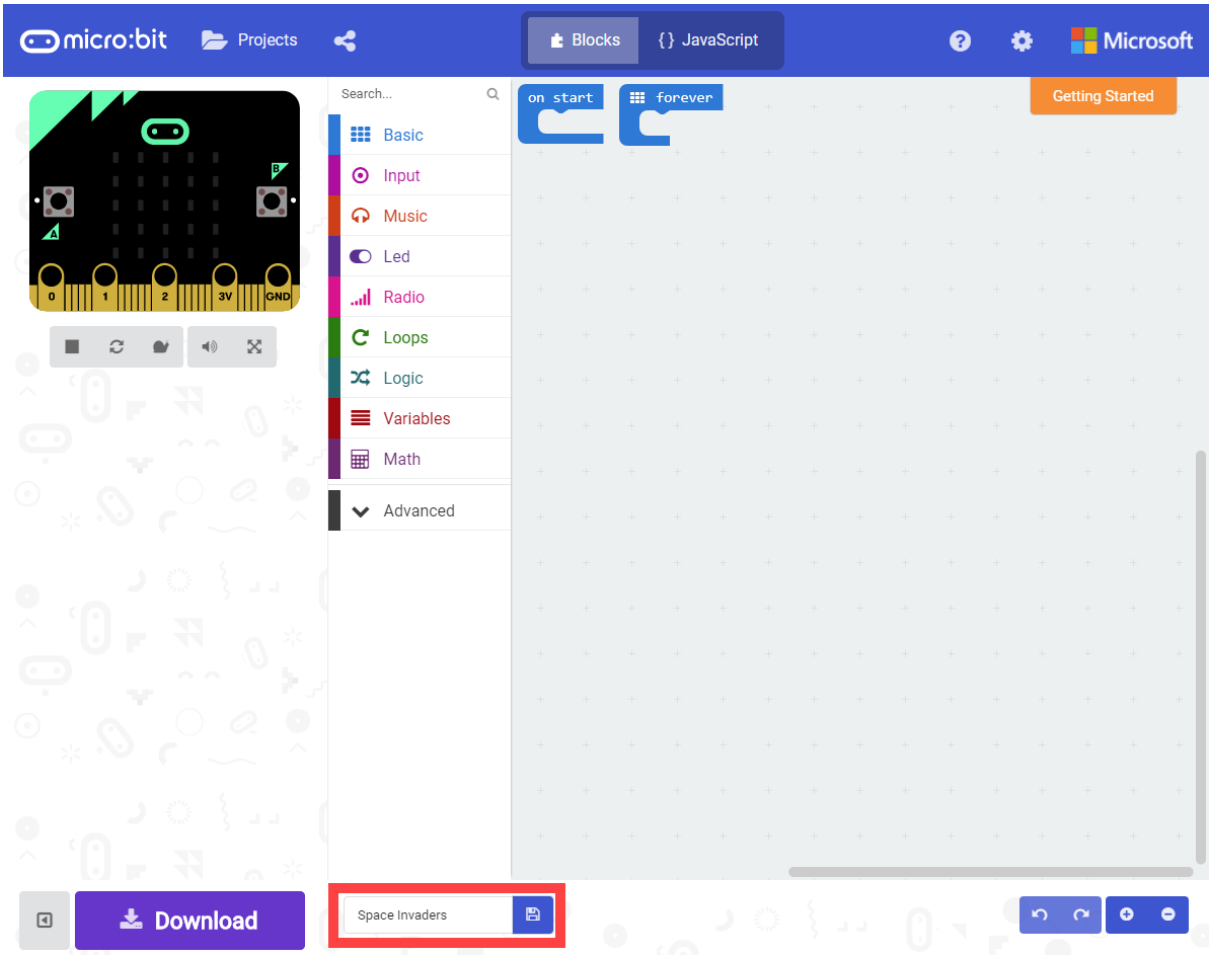
1. Plug your Micro:bit into the computer using the USB cable
2. Open a web browser and go to http://microbit.org/code/
3. Under the words "Microsoft Block Editor", click the purple "Start with this editor" button
4. At the top of the editor page, rename your project to "Space Invaders"



Micro:bit plugged into laptop using the supplied USB cable



Start with this editor on Micro:bit website



Rename your new project to Space Invaders

Goals

Great! You should now have a new Block Editor project open and ready to start creating your game.

