

N G

V

ESCHER X NENDO

BETWEEN TWO WORLDS

2 DEC 2018 – 7 APR 2019

DIGITAL CREATIVES: TESSELLATE BY CODE

WORKSHOP INSTRUCTIONS



DIGITAL CREATIVES: TESSELLATE BY CODE WORKSHOP INSTRUCTIONS

The NGV Digital Creatives Programs enable students to use digital technologies to explore, interpret, create and share works of art.

SUPPORTED BY



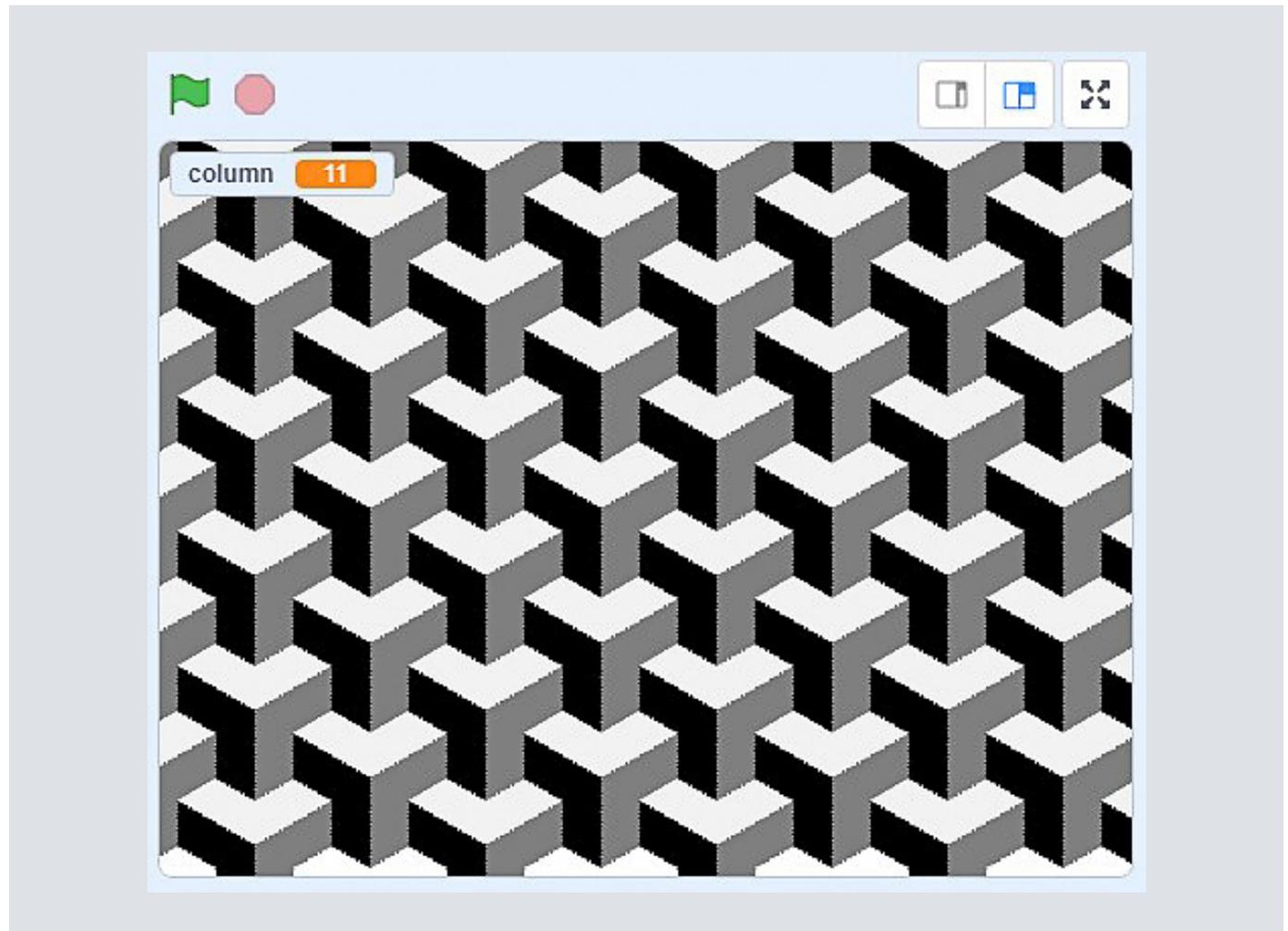
M. C. Escher
Regular division of the plane no. 123 (Fish)
April 1964 (detail)
pen and ink, pencil and watercolour
Escher Collection, Gemeentemuseum
Den Haag, The Hague, the Netherlands
© The M. C. Escher Company, the
Netherlands. All rights reserved