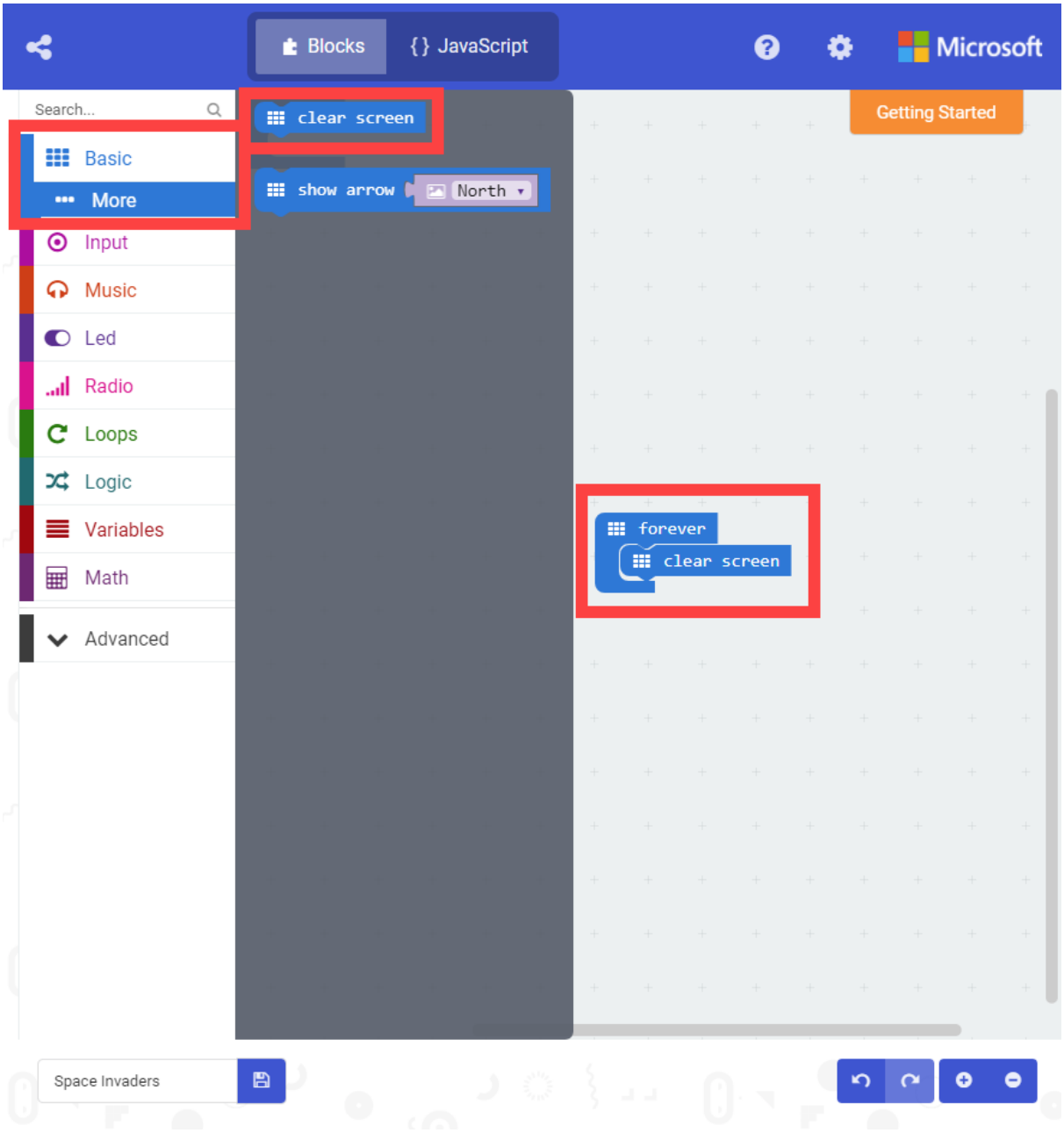
4 Lighting the LEDs

We're going to start simple, by just getting an LED to display on the screen. Then we'll see how we can make a pattern of LEDs blink.

First, we need a loop. A loop is a block of code which repeats. Some loops repeat forever, others repeat for only a certain number of times. We want a "forever" loop.

Actions

1. Click the "Basic" tab on the left
2. Click and drag a "forever" block into the middle of the screen.

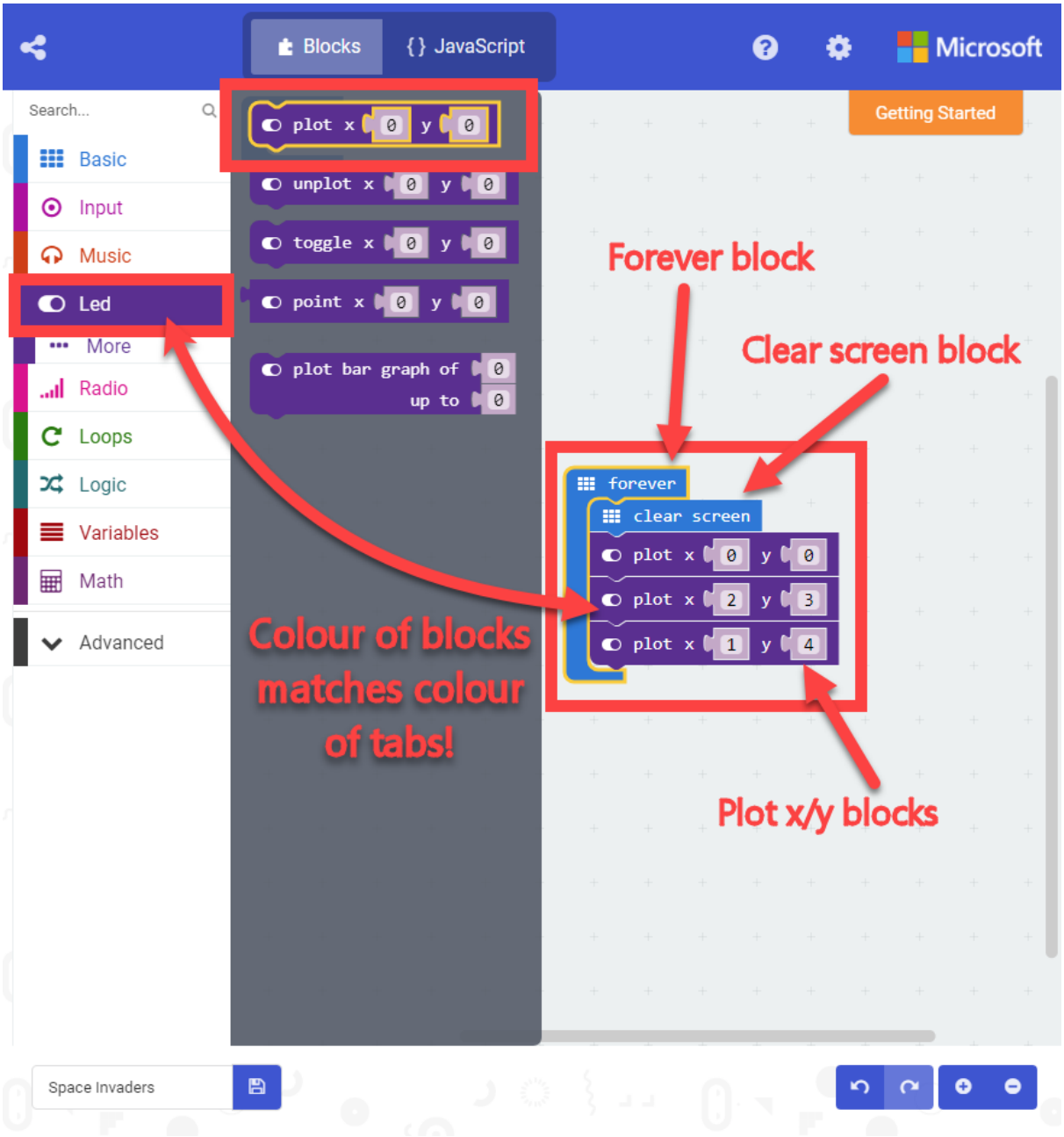


Forever block in the Basic tab

Each time around the loop, we're going to clear the screen and then light up some LEDs again. Later, we'll see how this allows us to move the defender and the space invaders around the display.

Actions

3. Click and drag a "Clear screen" block from the "Basic" tab to the inside of your "forever" block
4. Click and drag a "Plot x/y" block from the "LED" tab to just after the "Clear screen" block
5. Add more "Plot x/y" blocks and change the x/y values to plot more pixels. You can choose any number between 0 and 4 (including 4)!
6. Click "compile" at the top of the screen and download the file to your Microbit.



Plotting pixels

Goals

You should now see your pattern of LEDs on the display of your Micro:bit!

5 Defender Position

Now we know how to make the LEDs light up, we want to be able to use the bottom row of LEDs to display the defender. The defender will be represented by a single LED in the column the defender can shoot in.

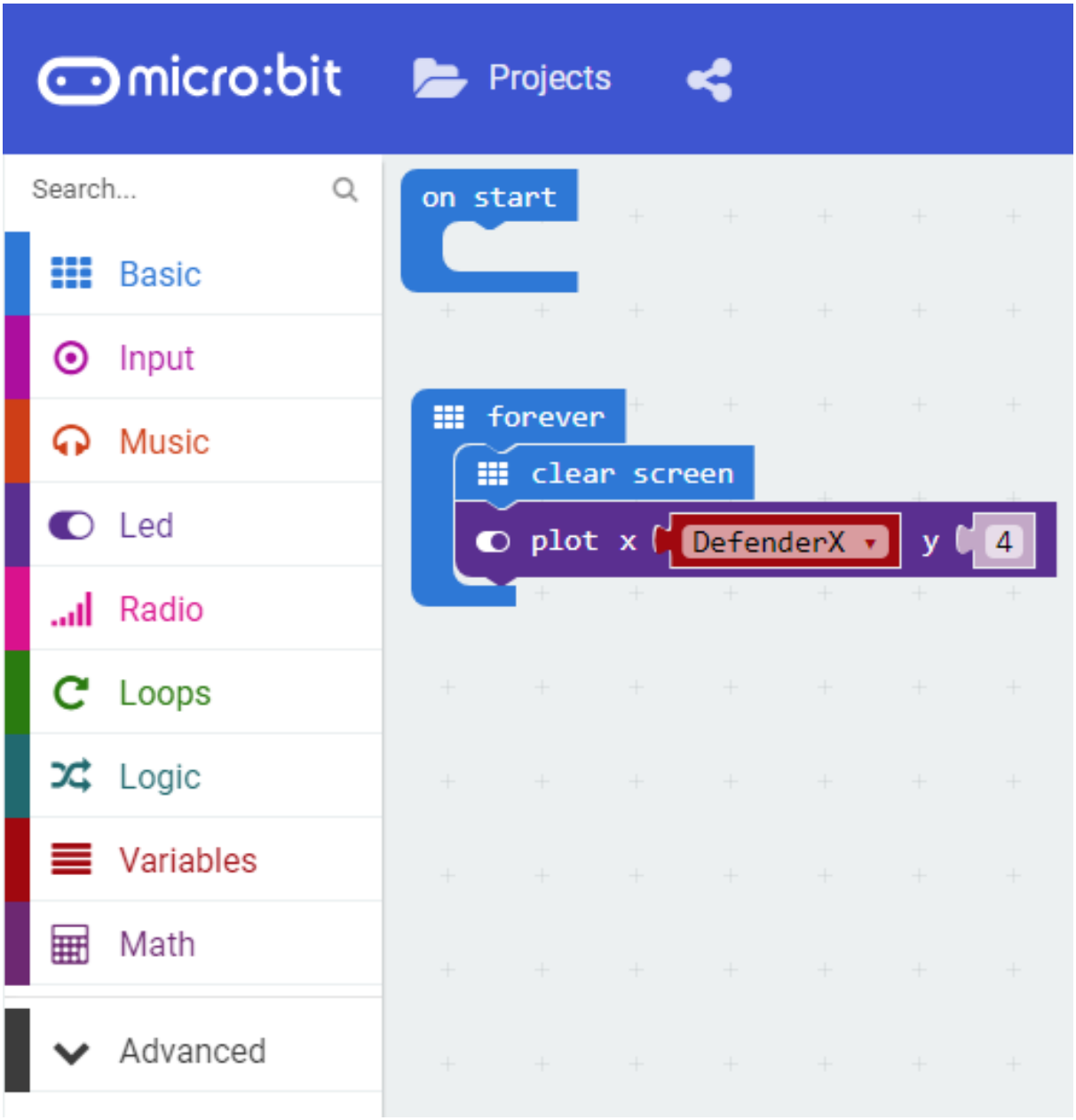
We need to track the defender's position - 0 for left-most column, 4 for right-most and 1,2,3 for the columns in between. To keep track of which column the defender is in, we can use a "variable".

Notes

A variable is a named thing which can be set to a whole number (0,1,2,3,.....) or a logic value (true/false). We can look at the value of a variable or change the value of the variable at any point in the code. A variable lets us store information for later.

Actions

1. Click and drag an "Item" block from the "Variables" tab into the "x" value of a "plot" block
2. Click the down arrow next to the word "item" in the block
3. Click "Rename variable..."
4. Rename the variable to "DefenderX" (without the quotes)
5. Set the "y" value of the "plot" block to 4
6. Remove any other "plot" blocks from your "forever" loop



Plotting the Defender

Goals

Click run to see a simulation of your program in the editor. You should see the bottom-left LED light up.

6 Moving the defender

We now know how to use a variable to track the defender's position and make the LED light up. But the value of the variable is never changed - our defender always stays in the bottom left!

We're going to use the tilt sensor to move our defender around. When the board is tilted left, the defender will move towards the left hand side of the display. When the board is tilted right, the defender will move towards the right hand side of the display.

Actions

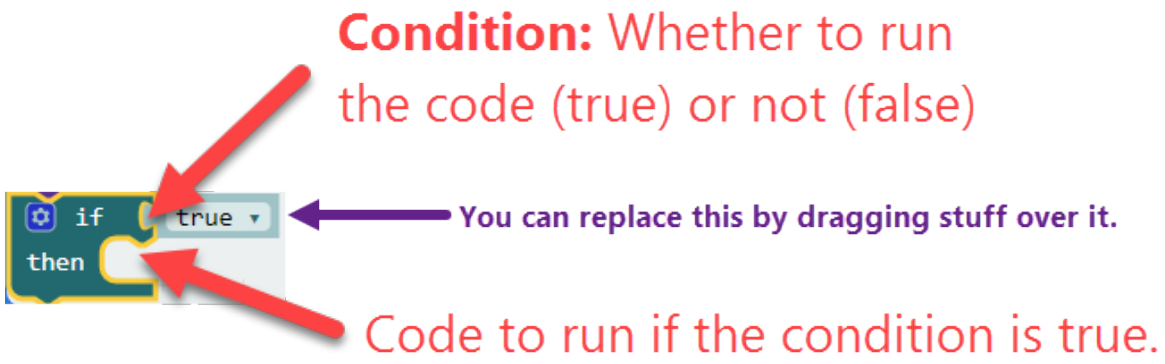
1. Click and drag another "forever" block into the editing area (from the "Basic" tab)
2. Click and drag an "if" block from the "Logic" tab into the "forever" block

Notes

An "if" block is a decision block (often called a Conditional block). You test something, and if that test passes, then the code inside the block runs. Otherwise, the code inside the block doesn't run and the programs goes to the block after the if block.

Notes

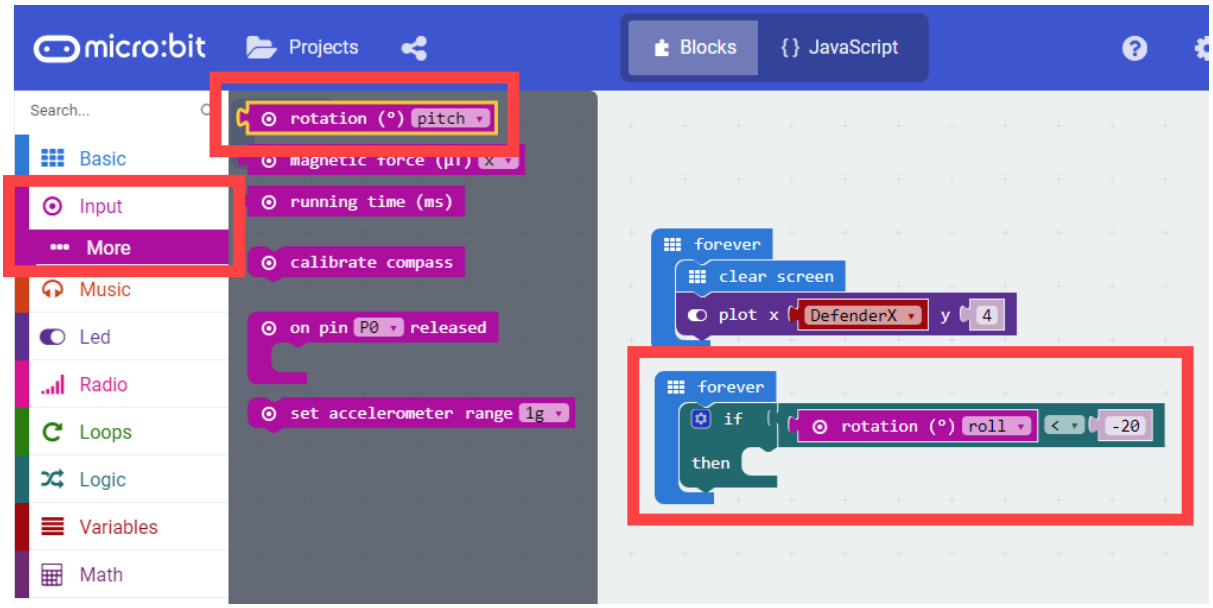
The "test" the if-block uses is called the "condition". It is a logic equation. For example, "is five greater than four" is a condition (to which the answer is always "yes" - usually called "true"). If the condition is "true" the code inside the if block happens, otherwise the condition is "false" so the code inside doesn't happen.