AIM

In this workshop, we will use computer code to generate a tessellation. We will use Scratch – a block-based visual programming language – to make a monochromatic rotation/translation tessellation that looks like stacks of neatly repeating cubes. The pattern is made up of one shape rotated around a fixed point that repeats across the surface. The final pattern will look like this:

OUTCOME

The finished project can be viewed [here](#).



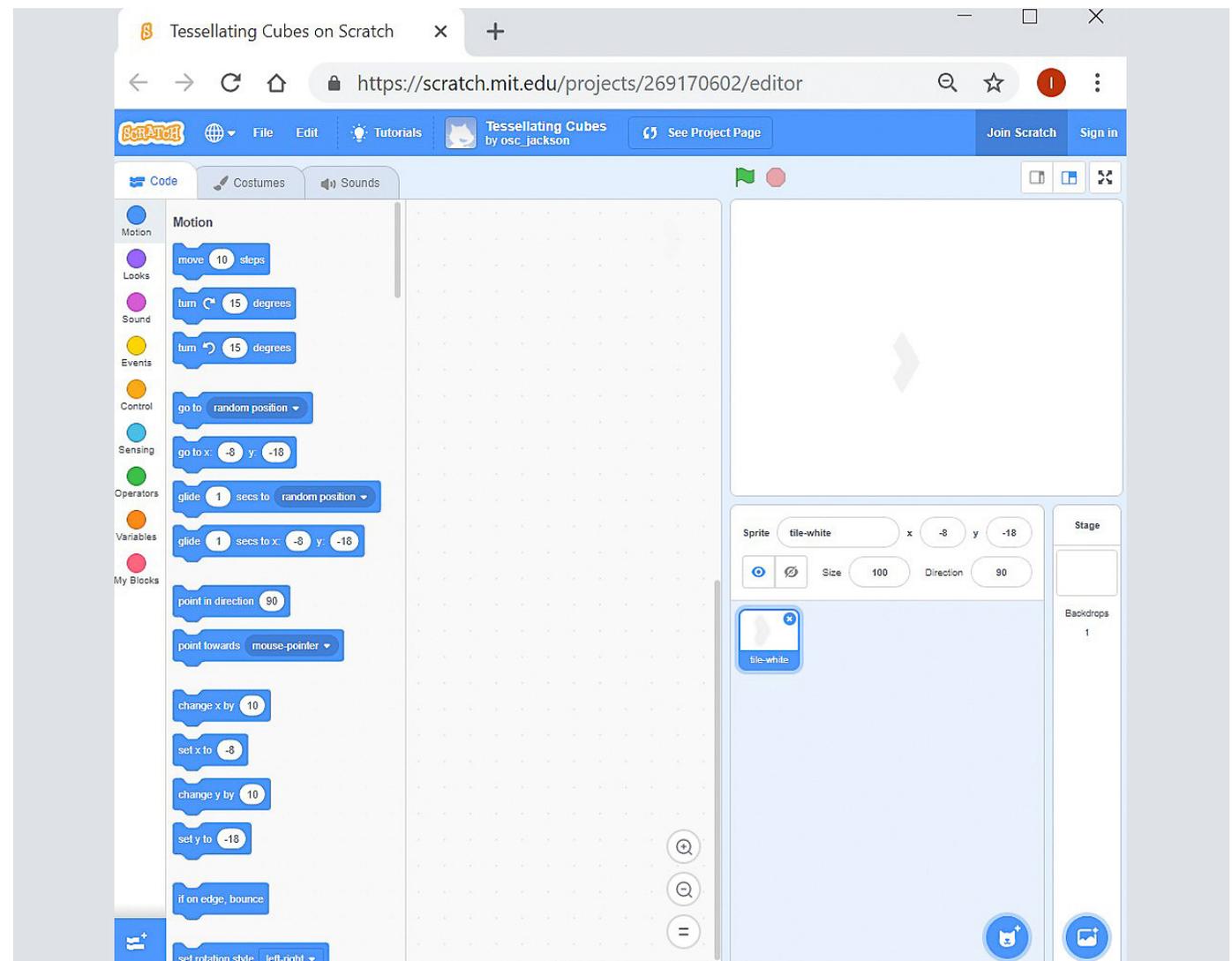
STEP BY STEP INSTRUCTIONS

STEP 1

Open the Tessellating cubes project in Scratch.
(<https://scratch.mit.edu/projects/269170602/#editor>)

You'll notice a single sprite that looks a bit like an arrow, called *tile-white*. If you click on the **Costumes** tab, you'll see the same sprite with two more costumes: *tile-grey* and *tile-black*.

Return to the Code tab. Click and drag the *tile-white* sprite onto the stage.



STEP BY STEP INSTRUCTIONS

STEP 2

We want the *tile-white* sprite to start in the middle of the stage and to point downwards.

To do this, you need to make a *script* (this tells your sprite what to do). Begin by dragging the **event** block, **when (flag) clicked**, to the script area. Then, in the **Motion** blocks, click and drag the **go to x_y_block** so that it attaches to the **event** block.

Change the numbers to x: 0 and y: 0. This will make your sprite move to the centre of the stage. Next, drag the **point in direction block** to the script area and change the number to 180 (90 is the default setting). From the **Looks** block category, add the **switch costume to tile-white** block to your script.

The screenshot shows the Scratch editor interface. The browser address bar displays <https://scratch.mit.edu/projects/269170602/editor>. The project title is "Tessellating Cubes on Scratch" by osc_jackson. The "Code" tab is active, showing a script for the "tile-white" sprite. The script consists of four blocks: "when green flag clicked", "go to x: 0 y: 0", "point in direction 180", and "switch costume to tile-white". The "Looks" block category is selected in the left sidebar. The "Sprite" panel on the right shows the "tile-white" costume selected, with the x and y coordinates set to 0 and the direction set to 180. The "Stage" panel shows the "tile-white" costume on the stage.