An if-block: Condition determines if the code inside runs.

Actions

3. Click and drag a "less-than" block ("¡" block) from the "Logic" tab to the connector on the right of the word "if"
4. Click and drag a "rotation" block from the "Input" tab to the left-hand "0" of the "less-than" block
5. Click the drop down and select "roll" instead of "pitch"
6. Set the "0" on the right-hand side to "-20"



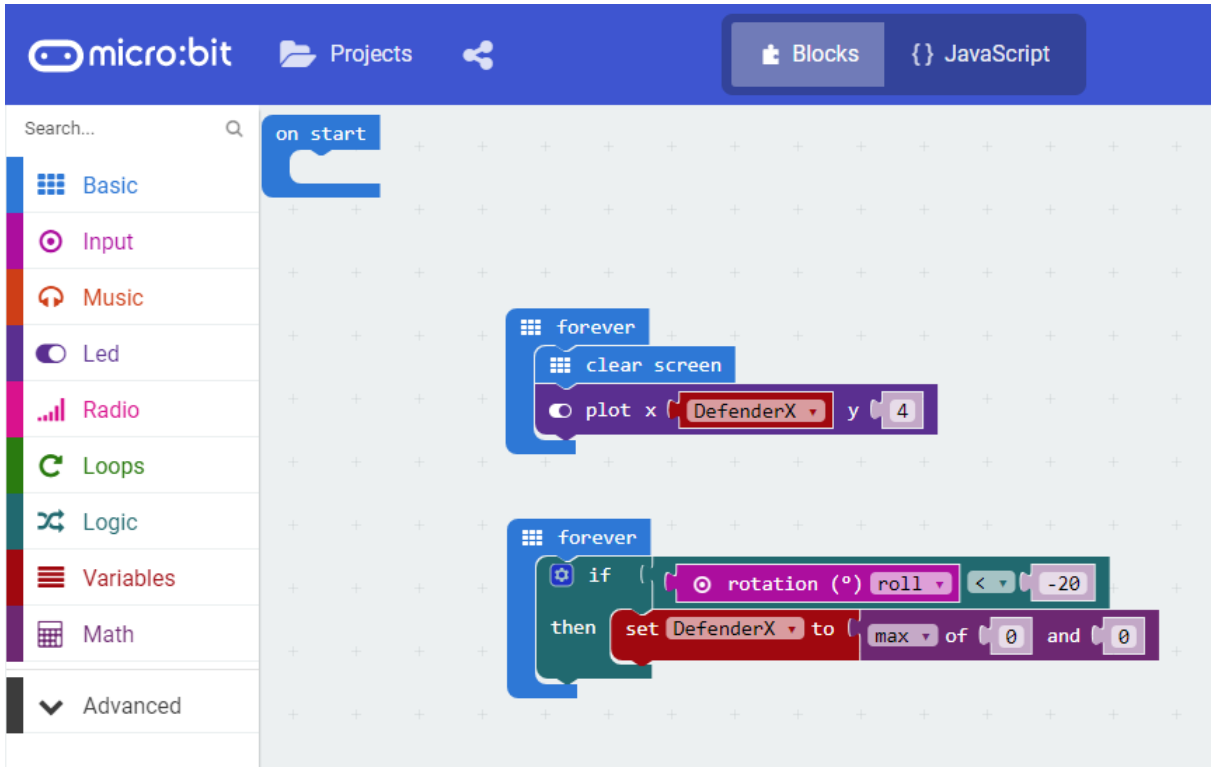
First condition for rotation of the Micro:bit

Notes

This code continuously loops, checking to see if the tilt of the Micro:bit is 20 degrees or more to the left. If it is, it will execute the (empty) code inside the if block.

Actions

7. Click and drag a "set item to" block from the "Variables" tab to inside the "if" block
8. From the drop down, change "item" to "DefenderX"
9. Click and drag a "max" block from the "Maths" tab to the right-hand connector of the "set" block



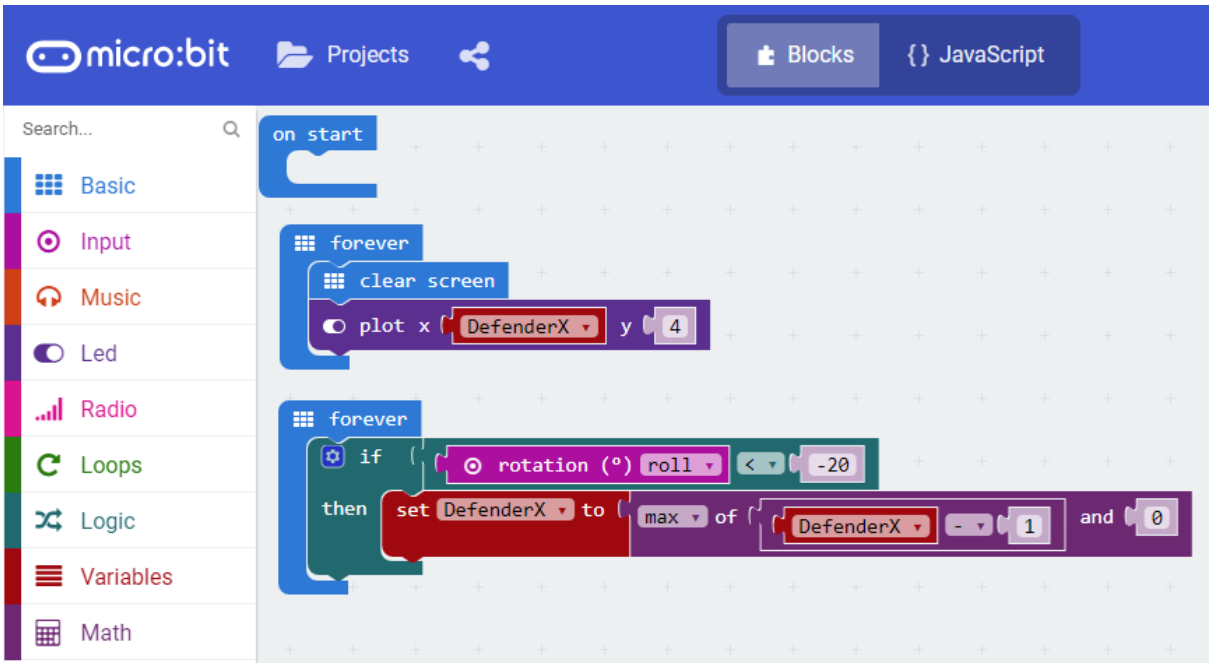
First use of a max-block

Notes

"Max" is a clever maths operation which picks the larger of the two numbers it is given.