STEP BY STEP INSTRUCTIONS

STEP 3

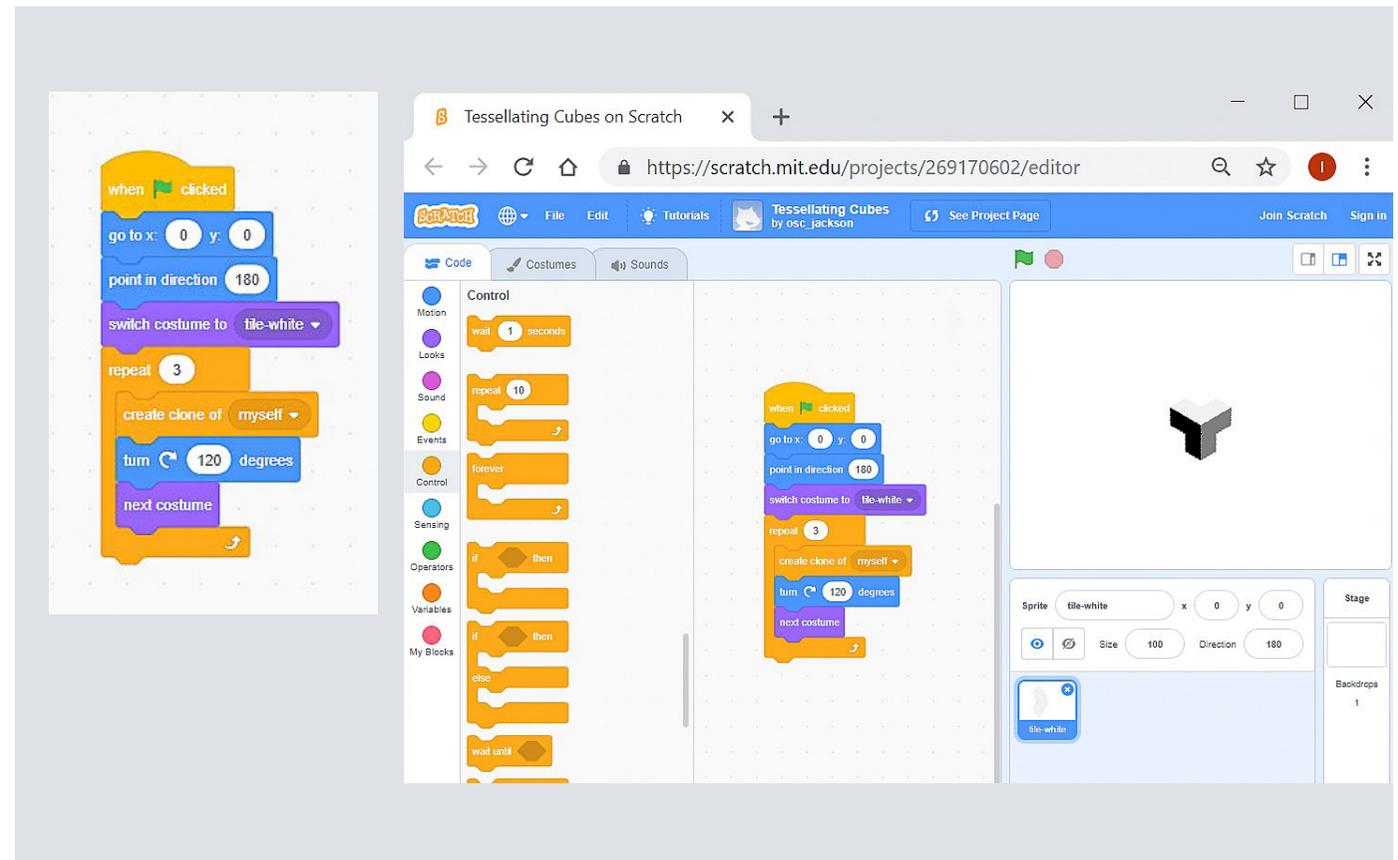
To repeat the shape we can make a clone. In the **Control** block category, click and drag **create clone of myself** to the script area and add this to your line of block codes.

Next, drag the **motion** block **turn (clockwise) _ degrees** and change the number to 120.

We want the clone to be a different colour, so click and drag the **next costume block** from the **Looks** category.

We want to repeat this set of instructions three times. In the **Control** block category, click and drag the **repeat** block to sit underneath the **switch costume to tile-white block**, as shown in the image below. Now change the number to 3 (to repeat 3 times).

We have created the shape for our tessellating pattern.



STEP BY STEP INSTRUCTIONS

STEP 4

We now want to make the shape repeat in a column by changing the vertical axis, which is the y axis.

Let's start by moving our shape to the top of the stage. Change the initial y coordinate to y: 200 in the **go to x:0 y:0 block** (this should be the second code block in your script). Next, click and

drag the **motion** block, **change y by** to the end of your script. Set the number to -66.

Wrap another repeat block around the **repeat 3** and **change y** blocks, as shown. Change the repeat number to 6.

Click the green flag to see your shape repeat 6 times!

The screenshot displays the Scratch editor interface. The browser address bar shows the URL <https://scratch.mit.edu/projects/269170602/editor>. The project title is "Tessellating Cubes on Scratch" by osc_jackson. The code editor shows the following script:

```
when green flag clicked
  go to x: 0 y: 200
  point in direction 180
  switch costume to file-white
  repeat (6)
    repeat (3)
      create clone of myself
      turn 120 degrees
      next costume
    change y by -66
```

The stage area shows a vertical column of six white cubes, each rotated 120 degrees, creating a tessellating pattern. The sprite area shows the selected costume is "file-white" with a size of 100 and a direction of 180 degrees.