Actions

10. Click and drag a "subtract" block ("-" block) from the Maths tab to inside the left-hand value of the "max" block
11. Click and drag a "DefenderX" item block to inside the left value of the "subtract" block
12. Set the right side of the "subtract" block to 1



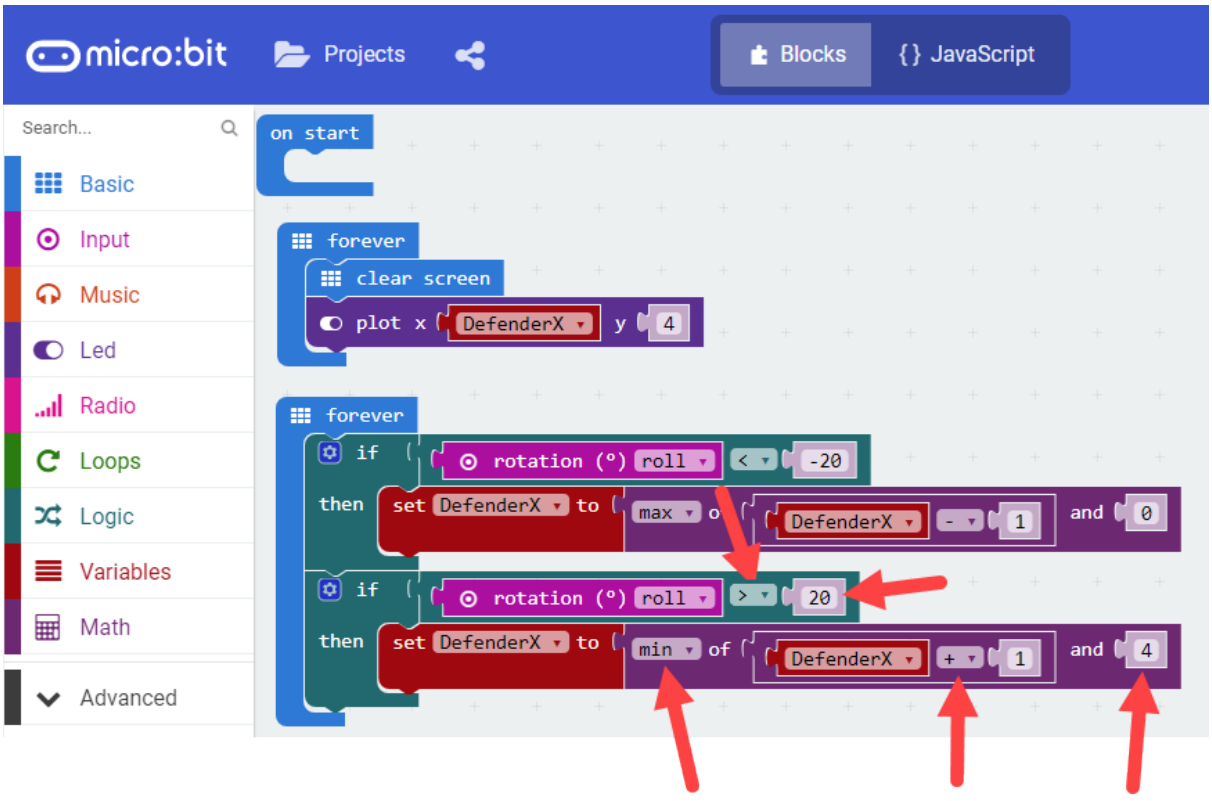
Code for moving the defender left

Notes

The code inside the if block will now set the "DefenderX" variable to the maximum of "DefenderX - 1" and "0". In other words, if the defender is in the left-most column (column 0) it will stay there. If it is not in the left-most column, the defender will move one column to the left. E.g. if it is in column 3, it will move to column 2.

Actions

13. Copy and paste the "if" block to after itself (use Ctrl+C to copy, Ctrl+V to paste)
14. Set the condition to use ">" (greater-than) instead of "<" (less-than)
15. Set the right hand comparison value to "20" instead of "-20"
16. Set the maths operation to "min" instead of "max"
17. Change the "subtract" operation to "addition"
18. Set the right hand "and" value of the "min" block to "4"



Code for moving the defender left and right

Notes

The tilt direction in the simulator in the editor is the opposite to the real Micro:bit.

Goals

Compile and save your code to your Micro:bit - you should now see the Defender move left and right on the bottom of the display when you tilt the Micro:bit left and right.

Notes

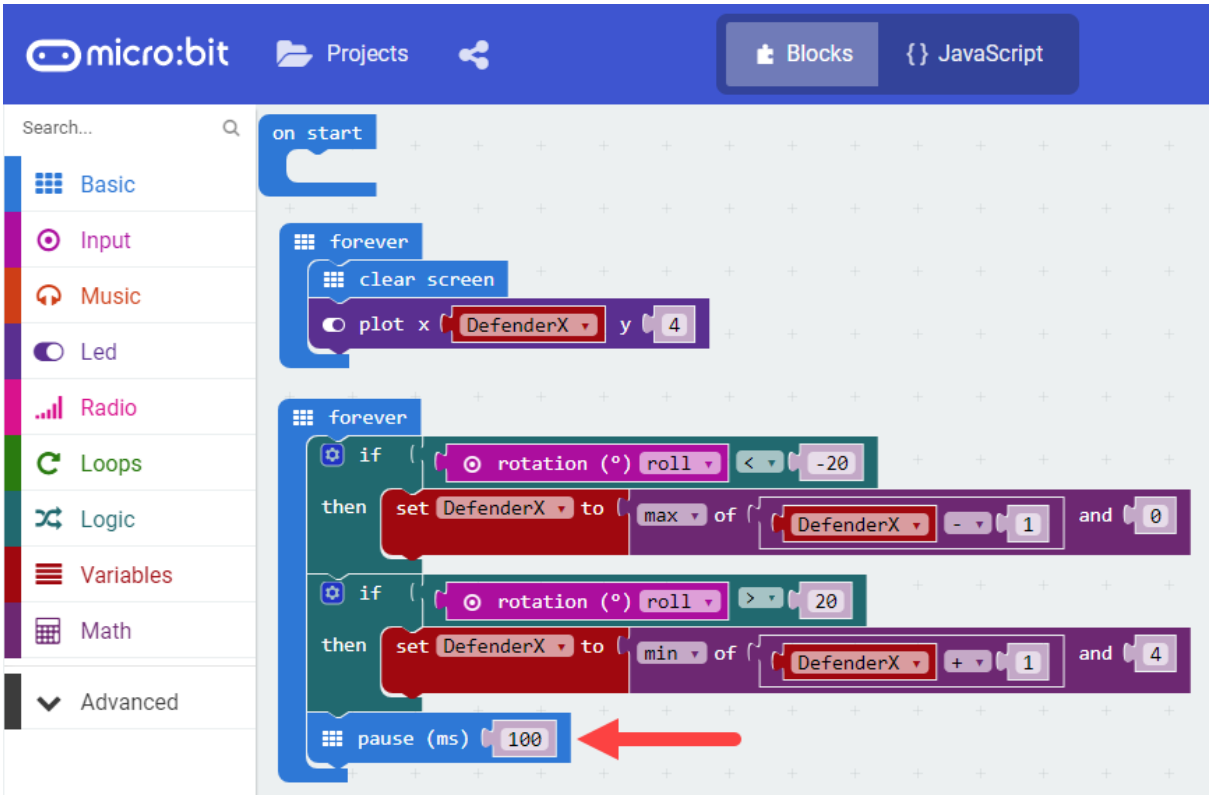
You may notice the defender moves very quickly - too quickly! We can fix that by adding a delay to the loop.

Notes

A delay pauses the execution of the blocks for a length of time. The length of time is in milliseconds. There are 1000 milliseconds to 1 second.

Actions

19. Click and drag a "pause" block from the "Basic" tab to the end of the "forever" loop after your "if" blocks
20. Set the value to "100" (if it is not already 100)



Improved code for moving the defender left and right

Goals

Compile and save your game to your Micro:bit. You should now be able to control the defender position so that you can put it in a particular column by tilting left and right.

7 Invaders Positions

There will be three invaders, that will start at the top-left and work their way across as a block from left to right. When they reach the right hand side, they will jump back to the left again.

We will need to keep track of which invaders are alive and which are dead. We can do this using three variables named "Invader1", "Invader2" and "Invader3". If an invader variable is "true", it will mean the invader is alive. If it is "false", the invader is dead.

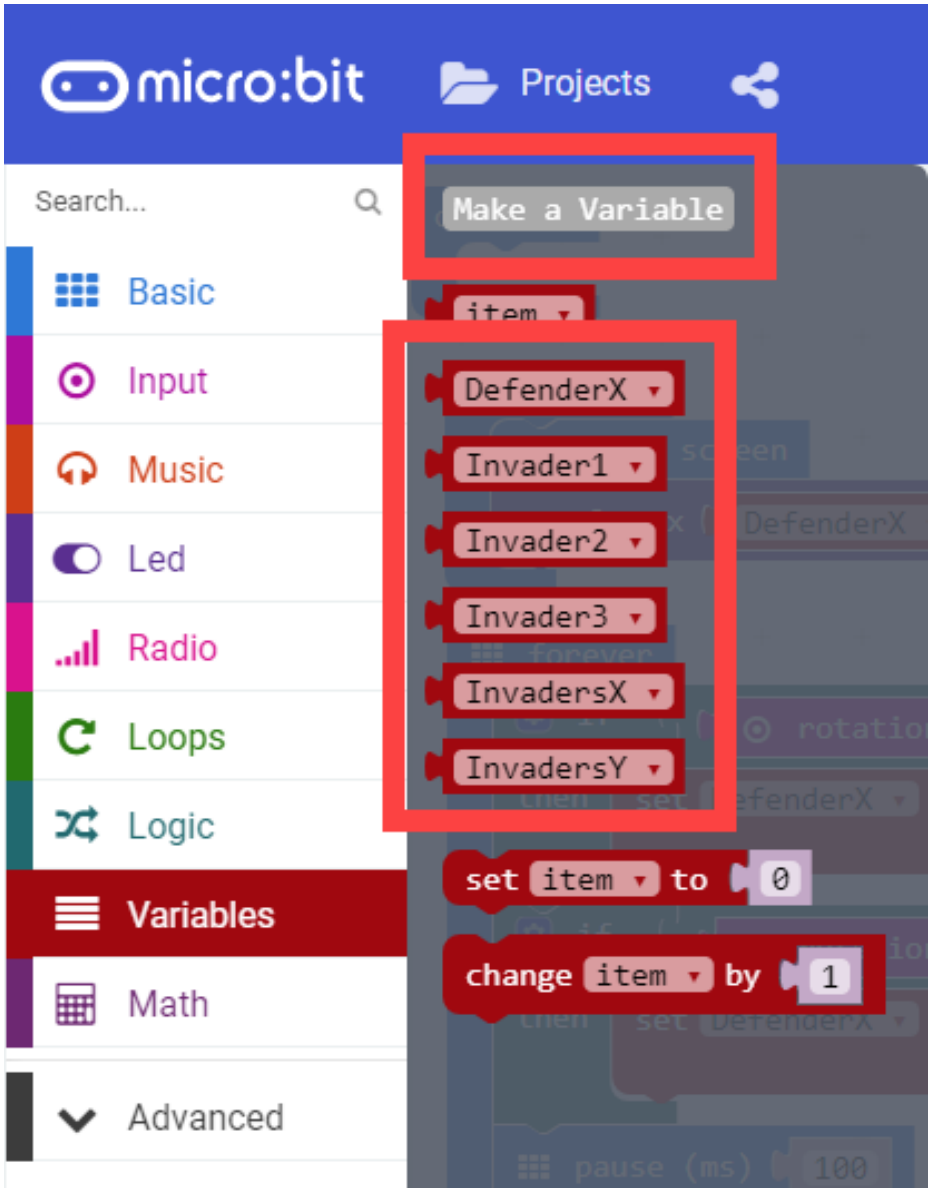
We will also need to know where the invaders are. We will use two variables for this: one for the X-location (column number) that the left-most invader is in, and one for the Y-location (row number) that the invaders are in.

Actions

1. Add blocks to your game's code so that it matches the screenshot below.

   You will need to add a new "forever" block.

   You will need to use the "New variable" option from the drop down.