STEP BY STEP INSTRUCTIONS

STEP 5

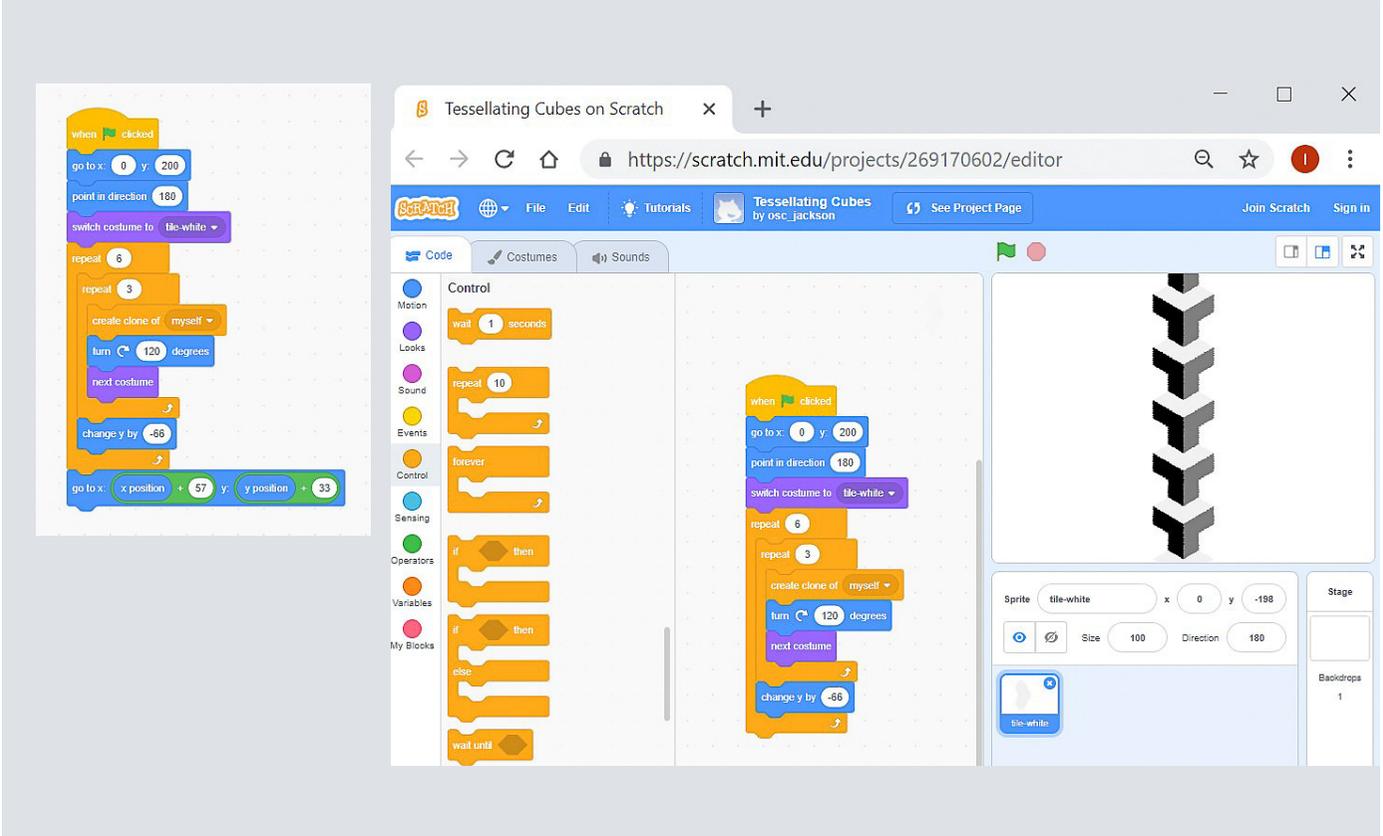
Operator

Now we are going to make the next column, but this time we are starting from the bottom and going up. First we will reset the starting point using an **operator** block (Operator blocks script maths operations).