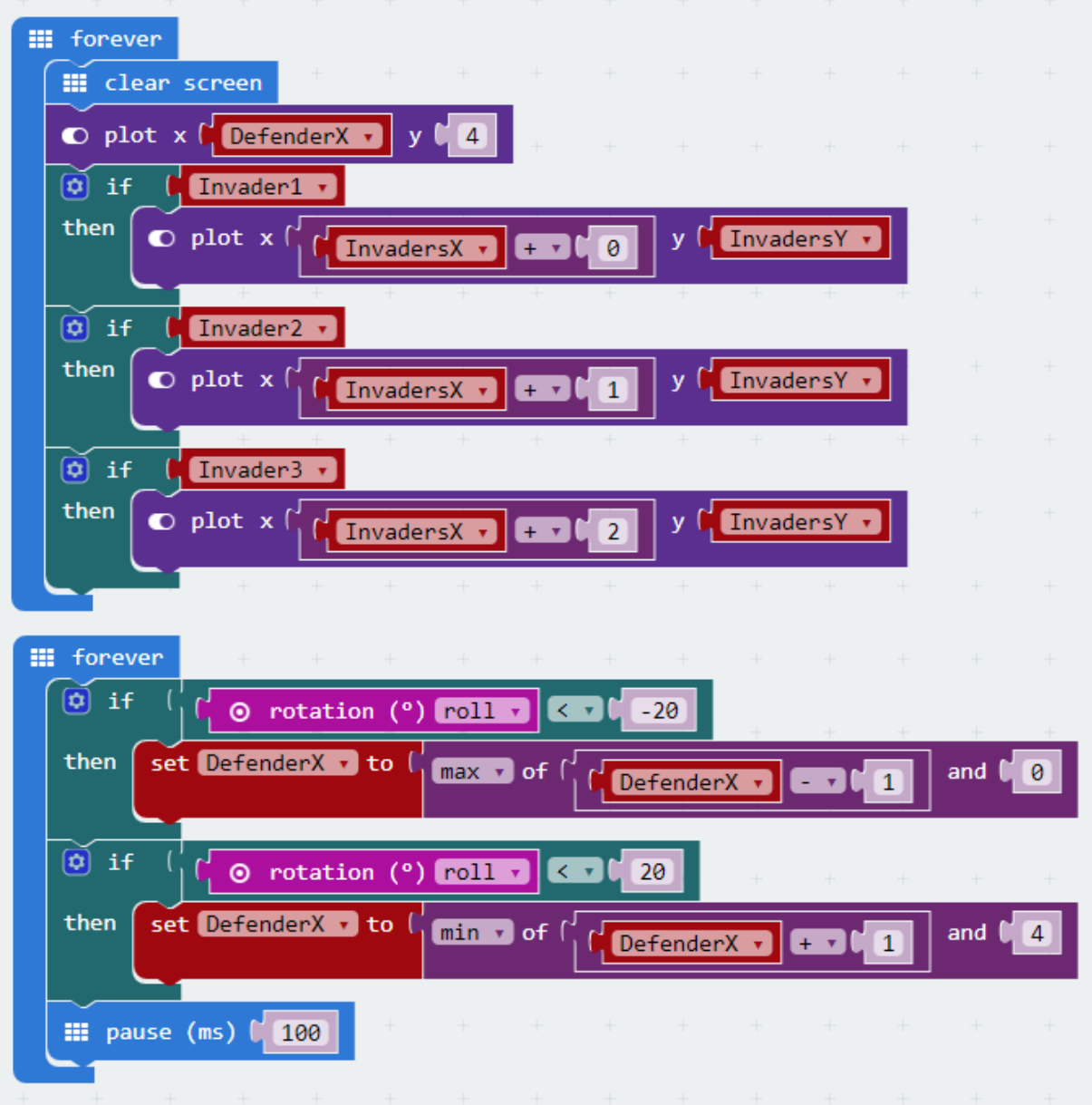


Creating a new variable using the drop-down arrow

Now we need to plot the invaders - i.e. to display them on the LEDs. We can do this by using the current location of the invaders and whether each invader is alive. If the invader is alive, we turn on the relevant LED. Otherwise, we leave the LED off.

Actions

2. Add blocks to your game's code (extending the section we made earlier for displaying the defender) so that it matches the screenshot below.



Code for displaying the invaders and the defender

Goals

Compile and save your game to your Micro:bit game to your Microbit. When the device powers on, you should now see the defender moving as before and the three invaders (staying still) in the top-left corner. (We'll make them move in the next section!)

8 Starting the game

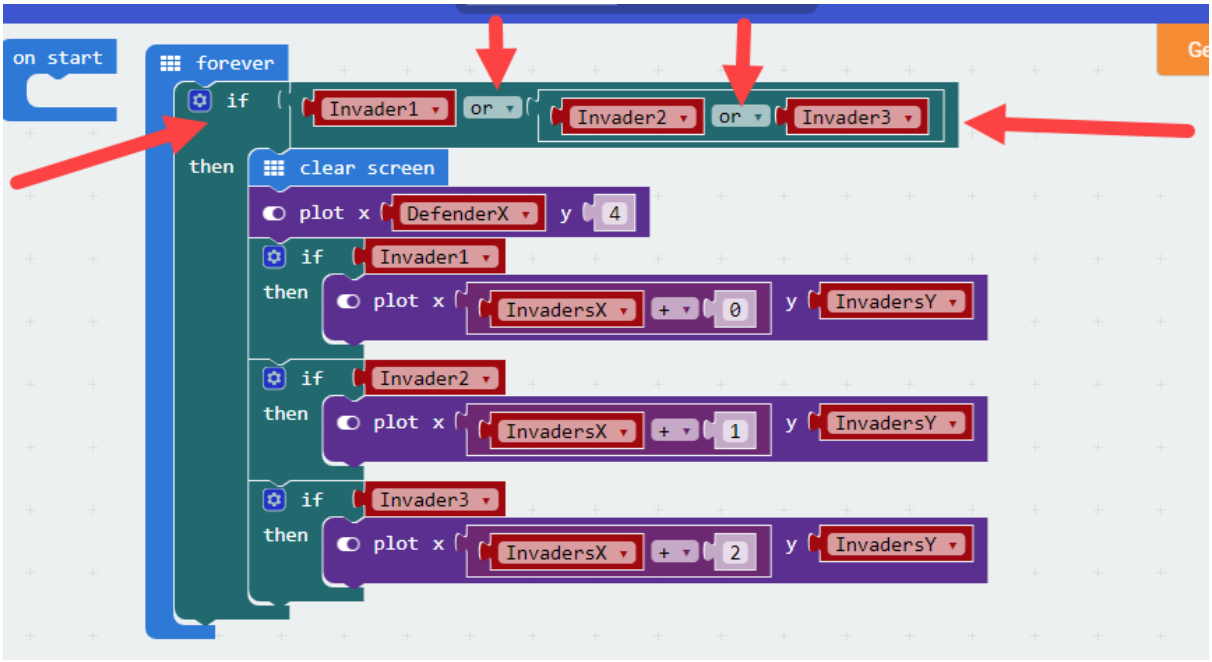
As soon as the Micro:bit switches on, the game begins. But, we want to be able to draw the letters "Go!" on the screen then start the game. And at the end of the game, we want to show the player their score.

To be able to do this, we need to make sure our invaders and the defender are only drawn while the game is being played, not before and after. But! The game can only be being played when at least one of our invaders is alive!

So we can make sure our invaders and defenders are only drawn when the game is being played, by putting an if-block around our "plot" code. The condition of the if block will be whether any of the invaders are alive.

Actions

1. Click and drag an "if" block from the "Logic" tab into the editing area
2. Click and drag the "clear screen" block (which should drag the blocks after it too) from the "forever" loop into the "if" block
3. Click and drag an "or" block from the "Logic" tab into the conditional part of the "if" block
4. Click and drag another "or" block into the inside of the "or" block you created in the previous step.
5. Click and drag "Invader1", "Invader2" and "Invader3" blocks from the "Variables" tab into the "or" blocks
6. Click and drag the "if" block (and all its contents) back into the "forever" loop



Only draw the player / invaders when playing the game

Goals

Compile and save your game to your Micro:bit. When the Micro:bit powers on, you should now see the defender at bottom of the device.