Begin by adding the **motion** block: **go to x: y:**. In the **operator** block category, drag this block  to sit inside both the x and y brackets. Next, add the **motion** blocks **x position** and **y position**. Modify the equations to read (x position + 57) and (y position + 33)

Your script should look like this:

To make your shape repeat vertically (going up), copy the series of blocks created in Step 4 and add them to your script. This time, **change y by 66**. Your shape should tessellate up and down in 2 columns, like so:



The screenshot shows the Scratch editor interface. The code area contains the following script:

```
when clicked clicked  
go to x: 0 y: 200  
point in direction 180  
switch costume to tile-white  
repeat 6  
  repeat 3  
    create clone of myself  
    turn 120 degrees  
    next costume  
  change y by -66  
  go to x: x position + 57 y: y position + 33
```

The stage area shows a vertical column of tessellating cubes, with the top cube being a white tile and the others being grey.

STEP BY STEP INSTRUCTIONS

STEP 6

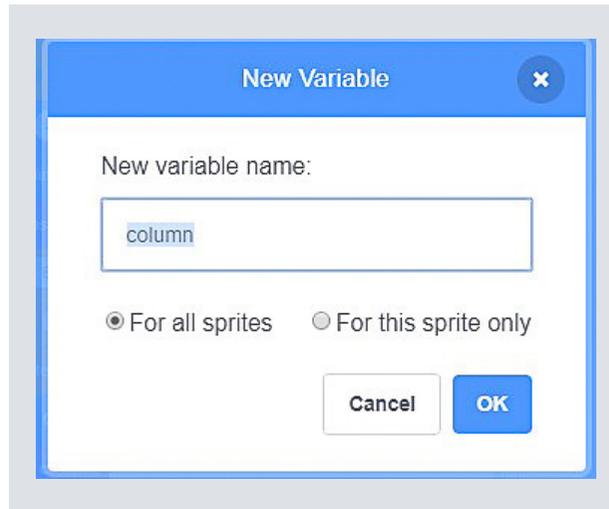
Variables

We want to fill our stage with this tessellating pattern, so now let's reset our starting point to the edge of the stage, like so:

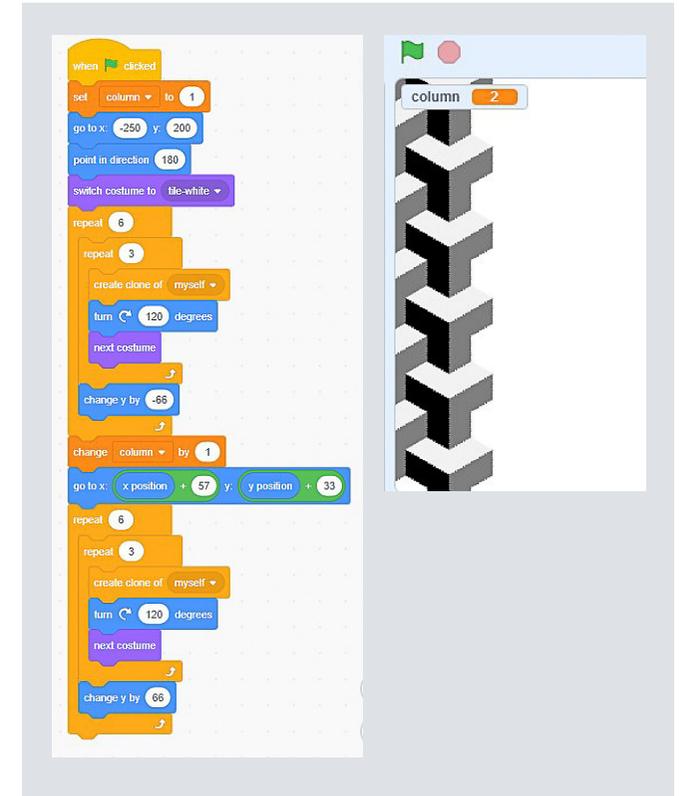


To continue the pattern, you could repeat the same steps, but there would be a lot of blocks of code.