9 Controlling the game

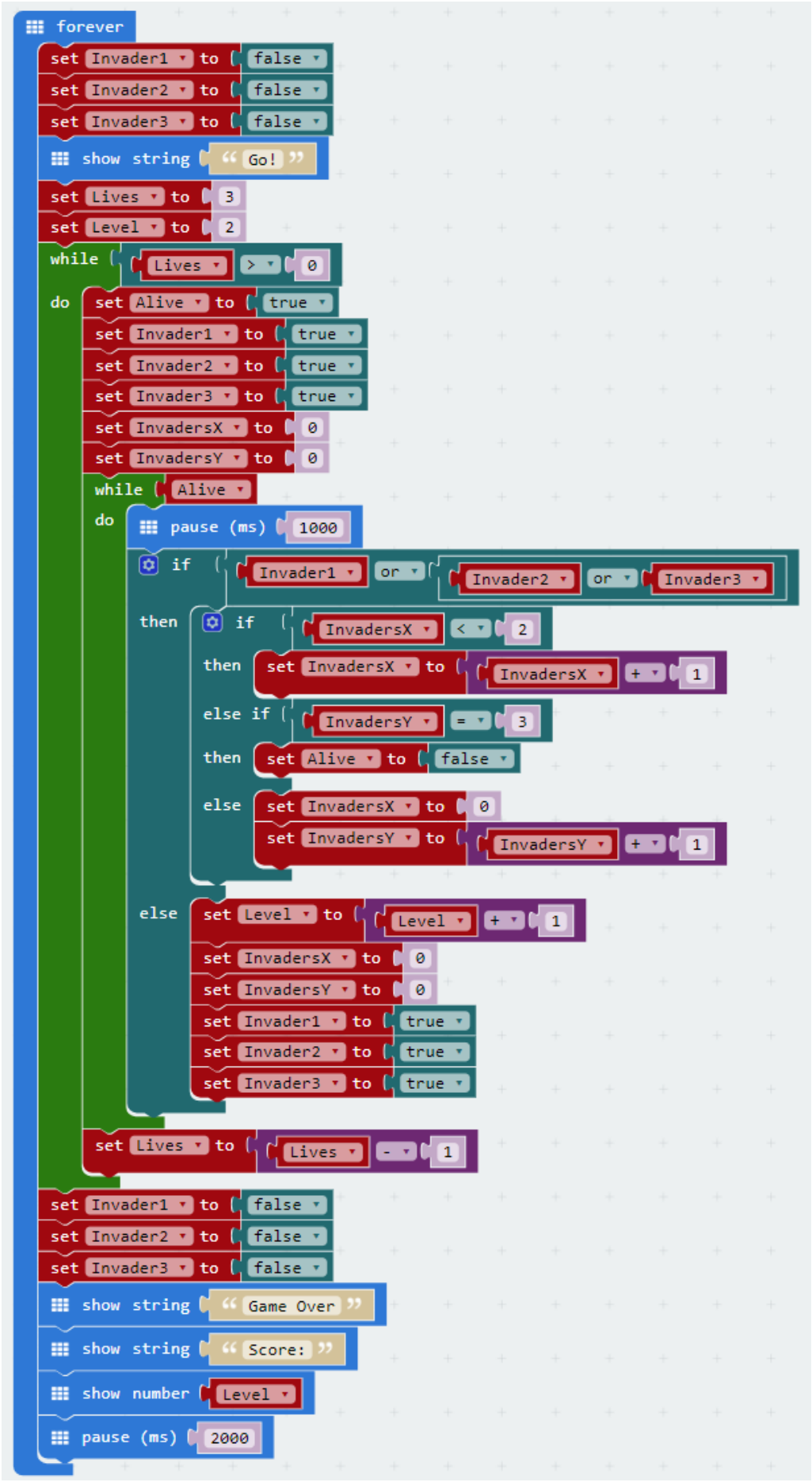
Our game is almost complete - we just need to add the final two sections of code. The first one is what we call the "Game Logic". The second is the section to enable the defender to shoot players.

The Game Logic is the main section of control code which determines how the game proceeds (as opposed to how its drawn or how the player moves). Game Logic also includes the number of lives a player has and what determines when a player dies.

Our game logic breaks down into two loops: An outer loop that allows the player to keep playing while they have lives left. And an inner loop: Which progresses through harder/faster levels until the player dies.

Actions

1. Add blocks to your game's code so that it matches the screenshot below.


forever
set Invader1 to false
set Invader2 to false
set Invader3 to false
show string "Go!"
set Lives to 3
set Level to 2
while Lives > 0
do set Alive to true
set Invader1 to true
set Invader2 to true
set Invader3 to true
set InvadersX to 0
set InvadersY to 0
while Alive
do pause (ms) 1000
if Invader1 or Invader2 or Invader3
then if InvadersX < 2
then set InvadersX to InvadersX + 1
else if InvadersY = 3
then set Alive to false
else set InvadersX to 0
set InvadersY to InvadersY + 1
else set Level to Level + 1
set InvadersX to 0
set InvadersY to 0
set Invader1 to true
set Invader2 to true
set Invader3 to true
set Lives to Lives - 1
set Invader1 to false
set Invader2 to false
set Invader3 to false
show string "Game Over"
show string "Score:"
show number Level
pause (ms) 2000

Questions

1. Can you work out what is going on in this code?
2. Before you run the code, from your understanding of the code, do you think the space invaders will move from left to right or from right to left?
3. Before you run the code, from your understanding of the code, how many lives will the player get?
4. Before you run the code, from your understanding of the code, will the speed of each level increase? If so, by how much each time?

Goals

Compile and save your game to your Micro:bit. You should see the invaders move around the display and the defender move at the bottom of the display.

Questions

5. Now you've tried running the code, which direction do the space invaders move?
6. How many lives did the player get?

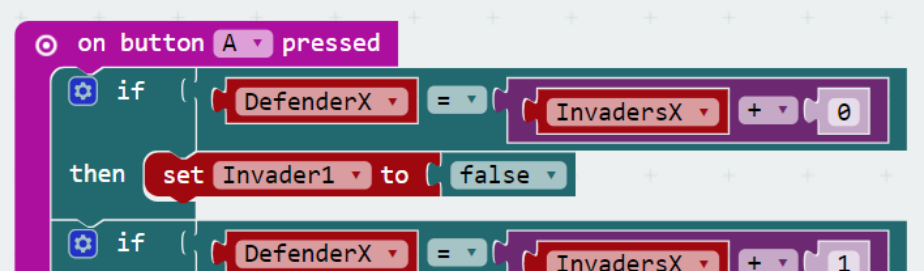
The speed of the current level is reset when the player dies, so you won't have seen the level-speed increase yet.

10 Shooting invaders

This is the last part to our code - shooting the invaders! We're going to program our game so that, after the game has started, when button A is pressed, the invader that is in the same column as the defender will be shot.

Actions

1. Click and drag an "on button A pressed" block from the "Input" tab onto the editing area.
2. See if you can work out what if-blocks and conditions you will need to add to the "on button A pressed" block, to determine which invader the defender is shooting at. Hint: A screenshot of a small part of the code is shown below.



See if you can work out the last section of code!

Notes

Hint: Think about the position of the defender (DefenderX) and the position of the invaders (InvadersX). You will want to compare them somehow!

Goals

Test your new code. Does it work? If not, keep trying - code, test, repeat - that's how real computer scientists and software engineers work.

Actions

3. Try to get a working version of shooting the invaders. If you're having problems, ask a workshop helper.

Goals

Congratulations! You've finished making the game!

Questions

7. Are there any improvements to the game you can think of? Have a go at programming them. Remember: code-test-repeat.