Instead, we can make the program recognise odd and even numbered columns and change the action based on that. Go to the **Variables** category of blocks. Click **Make a Variable** and give this any name. Be sure to click the option: **For all sprites**.



You will be using the **Set columns to 0** and **Change columns by 0** blocks from the **Variables** category. Set the number to 1 for each block. Click and drag each block to your script, as shown:



STEP BY STEP INSTRUCTIONS

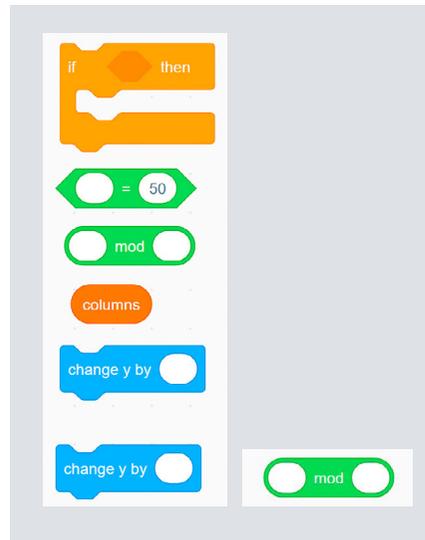
STEP 7

We want odd numbered columns to form downwards, and the even ones, upwards.

We can use an **if/else Control** block to differentiate between odd and even columns. If our column variable is odd, the y value is minus (-) and if it's even, y is positive (+).

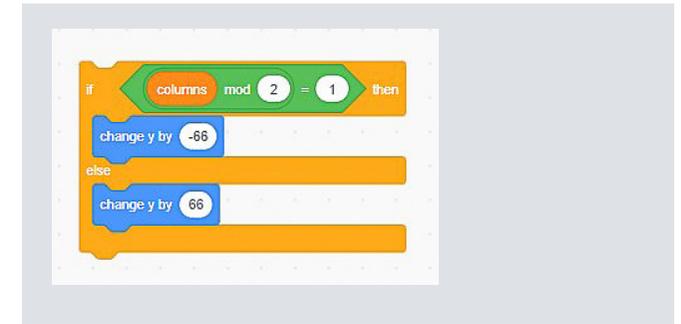
You will need to create a series of blocks to tell the program: 'if the column is an odd number, place the next clones down by 66 each repetition, otherwise, place them up by 66'.

To achieve this, you will need to use these blocks:



(mod means modulo, which is a way to find every second column (1, 3, 5 etc.))

Arrange the blocks and add the numbers, as shown:



HANDY TIP

It may help to find these blocks and place them in your script area separately.

STEP BY STEP INSTRUCTIONS

NOW USE WHAT YOU HAVE LEARNT
TO MAKE YOUR OWN TESSELLATION!

STEP 8

Now, we are going to replace some of the code blocks used earlier. This will simplify the code and make your tessellation come to life!

Remove and delete the blocks as shown below.

Add your **if/else** series of block codes, from step 8, and the **repeat 10** block, like so:

The image displays two versions of a Scratch script for creating a tessellation. The left version shows a script starting with 'when clicked', setting 'Columns' to 0, going to x: -250, y: 200, pointing in direction 180, and switching costume to 'tile-white'. It then enters a 'repeat 6' loop containing a 'repeat 3' loop with 'create clone of myself', 'turn 120 degrees', and 'next costume' blocks, followed by a 'change y by -66' block. A red arrow indicates this block is being moved. The right version shows the modified script where the 'repeat 3' loop is replaced by an 'if/else' block: 'if column mod 2 = 1 then change y by -66 else change y by 66'. A 'repeat 10' block is added around the 'if/else' block. The script ends with 'change column by 1' and 'go to x: x position + 57, y: y position + 33'. A small window on the right shows the resulting 3D tessellation pattern.

Test your code to see if it works.